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NOTICE

This dictionary is intended to assist U. S. military personnel and research agencies in interrogating German scientific personnel and in translating German scientific documents. Most of the terms defined are not included in any standard German or German-English dictionary.

Translations of the German terms are based upon information collected over a period of approximately 10 months by Military Intelligence Service interrogators. Definitions of the terms have been taken from Weld's "Glossary of Physics" and other standard English scientific works, except in the case of new terms for which no published definition was available. While every effort has been made to confirm the accuracy of the definitions, inaccuracies may be found. It is requested that these be brought to the attention of the Chief, CPM Branch, Military Intelligence Service, War Department, Washington 25, D. C.

Abampere: *abampere.* The c.g.s. electromagnetic unit of current, viz., that current which, in a one-turn circular conductor of 1 cm radius in a vacuum, produces a magnetic intensity of 2π oersteds at the center of the circuit. Equal to 10 absolute amp.

Abbau: *degradation.* (1) (Of energy) Any process whereby available energy becomes unavailable, as by conversion into heat. If the unavailable energy is allowed to escape, the term dissipation is more apt to be used. (2) (Of radiation) The transformation of radiation of given type into a form having lower frequency and lower quantum energy, as in the Compton effect.

Abbe'sches Prisma: *Abbe prisms.* One of several prism combinations devised by Abbe for various purposes, e.g., those used in the prism binocular and in the Abbe refractometer.

Abcoulomb: *abcoulomb.* The c.g.s. electromagnetic unit of electric charge or quantity, defined as that quantity of electricity which is carried past any point of a circuit in one second when the current is one abamp. Equal to 10 absolute coulombs.

Aberration: *aberration.* An error, or deviation from ideal. (1) (astron.) Aberration of light is an apparent angular displacement of a star due to the earth's orbital motion. Its maximum value, the aberration angle or aberration constant, is about 20.5 seconds. (2) (Geom., Opt.) Lack of point-to-point correspondence between an object and its image. Spherical aberration includes various faults of an optical image with monochromatic light, such as lack of sharpness, coma, astigmatism, curvature, lack of flatness, and distortion. (3) (Chromatic) The effect of dispersion upon the distinctness of optical images.

Abfarad: *abfarad.* The c.g.s. electromagnetic unit of capacitance, corresponding to one abcoulomb per abvolt. Equal to 10^9f.

Abflachung der Kugel: *oblateness.* In re a spheroid, like the earth: the fraction (E–P)/E, in which E and P are respectively the equatorial and the polar diameters. Value for the earth, about 1/297.

abgestimmte Spule: *loading coil.* A coil of adjusted inductance, introduced into certain complicated circuits to impart desired characteristics.

Abhenry: *abhenry.* The c.g.s. electromagnetic unit of inductance (or mutual inductance), viz., that of a circuit in which the variation of current at the rate of 1 abamp-sec induces an e.m.f. of 1 abvolt. Equal to 10^{-9} henry. Because its c.g.s. dimensional value is 1 cm, it has been called the cm of inductance.

Ablenkungsoszillator: *sweep oscillator.* An oscillator used to deflect periodically the beam of a cathode-ray oscillograph or television tube so as to give a displacement which is a function of the time. The voltage applied to the deflecting plates is the sweep voltage, and the amplitude of the displacement of the spot is the sweep amplitude.

Abloesungsenergie: *extraction energy.* The energy corresponding to an ionizing potential.

Abnahme: *degradation.* See Abbau.

Abohm: *abohm.* The c.g.s. electromagnetic unit of resistance; defined as the resistance of a conductor which, when a constant current of one abamp flows through it, maintains a p.d. of 1 abvolt between its terminals. Equal to 10^{-9} absolute ohm.

Abschirmung: *screening.* (1) The effect of the inner orbital electrons of an atom upon the attraction of the nucleus for the outer electrons. (2) The effect of the outer layers of atoms in a crystal upon radiation or upon fields of force reaching the inner layers. (3) The effect of a conducting shell upon an electric field, or of an iron shell on a magnetic field.

Abschirmungskonstante: *screening constant.* A coefficient, such that if the electronic charge be multiplied by it, the product represents the apparent amount of reduction in the charge of the nucleus of an atom (as indicated), due to the screening effect of an inner electron group. With respect to corresponding X-ray spectrum lines, this coefficient is nearly the same for all elements of high atomic number.

Abschirmungszahl: *screening number.* See Abschirmungskonstante.

Abschlemmen: *levigation.* The sorting of different-sized particles by virtue of the varying rate of fall of fluid.

Abschweifung: *straggling.* The statistical variation in the range of different alpha particles, all of the same initial speed, in the same gas. The (Gaussian) distribution corresponding to this variation is represented by the straggling curve, similar to the normal error curve.

absolute Einheiten: *absolute units.* (1) A system of units defined in terms of phenomena of supposedly universal occurrence, rather than in terms of the properties of special substances or systems. E.g., Planck's system of absolute units, in which the units of mass, length, time, and temperature are so chosen that the gravitational constant, the velocity of light, the Planck constant, and the ideal gas constant all have the numerical value

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unity. (2) Dynamic units defined without reference to gravity, e.g., the dyne and the erg.

absolute Temperatur: *absolute temperature.* Temperature as reckoned from a zero corresponding to the entire absence of translational molecular motion, on either the hydrogen constant volume or the Kelvin scale. Absolute zero is approximately —273.2 degrees Centigrade or —459.8 degrees Fahrenheit.

Absorption: *absorption.* (1) A process in which a fluid, liquid or gaseous, passes into the interstices of a porous substance and is held there by absorption or capillarity. (2) The transformation, into other forms, of the energy of any emission as it passes through a material substance. (3) (Dielectric) The persistence of a measurable electric polarization exhibited by many dielectrics after the electric intensity responsible for the polarization has been reduced to zero.

Absorptionsfaktor: *absorption factor.* (1) One minus the attenuation factor. (2) The ratio of the energy flux in a diffracted X-ray beam in the powder method to that which it would have without absorption by the powdered material.

Absorptionsgrenze: *absorption limit.* The wave length or frequency corresponding to an abrupt discontinuity in the intensity of an X-ray absorption spectrum, which gives the appearance of a sharp "edge" in the photograph of such a spectrum.

achromatisch: *achromatic.* (1) In re an optical system: having the same focal length for two distinct wave lengths, and hence approximately free from chromatic aberration in this range. (2) In re a color: devoid of hue. Such a color is often called a gray.

Absorptionshygrometer: *absorption hygrometer.* One of several types of hygrometer dependent upon the elongation or shrinkage of a hair or similar organic structure with changes of humidity.

Absorptionsindex: *absorption index.* The value of the ratio $\mu\lambda/4\pi$ n for any medium traversed by radiation of wave length λ for which the refractive index is n and the absorption coefficient is μ.

Absorptionskante: *absorption edge.* See Absorptionsgrenze.

Absorptionskoeffizient: *absorption coefficient.* The fractional rate at which the flux density of an emission diminishes by absorption, in respect to the thickness of medium traversed; expressed by the equation

$$\mu = \frac{-\frac{dI}{dx}}{I}$$

where I = flux density, x = thickness. The mass absorption coefficient is similarly defined, except that the mass per unit area of medium replaces the thickness x. For a substance of density d, this coefficient is therefore equal to μ/d.

Absorptionsspektrum: *absorption spectrum.* The spectrum of radiation which has passed through some selectively absorbing substance, e.g., of white light after passage through a vapor or a solution.

Absorptionsvermoegen: *absorptivity.* The fraction of the radiant energy of a given character, normally incident upon the surface of a body, which is absorbed by the substance of that body. For an ideal black body, its value would always be unity.

Absorptivitaet: *absorptivity.* See Absorptionsvermoegen.

Abstimmkondensator: *tuning condenser.* A condenser of variable capacitance, used to adjust the natural frequency of an oscillatory circuit.

Abstimmspule: *tuning coil.* A coil of variable inductance, used to adjust the natural frequency of an oscillatory circuit.

Abvolt: *abvolt.* The c.g.s. electromagnetic unit of electromotive force or potential; defined as that p.d. through which 1 erg of work is required to transfer 1 abcoulomb of electricity. Equal to 10^{-8} absolute volt.

Abwatt: *abwatt.* A unit of power, corresponding to one abamp through a potential difference of one abvolt and equal to 10^{-7} watt.

Achsengesetz: *law of axes.* States that the opposite ends of any one of the axes of a crystal are cut by the same number of similar faces similarly arranged.

Achsenverhaeltnis: *axial ratio.* The ratio between the length of the arbitrary unit of measure along one axis of a crystal to that used along some other axis.

achtfach Untersetzer: *scale of eight.* A vacuum tube circuit for counting pulses, in groups of eight, from ion or photon counters.

Adhaesion: *adhesion.* An interaction between the surfaces of two closely adjacent bodies, which causes them to cling together, as paint or a lead-pencil mark adheres to a wall or to paper.

adiabatisch: *adiabatic.* (1) A term used to characterize any process which takes place without transfer of heat to or from the body concerned. (2) Taking place under conditions prescribed in the statement of the (quantum) adiabatic•hypothesis. (3) (n.) The graph representing an adiabatic process.

adiabatische Gleichung: *adiabatic equation.* A characteristic equation relating the quantities which define the state of a body during an adiabatic change.

adiabatische Hypothese: *adiabatic hypothesis.* A hypothesis of the quantum theory, set forth by Ehrenfest, to the effect that, if the motion of a mechanical system is initially adjusted in accordance with the appropriate quantum condition and if the motion is very gradually changed, it continues to operate under the same quantum condition with the same set of quantum numbers.

Adsorption: *adsorption.* A term applied to the phenomena connected with the adherence of molecules of a foreign substance to the surface of a solid or a liquid.

Adsorptionswaerme: *heat of adsorption.* Heat resulting from the transportation of energy which takes place during adsorption; expressed quantitatively in calories per gram or per mol, or, in the case of gases, sometimes in calories per cm^3.

Aehnlichkeit: *similitude.* (1) A principle, set forth by R. C. Tolman, which he states as follows: "The fundamental entities out of which the physical universe is constructed are of such a nature that from them a miniature universe could be constructed exactly similar in every respect to the present universe." (2) A term used in connection with physical quantities having the same dimensional structure; e.g., in the expression $\sqrt{R^2 + 4\pi^2 n^2 L^2}$ for the impedance of an inductive circuit, the two terms under the radical have dimensional similitude.

aeolotropisch: *aeolotropic, eolotropic.* Not isotropic; having different properties in different directions, as a crystal.

aequatorielle Quantenzahl: *equatorial quantum number.* Syn. magnetic quantum number.

aequipotential: *equipotential.* Having the same value of the potential throughout. E.g., a conductor in electrical equilibrium is electrically equipotential.

aequivalente Absorption: *equivalent absorption.* In re any sound-absorbing object: the area of a surface of unit acoustic absorptivity which would absorb sound energy at the same rate as the given object under the same conditions.

aequivalente Absorptionskraft: *equivalent absorbing power.* The thickness of any given absorbing material which will reduce the intensity of an emission in the same ratio as unit thickness of a standard substance (e.g., air) under specified conditions. Not to be confused with equivalent absorption.

aequivalente Bahnen: *equivalent paths.* The optical path requiring the same time when traversed by light of the same frequency.

aequivalente Elektronen: *equivalent electrons.* (1) (In atoms.) Electrons which have equal azimuthal quantum numbers and equal principal quantum numbers. (2) (In molecules.) Electrons which are identical in all orbital properties, except for a possible difference in sign of the orbital moment.

Aequivalentgewicht: *equivalent weight.* That weight or mass of an acid, base, or salt which equals one mol divided by the total number of valence bonds connecting the positive and the negative ions of the molecule. E.g., for HCl the division is one; for Ca. $(OH)_2$ it is two; for $Fe_2 (SO_4)_3$ it is six; etc.

Aequivalentleitvermoegen: *equivalent conductance.* The ratio of the electric conductivity of an electrolytic solution to the concentration in moles per $centimeter^3$.

Aequivalenzprinzip: *equivalence principle.* (1) A principle of the general relativity theory which points out that phenomena ascribed to the existence of a gravitational field may with equal validity be attributed to the effect of acceleration; illustrated by the sensations which one experiences in an elevator. (2) Equivalence principle of Pauli is an obsolescent synonym for exclusion principle.

Aerodynamik: *aerodynamics.* That branch of dynamics which treats of the forces exerted by air or other gases upon bodies exposed to them.

aeussere Arbeit: *external work.* Work done by a system against external forces, or upon the system by external forces, e.g., work done in compressing a gas, or by a gas during expansion against a piston.

aeusserer Widerstand: *external resistance.* The resistance of that part of a circuit in which no e.m.f. is operative, e.g., the line connected between the terminals of a battery or other generator.

Aether: *ether, aether.* A hypothetical medium, which has been supposed to pervade all space and all matter and assumed as the vehicle of propagation of light and other forms of radiation.

Aetherverschiebung: *ether drift.* A hypothetical rela-

tive motion of material bodies with respect to the ether; much sought for but never detected with certainty.

Aggregat: *aggregation.* The collection of molecules composing any portion of matter. State of aggregation denotes the condition of the body as dependent upon the relative positions and the motions of the molecules, e.g., liquid, gaseous, etc.

Aggregatzustand: *aggregation.* See Aggregat.

agonische Linie: *agonic line.* The line on the earth's surface, at all points of which the magnetic declination is zero.

Airy'sches Experiment: *Airy experiment.* A celebrated observation by Airy (1871) to the effect that the aberration of light is independent of the medium filling the telescope with which the observation is made.

Akkommodationskoeffizient: *accommodation coefficient.* The degree to which reflected or re-evaporated molecules, on the average, "accommodate" their energy to that of the surface which they strike; measured by the ratio of the observed heat loss from a surface to the theoretical heat loss which would take place if all the gas molecules came to thermal equilibrium with the surface.

Akkumulationskoeffizient: *accumulation coefficient.* The ratio of the rate at which adsorbed molecules accumulate on a surface to the rate at which they strike.

Akkumulationszeit: *accumulation time.* In the theory of radiation, the time supposedly required for the accumulation of a quantum of radiant energy, before it can be released.

akkumulative Messmethode: *cumulative method.* A method of measurement in which a multiple of the unknown quantity is measured and the result divided by the multiplier; as in finding the period of a pendulum by timing a hundred successive swings.

Akkumulator: *accumulator.* Syn. storage cell, secondary cell.

Aktinium Reihe: *actinium series.* One of the principal radioactive series, beginning with actinium.

Aktinometer: *actinometer.* (1) An instrument for measuring the actinic value of a given light or other radiation. (2) An instrument for measuring the flux density of solar radiation.

aktiv: *actinic.* In re radiation: capable of producing chemical change, as in the photographic action of light.

Aktivitaet: *activity.* (1) A measure of the intensity of the emission from a radioactive substance, in terms of observable effects. (2) An excited state in a gas, due to ionization. (3) Syn. power (Obs.).4. (Opt.) The property of producing optical rotation. (5) (Chem.) The concentration of free ions of a given type, e.g., hydrogen.

akustische Impedanz: *acoustic impedance.* A complex quantity used in re the propagation of sound across any surface. It is a combination of a real term, the acoustic resistance, corresponding to internal friction and responsible for the dissipation of energy, and an imaginary component, the acoustic reactance, depending upon the inertia and the elasticity of the medium; both are expressed in acoustic ohms.

akustische Inertanz: *acoustic inertance.* A quantity which, in the propagation of sound, enters into the acoustic reactance in a manner analogous to that in which inductance enters into electrical reactance. It is equal to the mass of the body of medium divided by the square of the cross section of the conduit in which it is contained.

akustischer Strahlungsmesser: *acoustic radiometer.* An apparatus for measuring acoustic flux density.

akustischer Widerstand: *acoustic reactance, acoustic resistance.* Corresponding to internal friction and responsible for the dissipation of energy.

akustisches Absorptionsvermoegen: *acoustic absorptivity.* The ratio of the sound energy absorbed by a surface to that incident upon it.

akustisches Ohm: *acoustic ohm.* A unit of acoustic resistance, reactance, or impedance, corresponding to 1 bar of sound pressure per cm^3 per second of volume velocity.

akustisches Reflektionsvermoegen: *acoustic reflectivity.* The ratio of the flux density of the sound reflected from a surface to that incident upon it.

Albedo: *albedo.* The reflection factor of a diffusely reflecting surface; esp. of a celestial object, as a planet.

allgemeine Strahlung: *general radiation.* Continuous radiation such as white light or the background of an X-ray spectrum.

allgemeine Struktur: *gross structure* (1) The array of bands in a band spectrum, each represented by its head or by its zero line, without attention to the individual lines of which the bands are composed. (2) The general multiplet structure of an atomic spectrum.

allochromatisch: *allochromatic.* A term used to characterize crystals which have photoconductivity on account of dispersed microscopic or sub-microscopic particles occurring naturally or as a result of exposure to certain radiations.

Allotropie: *allotropy, allotropism.* The property, possessed by many substances, of existing in different modifications, called allotropic forms, e.g., carbon, which represents itself as diamond, as graphite, or in the amorphous form of soot.

Alpha, Beta, Gamma, . . . Linien: *alpha, beta, gamma, . . . lines.* The lines of a spectral series, arranged in the order of increasing frequency. E.g., the $L\beta$ line is the second line of the L series of an element. If the line is a doublet, the components are designated $L\beta_1$, $L\beta_2$; etc.

Alpha, Beta, Gamma . . . Zustand: *alpha, beta gamma . . . form or state.* Terms used to distinguish the different isomers of the same composition or different allotropic modifications of an element. E.g., these states of iron depend upon its temperature, and only the alpha iron is highly magnetic.

Alpha-strahlen: *alpha rays.* A corpuscular emission from certain types of radioactive atom, each particle emitted consisting of a completely ionized helium atom, i.e., of a helium nucleus.

Alpha-strahlen Spektrum: *alpha-ray spectrum.* A separation of alpha particles of different speeds, usually by the magnetic field alone, but in some cases by both magnetic and electric fields.

Alternationsgesetz: *alternation law.* The first of the Kossel-Sommerfeld (spectroscopic) laws.

ambipolar: *ambipolar.* Operating in both of two opposite directions at once, e.g., the current in an electrolytic cell, in which there are ions moving in both directions.

Amici'sches Prisma: *Amici prism.* A combination of three triangular prisms, viz., an isosceles flint-glass prism included between two equal crown-glass prisms, the refracting angles being such as to produce dispersion without deviation. Used in direct-vision spectroscopes, etc.

amorph: *amorphous.* Devoid of regular structure, esp. of crystalline structure.

Ampere: *ampere.* The practical unit of electric current. The absolute ampere is 1/10 of the abampere. The international ampere is the value of a steady current which would deposit 0.00111800 grams of silver per second from a solution of silver nitrate. The ratio of the international to the absolute ampere is about 0.99993.

Amperemeter: *ammeter.* An instrument for measurnig electric currents in amperes.

Ampere'sche Regel: *Ampère law.* The laws appears in two equivalent forms: 1. The magnetic intensity due to a current i (abamperes) in an element of length dl, at any point P distant r from it, is

$$dH = ipdl/r^3 = i \sin\theta dl/r^2,$$

in which p is the normal from the point P to the line of the element dl, and θ is the angle between dl and the line r joining it to P. 2. The line integral of the magnetic intensity over any closed path in a magnetic field is equal to 4π times the total electric current i, in abamperes, linked with the path; so that if a unit magnetic pole is carried around the path, the work done is $4\pi i$ (ergs).

Ampere'scher Strom: *Ampèrian current, A. whirl.* An electric current in a resistanceless circuit in an atom or a molecule, accounting for its magnetic moment.

Ampere'scher Wirbelstrom: *Ampèrian whirl.* See Ampere'scher Strom.

Ampere'sches Gesetz: *Ampere law.* See Ampere'sche Regel.

Amperestunde: *Ampère-hour.* The quantity of electricity which flows past any point of a conductor carrying a current of one amp, in 1 hour; equal therefore to 3600 coulombs.

Amperewindung: *ampere-turn.* A unit of magnetomotive force corresponding to the effect of a current of one amp traversing one turn or winding.

Amplitude: *amplitude.* One-half the complete range of any symmetrical vibration or periodic variation; e.g., a pendulum swinging through an angle of 10 degrees has an amplitude of 5 degrees. In an asymmetric vibration, the amplitude usually expresses the maximum displacement from the normal or neutral state during the cycle.

Analysator: *analyzer.* An apparatus, e.g., a Nicol prism, for detecting and testing the properties of polarized light.

Analyse von positiven Strahlen: *positive-ray analysis.* The separation and measurement of the masses of atoms by subjecting their positive ions to deflection by electric or magnetic fields.

anastigmatisch: *anastigmatic.* Free from astigmatism for narrow, oblique pencils.

Anemograph: *anemograph.* A recording anemometer. The record is called an anemogram.

Anemometer: *anemometer.* An instrument for measuring the velocity of the wind.

aneroid: *aneroid.* Free from liquid or fluid parts, as an aneroid barometer, calorimeter, etc.

Aneroidbarometer besonderer Art: *statoscope.* A very sensitive aneroid altimeter.

angenaeherter Knotenpunkt: *partial node.* A region in a stationary wave system similar to a node, but at which the amplitude is a minimum without being reduced to zero.

Angstroem: *angstrom.* A unit of length, equal to 10^{-8} cm, used in expressing wave lengths of light, etc.

Angstroemskoefficient: *Angstroem coefficient.* The coefficient A in Angstroem's formula for the scattering coefficient for dust in the atmosphere, viz., $S = A\lambda^{-B}$ in which λ is the wave length and B ranges from 0 to 4 for different sized particles.

anhysteretisch: *anhysteretic.* Taking place without hysteresis; applied to magnetization under certain conditions.

Anion: *anion.* One of the negative ions moving toward the anode in an electrolytic cell or a discharge tube.

Anode: *anode.* That electrode from which positive ions are dispersed or toward which negative ions are collected, within an electrolytic cell, discharge tube, or similar apparatus.

plate. The positive electrode of a thermionic vacuum tube.

Anodenfall: *anode drop.* An abrupt fall of electric potential at the anode of an electrolytic cell or vacuum tube.

Anodenfluessigkeit: *anolyte.* The solution surrounding the anode in an electrolytic cell.

Anodenstrahlen: *anode rays.* Positively charged particles in a vacuum tube, which have their origin in the anode. They are of atomic dimensions, being derived, apparently, from metallic salts on the anode.

Anodenstrom: *plate current.* A current flowing to or from the anode or "plate" of a vacuum tube.

Anolyt: *anolyte.* See Anodenfluessigkeit.

anomale Dispersion: *anomalous dispersion.* An inversion of the usual change of refractive index with wave length in the vicinity of an absorption band.

Anpassungsstrom: *transient.* A temporary component of the current in a circuit which is adjusting itself to a new condition of load or of impressed e.m.f. In the current-time equation for such a circuit, the transient component may be represented by a term which rapidly approaches zero.

anregen: *excite.* (1) To bring (an atom or a molecule) to a higher quantum state than its normal or ground state of lowest energy; as by heating, by radiation, or by electron impact. (2) To magnetize, as by a current.

Anregungsfunktion: *excitation function.* (1) The probability of excitation of a spectrum line due to electron impact, expressed as a function of the energy of the electron. (2) A function which expresses the correction necessary in comparing calculated and observed spectral line intensities, because of the unequal numbers of atoms or molecules in the different excited states. (3) An expression for the probability that an atomic nucleus will be rendered radioactive by the impact of a rapidly moving particle, in terms of the particle energy or other factors.

Anregungsgrenze: *excitation limit.* The least value of the quantum energy of an incident, exciting electron which is capable of producing lines of a given spectral series.

Anregungspotential: *excitation potential.* The critical potential for the excitation of a given radiation, either a line or a group of lines.

Anregungswahrscheinlichkeit: *excitation probability.* In re the excitation of a gas by electronic impact: the number of excited atoms produced per unit electron current, per unit path length, per unit pressure at zero degree C.

Anregungswelle: *excitation wave.* A term used by Frenkel to charactreize the process of absorption of radiation in a crystalline solid and its transformation into heat by the excitation of the atoms.

Antikathode: *anticathode.* A plate or block of metal placed opposite the cathode in an X-ray tube to intercept the cathode rays.

Antinode: *antinode.* A point, line, or surface, between two nodes of a vibrating body, at which the amplitude has a maximum value.

antiparallel: *antiparallel.* Extending or moving in parallel lines but in opposite directions.

Antiresonanz: *antiresonance.* A condition which, in a divided oscillatory circuit, is the antithesis of the resonance condition and through which the oscillation amplitude is reduced to zero.

Antizyklon: *anticyclone.* A rotary atmospheric disturbance, turning in the opposite direction from a cyclone about a center of high pressure.

aperiodisch: *aperiodic.* Devoid of periodicity or rhythm.

aperiodisch-ausschwingend: *deadbeat.* Coming to rest without oscillation, as the indicator of a highly damped galvanometer.

Apertur: *aperture.* (1) Any opening, as in a screen. (2) The diameter of the entrance-pupil of an objective. (3) (Angular.) The angle subtended at the focal point of an optical instrument by the diameter of the entrance-pupil. (4) (Relative.) In a telescope or a camera: the ratio of the focal length of the objective to the diameter of the entrance-pupil; it determines the photographic speed of the objective.

Aperturmeter: *apertometer.* A device, due to Abbe, for measuring the numerical aperture of microscope objectives.

Aperturwinkel: *aperture angle.* The angle subtended by the radius of the entrance-pupil of an optical instrument at the (axial) object-point.

aplanatisch: *aplanatic.* (1) In re a lens: free from spherical aberration for a given point on the axis. (2) In re an optical system: free from spherical aberration as in (1) and also fulfilling the sine condition of Abbe.

apochromatisch: *apochromatic.* In re an optical system: more highly corrected than an ordinary achromatic lens, i.e., achromatized for more than two wave lengths.

Apsis: *apse, apsis.* A point on a central orbit at which the tangent is perpendicular to the radius vector from the center of force, or at which the radius vector has a maximum or a minimum value.

Aragopunkt: *Arago spot.* A bright point which, owing to diffraction, appears at the center of the shadow of a sphere or other object casting a circular shadow in light from a point source.

Arbeit: *work.* A physical magnitude relating to the transfer of energy from one body to another through the agency of mechanical force. Its measure is the scalar product of the force by the simultaneous linear displacement.

Arbeitsfunktion: *work function.* A general term applied to the energy required to transfer electrons, ions, molecules, etc. from the interior of one medium across the boundary into an adjacent medium. It is of especial significance in photoelectric and thermionic emission, sometimes referring to energy per unit charge and expressed in ergs or joules, sometimes to energy per electron-volts.

Arbeitssubstanz: *working substance.* A substance whose changes of volume and pressure figure in a thermodynamic process, as in the operation of a heat engine.

Archimedes'sches Prinzip: *Archimedes principle.* States that the buoyant force of a liquid upon a partly or wholly submerged body is equal to the weight of the displaced liquid, and acts vertically upward through the center of displacement.

Armatur: *armature.* (1) A removable part of a magnetic circuit, of ferromagnetic material and usually of low reluctance; e.g., a bar of iron placed across the poles of a magnet. (2) That part of a generator or motor, or other electromagnetic device, upon whose relative motion with respect to the main magnetic field the operation of the device depends.

astatisch: *astatic.* Coming to rest indifferently, without any particular orientation; e.g., an astatic pair, composed of two parallel, equally magnetized needles, rigidly connected, with their like poles in opposite directions.

Astigmatismus: *astigmatism.* The property of being astigmatic, as a lens or a mirror, i.e., having different focal power in different meridians. In an astigmatic bundle of rays, the rays do not all intersect at one point. Astigmatism of the eye is mainly due to lack of sphericity in the cornea, which has different curvature in different meridians.

Asto'nscher Dunkelraum: *Aston dark space.* (1) A thin, nonluminous region of the discharge in a vacuum tube which sometimes is observed between the cathode glow and the cathode itself. (2) Aston also discovered a dark space next to the anode.

Astrophysik: *astrophysics.* The physics of astronomical bodies and regions.

atherman: *athermanous.* Opaque to infrared.

Atmosphaere: *atmosphere.* (1) The air. (2) Any gaseous medium. (3) A unit of pressure, defined as the pressure of 76 cm of mercury at zero degrees C. under standard gravity. Equal to about 1,013,250 dynes/cm^2.

atmosphaerisch: *atmospheric.* (1) (adj.) Pertaining to the atmosphere. (2) (n.) An electrical disturbance or stray produced by conditions in the atmosphere.

atmosphaerisches Gesetz: *Law of atmospheres.* A law, first stated by Laplace, expressing the distribution of molecules in an ideal atmosphere subject only to gravity and thermal agitation. In one form, the number of molecules per unit volume at any altitude h is given by

$$N = N_0 e - \frac{3g}{\overline{U^2}} h$$

where N_0 is the number at the arbitrary elevation zero. $\overline{U^2}$ is the mean square speed of molecular motion. It is a special case of the Boltzmann principle.

atomare Anordnung: *atomic domain.* One of the simplest spacefilling polyhedrons which contain the contacting spheres used to represent the atoms in a crystal.

atomarer Absorptionskoeffizient: *atomic absorption coefficient.* The absorption coefficient of an element divided by the number of atoms per unit volume.

atomare Refraktion: *atomic refraction.* The product of the specific refractive power of an element by its atomic weight.

atomarer Streufaktor: *atomic scattering factor.* Syn. atom form factor.

atomarer Streukoeffizient: *atomic scattering coefficient.* In re the scattering of a stream of electrons in traversing a substance: the scattered electron current per unit solid angle in any direction, per atom of scattering material, per unit incident electron current.

atomarer Strukturfaktor: *atomic structure factor.* Syn. atom form factor.

atomares Bremsvermoegen: *atomic stopping power.* In re the effect of different elements upon the motion of alpha particles: the quantity

$$S \cdot Z^{-2/3}$$

in which S is the stopping power relative to oxygen and Z, the atomic number. Its value is approximately 0.23 for all elements.

atomare Suszeptibilitaet: *atomic susceptibility.* The specific or mass susceptibility of an element, multiplied by its atomic weight.

Atomformfaktor: *atom form factor.* (1) A quantity occurring in the expression for the intensity of an X-ray beam reflected by a crystal, whose value depends upon the varying configuration of the electrons in the crystal atoms relative to the center of the atom, as well as upon the angle of incidence and the wave length of the X-rays. (2) A quantity used in a manner similar to (1), but in reference to the scattering of either X-rays or electrons by gases.

Atomfrequenz: *atomic frequency.* A natural frequency of vibration ascribed to the atoms composing a solid, and associated with the elastic constants of the solid.

Atomrefraktion: *atomic refraction.* See atomare Refraktion.

Atomsuszeptibilitaet: *atomic susceptibility.* See atomare Suszeptibilitaet.

Atomvolumen: *atomic volume.* The volume of 1 gram atom of an element in the solid state.

Atomwaerme: *atomic heat.* The product of the atomic mass of an element by its specific heat; or the thermal capacity of 1 gram atom of the element.

Atomzahl: *atomic number.* The number assigned to any element in the complete series of elements, arranged in the order of the complexity of the atom; supposed to represent the number of electrons surrounding the nucleus.

Audiofrequenz: *audio frequency.* A vibration frequency within the range of human tone perception.

Audiooszillator: *audio-oscillator.* A generator of a.c.'s within the audible frequency range.

Aufloesung: *resolution.* (1) The separation of a vector into its components. (2) The sharpness with which the images of two closely adjacent sources, two adjacent spectrum lines, etc., may be distinguished.

Aufloesungsvermoegen: *resolving power.* (1) Of an optical system: a measure of the distinctness with which the images of two point-sources of light may be separately detected. E.g., for a telescope, it is the least angular separation of the two point-sources (as stars) which can be recognized, and exists when the center of the diffraction ring system of one falls on the first dark ring of the other. (2) (Spectroscopic.) Of a grating or a prism: the value of $\lambda/\Delta\lambda$ (where λ is the mean wave length for two close spectrum lines differing

in wave length by $\Delta\lambda$) when the principal maximum of one line coincides with the first minimum of the other, so that they are just distinguishable.

Aufspaltung: *exhaustion.* In re the potential energy of a material system: the quantity of work which would be required to effect the separation of the bodies or particles to infinite distances apart; a term due to Kelvin.

aufteilen in Blaetter: *laminate.* To divide into laminae; esp. the iron core of an electro-magnet, to minimize the effect of eddy currents.

aufteilen in duenne Bleche: *laminate.* See aufteilen in Blaetter.

aufteilen in duenne Schichten: *laminate.* See aufteilen in Blaetter.

Aufteilungskoeffizient: *partition coefficient.* Syn. distribution coefficient.

Auftriebskurve: *curve of buoyancy.* Any vertical section of surface of buoyancy through the metacenter.

Auftriebszentrum: *center of buoyancy.* Syn. center of displacement.

augenblickliche Achse: *instantaneous axis.* Syn. axis of instantaneous rotation.

augenblicklicher Mittelpunkt: *instantaneous center.* The point at which the instantaneous axis of a plane body moving in its own plane intersects that plane.

augenblickliche Rotationsachse: *axis of instantaneous rotation.* A straight line about which any rigid body in motion may be regarded as rotating at any instant.

augenblicklicher Schalldruck: *instantaneous sound pressure.* The actual pressure at any point of a medium traversed by sound waves, at any instant, minus the normal or static pressure. It may thus be either positive or negative.

augenscheinlich: *ocular.* Pertaining to the eye, or to vision.

Auger Effekt: *Auger effect.* The liberation of two electrons from different levels of an atom by a single X-ray quantum; a somewhat rare phenomenon first observed in argon.

Aureole: *aureole.* The hazy, less luminous, outer portion of an electric arc, often of a different color from that of the core.

aurrorale Linie: *auroral line.* A green line in the spectrum of the aurora borealis at wave length 5577 Å, undoubtedly due to a "forbidden" transition in oxygen. The line has been produced artificially by Kaplan.

Ausbreitungskonstante: *propagation constant.* In re the steady transmission of sound through any enclosure: the Napierian logarithm of the ratio of the volume velocity at entrance to that at exit of the wave train from the enclosure.

ausdehnendes Universum: *expanding universe.* Refers to the fact that the mean distance between the bodies of the universe is apparently increasing; the rate of recession of the more remote visible galaxies, as indicated by the red shift, being several thousand miles per second.

Ausdehnung: *expansion.* An increase in volume due to a change in energy.

Ausdehnungskoeffizient: *expansion coefficient.* A measure of the rate of expansion of a substance with temperature; usually defined as the ratio of the temperature rate of the change in length (or area, or volume), to the length (or area, or volume) at a chosen reference temperature or zero. Thus:

$$C = \frac{\Delta l}{\Delta t l_0}$$

Linear, superficial, and volume or cubical coefficients are thus similarly defined.

Ausdehnungsmesser: *extensometer, extensimeter.* An instrument for measuring small changes in length, such as those produced by tension or in magnetostriction.

Ausflusskoeffizient: *efflux coefficient.* A correction factor for the rate of efflux from an orifice, to allow for friction.

Ausgangsoeffnung: *exit-port.* The image of the entrance-port of an optical system; or the image of the field stop as formed by the part of the system which is posterior to the field stop. If the field stop is behind the entire lens system, it is identical with the exit-port.

Ausgangspupille: *exit-pupil.* The image of the entrance-pupil of an optical instrument. It determines the apertures of the bundles of emergent rays. The exit-pupil of the eye is a little behind the actual pupil.

ausgeglichen: *balanced.* (1) In re a circuit: having equal e.m.f.'s and equal currents in its main branches. (2) In re an electric network: having two conjugate branches, e.g., a Wheatstone bridge. (3) In re a

periodic variable: One whose average value is zero, e.g., a simple harmonic a.c. or voltage.

ausgleichend: *equilibrant.* In re a system of forces: That single force, if such exists, which would, in cooperation with the given system, produce equilibrium.

Ausgleichungslehrsatz: *compensation theorem.* States that if the impedance Z_B of any branch B of a network, in which the current is I_B, is altered by an amount ΔZ_B, the resulting change ΔI in the current I at any point of the network is equal to the current which would be produced at that point by a counter e.m.f. $-I_B \Delta Z_B$ introduced into the branch B.

Ausgleichungstrom: *transient.* See Anpassungsstrom.

ausloeschen: *quench.* (1) To extinguish, as a glowing solid or a spark, by immersion in a liquid. (2) To suppress or reduce the fluorescence or phosphorescence of a substance by the admixture of some other substance, or by the action of some agency such as radiation.

Ausschlussprinzip: *exclusion principle.* States that no two electrons in the same atomic or molecular system can have all their quantum numbers identical; discovered by Pauli.

Ausschlussphaere: *sphere of exclusion.* The spherical surface drawn about any molecule, from which the center of any other molecule is excluded.

ausserordentlich: *extraordinary.* Pertaining to that plane-polarized component of a ray of light which, in traversing a doubly refracting crystal, has its electric vector in the principal plane. So named because this component has different speeds in different directions.

ausserordentlicher Index: *extraordinary index.* The refractive index for the extraordinary ray in a uni-axial crystal; defined as the ratio of the velocity of the light outside the crystal to that of the extraordinary component within the crystal in any direction perpendicular to the optic axis (in which its value differs most from the index for the ordinary component).

Ausstrahlung: *radiation.* (1) The propagation of energy through space or through material media in the form of electromagnetic waves, but subdivided in some manner into discrete portions or quanta. Commonly classified, according to frequency, as Hertzian radiation, infrared, (visible) light, ultraviolet, X-rays, gamma-rays, etc. (2) Sometimes extended to include corpuscular emissions, as α and β "radiation", or emissions of mixed or unknown type, as cosmic "radiation."

Ausstroemung: *effusion.* The escape of a gas through a small opening.

Austausch: *exchange.* (1) The equalization of temperature among neighboring bodies through mutual radiation, as first pointed out by Prevost (1792). (2) An interaction between electrons, protons, alpha particles, etc., in the same or in different atoms; hence the terms exchange energy, e. force, etc.

Austrittsgeschwindigkeit: *velocity of escape.* (1) The speed with which a projectile or a particle would have to leave the surface of the earth or other planet in order never to return. (2) The speed with which an electron or other ion escapes from a conductor in thermionic or photoelectric emission, or with which a molecule emerges from a liquid in evaporation.

Auswahlprinzip: *selection principle.* An empirical rule, which governs the electron transitions actually occurring within an atom, as distinguished from those which might be expected, but apparently do not occur.

Auswahlverstaerker: *push-pull amplifier.* A combination of two vacuum-tube circuits so related that they are in phase for those frequencies which it is desired to amplify and out of phase for those which are to be eliminated.

Autokollimator: *autocollimator.* A telescope provided with a transparent scale in its objective focal plane, by means of which angles subtended by distant objects may be directly read.

autophoto-elektrisch: *autphotoelectric.* Relates to the hypothesis, due to Richardson, that thermionic emission is a form of photo-electric effect, in which radiation comes from the hot substance itself.

Autotransformator: *autotransformer.* A transformer of which the primary windings, or part of them, are connected differentially in series with the secondary and which has the effect of stabilizing the secondary voltage against variations in the primary voltage.

Avogadro'sches Gesetz: *Avogadro law.* States that at equal temperatures and pressures, equal volumes of all gases contain the same number of molecules.

Avogadro'sche Zahl: *Avogadro number.* The number of atoms in a gram atom of any element, or the number of molecules in a mol of any pure substance. Its value is approximately 6.064×10^{23}.

axiale Vergroesserung: *axial magnification.* The ratio of the interval between two adjacent image-points on the axis of an optical instrument to the interval between the corresponding axial object-points.

azeotropisch: *azeotropic.* In re a liquid mixture: in such proportion as to have a constant boiling point, the

distillate having the same composition as the original liquid. This property is known as azeotropism.

Azimuth: *azimuth.* (1) Position as measured by an angle reckoned around some fixed point or pole, e.g., the azimuth of a particle moving in an orbit, or (astron.) of a star in the sky reckoned around the horizon from the south point; (2) In re elliptically polarized light: the direction of the vibration plane of the light which would result if the phase difference corresponding to the ellipticity were reduced to zero without altering the amplitudes of the components.

azimuthale Quantenzahl: *azimuthal quantum number.* A quantum number associated with angular motion, which must be an integer for any allowed stationary state of a particle moving subject to a central field.

Babinet'sches Absorptionsgesetz: *Babinet absorption rule.* States that positive, uniaxial crystals have greater absorption for the extraordinary component, negative crystals for the ordinary component, of the light doubly refracted by them.

Babinet'sches Prinzip: *Babinet principle.* States that two diffraction screens, one of which is exactly the negative of the other, produce identical diffraction patterns.

Babo'sches Gesetz: *Babo law.* States that the vapor pressure of a dilute solution of given concentration bears approximately a constant ratio to that of the pure solvent as the temperature changes.

Back-Goudsmit'scher Effekt: *Back-Goudsmit effect.* A phenomenon analogous to the Paschen-Back effect but produced by a weak magnetic field upon the spectrum lines of an element having a nuclear magnetic moment.

Bahn: *orbit.* (1) The path described by a particle, or by the centroid of the body, under the influence of a gravitational or other force field. (2) The hypothetical locus of one of the non-nuclear electrons within an atom.

trajectory. The path followed by a projectile under the influence of gravity.

bahn . . . *orbital.* (1) (adj.) Pertaining to an orbit or to motion in an orbit. (2) (n.) An orbital wave function pertaining to a single electron; a characteristic solution of the Schroedinger equation for a one-electron problem, excluding spin.

Bahnelektron: *orbital electron.* One of those electrons of an atom or a molecule which are often visualized as moving in orbits around the nucleus or nuclei.

Bahnmoment: *orbital moment.* The moment of momentum of an atomic electron due to its orbital motion.

Bahnumkehrprinzip: *path-reversal principle.* The fact that if light follows a given course through any optical system, it will, if reversed, traverse the same course in the opposite direction, so that a point and its real image are interchangeable.

Bahnvalenz: *orbital valence.* An interaction between atoms in a molecule, ascribed to a coupling between orbital motions of electrons; a term introduced by Heitler.

ballistisch: *ballistic.* (1) Pertaining to projectiles. (2) A term applied to an instrument which indicates the effect of an impact or of a sudden rush of energy; as a ballistic pendulum or galvanometer.

Balmer Serie: *Balmer series.* A series of lines in the hydrogen spectrum, found by Balmer (1885) to be made up of frequencies progressing in proportion to the sequence of numbers

$$\left(\frac{1}{2^2}-\frac{1}{3^2}\right),\ \left(\frac{1}{2^2}-\frac{1}{4^2}\right),\ \left(\frac{1}{2^2}-\frac{1}{5^2}\right),\ \ldots\ldots$$

Over 30 lines have been identified in this series.

Bande: *band.* (1) One of the broad stripes characteristic of molecular spectra. They are really sequences of spectrum lines so closely spaced as to require high resolution to detect them. (2) Any sequence or range of frequencies. (3) A bright or a dark streak or stripe due to interference or diffraction.

Bandenausfilterung: *band elimination.* In re a wave filter: the transmission of an entire range of frequencies with the exception of a limited portion, or band, having transmitted portions on either side of it.

Bandendurchlaessigkeit: *band-pass.* In re a wave filter: having the property of transmitting only a certain band or range of frequencies.

Bandenkante: *band edge.* The frequency toward which the lines in any one band of a band spectrum appear to be concentrated.

Bandenkopf: *band head.* See Bandenkante.

Bankphotometer: *bench photometer.* Any one of various types of photometer, the parts of which are arranged on an optical bench.

Bar: *bar, barye.* The c.g.s. absolute unit of pressure, viz., one dyne/cm^2. The megabarye or megabar is one million baryes, and equals about 0.987 atm. Note. Some writers designate 10^6 baryes as a bar, and the barye as a microbar.

Barkhausen Effekt: *Barkhausen effect.* A succession of abrupt changes in magnetization in a smoothly varying magnetizing field; discovered by H. Barkhausen.

Barkhausen-Kurz Oszillator: *Barkhausen-Kurz oscillator.* A type of triode oscillator in which oscillations of frequencies ranging from 3×10^8 to 15×10^8 are generated, apparently by the movements of filament electrons passing back and forth through the positive grid and finally settling upon it.

Barnett Effekt: *Barnett effect.* The magnetization of a body by rotaing it, without applied magnetic field.

Barograph: *barograph.* A recording barometer.

Barostat: *barostat.* A pressure regulator, or an arrangement to maintain a constant pressure.

Baumé Skala: *Baumé scale.* One of two arbitrary hydrometer scales, used, respectively, for liquids of specific gravity less than unity and greater than unity.

Beattie-Bridgman'sche Gleichung: *Beattie-Bridgman equation.* An empirical characteristic equation for fluids, as follows:

$$pv^2 = RT\left(1-\frac{c}{vT^3}\right)\left[v+B\left(1-\frac{b}{v}\right)\right]-A\left(1-\frac{a}{v}\right)$$

in which R, A, B, a, b, c are constants determined by experiment for each substance.

Beau de Rochas' Kreis: *Beau de Rochas cycle.* The thermodynamic cycle of the ordinary, four-stroke, internal combustion engine; commonly called the Otto cycle.

Beckmann Thermometer: *Beckmann thermometer.* A mercurial thermometer having a very large bulb and a very fine bore; used for measurements of small temperature differences.

Becquerel Effekt: *Becquerel effect.* An e.m.f. observed in a circuit having two identical electrodes immersed in an electrolyte, when the electrodes are unequally illuminated.

Becquerel Membran: *Becquerel membrane.* A semipermeable membrane produced in situ by a chemical reaction e.g., by the contact of solutions of sodium sulfide and silver nitrate.

Becquerel Strahlen: *Becquerel rays.* The radio-active emission from uranium compounds, discovered by Becquerel in 1896 and consisting of beta and gamma rays from parts of uranium.

Bedingungsgleichung: *equation of condition.* An equation which must be rigorously fulfilled by a set of measured quantities, whatever other evidence may be available as to their values. E.g., the sum of the three angles of a triangle is 180 degrees, and any set of measurements upon them must be adjusted to meet that condition exactly.

Beharrungsvermoegen: *inertia.* A property common to all forms of matter and exhibited also by electrons and apparently by energy (quanta); manifested as a dynamic opposition to acceleration.

Bel: *bel.* A unit used to express relationship between two amounts of power (acoustic, electric, etc.) as an interval on a logarithmic scale. The number of bels in such an interval is the common logarithm of the ratio of the two powers compared; therefore the bel is the value of that interval for which the ratio is 10:1. Acoustically it is used to express differences in sound sensation level. Named for Alexander Graham Bell.

Belfils' Bruecke: *Belfils bridge.* A type of resonance bridge used to ascertain the harmonic purity of an electric wave train.

Belichtung: *exposure.* A measure of photographic stimulus defined as the product of the illumination by the exposure time; usually expressed in meter-candle-seconds.

Beleuchtungsschwerpunkt: *luminous center of gravity.* Syn, Photometric center.

Beleuchtungsstaerke: *illumination.* The ratio of the luminous flux incident upon an element of surface to the area of the element.

Beleuchtungsstaerkemesser: *lumeter.* A type of illumination photometer, depending upon the comparison of the illuminated test area with an annular area illuminated by a lamp through a revolving adjustable diaphragm.

Beleuchtungsstaerkenphotometer: *illumination photometer, illuminometer.* A portable photometer designed for the measurement of the illumination upon any surface, as a wall or a table.

Benetzungswaerme: *heat of wetting.* The quantity of heat evolved per unit mass of dry material when thoroughly wet by immersion in a liquid.

Beobachtungsgleichung: *observation equation.* An equation, admittedly only approximately true, which connects one or more quantities, to be experimentally determined, with the results of an observation upon some function of them.

Bereich: *domain.* One of the regions in a ferromagnetic substance in which the atomic magnetic moments are parallel. These regions apparently behave as units during change of magnetization. Attributed to Weiss.

Berichtigungsfaktor: *correction factor.* A constant coefficient, multiplication by which renders a functional expression approximately the correct representation of a variable, whereas before it was only proportional to the variable.

Bernoulli'sche Gleichung: *Bernoulli equation.* An equa-

tion which expresses the total head of a flowing liquid, as follows:

$$e + \frac{p}{dg} + \frac{v^2}{2g} = H;$$

in which e is the elevation above an arbitrary datum, p is the pressure, d the density, v the speed of flow, g the acceleration of gravity, and H the total head. The Bernoulli law states that for an unimpeded flow this total head H is constant. The equation appears also in other forms adapted to various situations.

Beschleunigung: *acceleration.* (1) (Linear.) The time rate of change of linear velocity, i.e., the derivative of the linear velocity with respect to time. (2) (Angular.) The time rate of change of angular velocity, or its derivative with respect to time.

lead. The opposite of lag.

Beschleunigungszentrum: *center of acceleration.* A point in a plane body, moving in its plane, at which the acceleration is momentarily zero.

beschraenken: *constrain.* To limit to a predetermined position or path. A body has constrained motion when restricted by material barriers to move in a given line, e.g., a railroad train along its track.

besonders starke Linie: *enhanced line.* A spectral line, from a spark or other very hot source, whose intensity is out of proportion with that of other lines as compared with an arc or a flame spectrum.

Bessel'sche Gleichung: *Bessel equation.* A linear differential equation of the form

$$x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} + (x^2 - a^2)\,y = 0$$

the solutions of which are expressible as power series in x known as Bessel's functions or Bessel's integrals. Important in problems of heat conduction, etc.

bestrahlen: *irradiate.* To subject to radiation of any kind.

Bestrahlung: *insolation.* (1) Exposure to solar radiation. (2) The intensity of the solar radiation received at any point on the earth's surface.

irradiation. (1) The process of irradiating. (2) A quantity defined in the same manner as illumination, except that it refers to any kind of radiation; quantitatively expressed as the amount of radiant energy received per unit time per unit area of the irradiated surface. (3) A visual illusion, which causes a bright object to appear larger than a dark one of the same dimensions.

Beta-strahlen: *beta rays.* An emission of electrons from the atoms of an element in radioactive transformation; proceeding in part directly from the nucleus and in part from the X-ray levels of the outer electron system.

Beta-strahlen Spektrum: *beta-ray spectrum.* A separation of beta particles of different speeds, usually by the magnetic field alone, but in some cases by both magnetic and electric fields.

Beta-transformation: *beta transformation.* A radioactive transformation in which the atomic nucleus loses an electron (beta particle).

Beta-umwandlung: *beta transformation.* See Beta-transformation.

Beugung: *diffraction.* A term applied to a variety of effects produced upon wave trains, such as light or X-rays, by the interposition of one or more obstacles, as a row of parallel bars in a grating or an array of atoms in a crystal; characterized by more or less systematic interference phenomena, e.g., bands, halos, or spot patterns.

Beugungsgitter: *diffraction grating.* A device for dispersing light or other wave emission by interference between wave trains issuing from fine, parallel slits in an opaque plate or from very narrow, parallel reflecting surfaces made by ruling grooves on polished metal.

Beugungswinkel: *diffraction angle.* The angle between the direction of an incident beam of light and any resulting diffracted beam.

Beweglichkeit: *mobility.* (1) Fluidity, low viscosity, e.g., of a liquid, or of a plastic solid beyond its yield point. (2) Syn. mobility coefficient.

Beweglichkeitskoeffizient: *mobility coefficient.* (1) (Electrolytic) The average speed per unit electric field with which ions of a given sign move in the direction of the field. (2) (Molecular) The average speed of diffusion, in the direction of the concentration gradient, of the molecules in a solution, at unit concentration and unit solution (osmotic) pressure gradient.

Bewegungsgleichung: *equation of motion.* An equation which gives information as to the motion of a body or of a point in space in terms of suitable coordinates, expressed as functions of the time.

Beziehung: *correlation.* A quantitative relationship between two variables which, while suggesting some connection between them, is not established with sufficient definiteness to take on a clear-cut functional character. An abstract number measuring the closeness of such a connection is called a correlation coefficient.

Bezugssystem: *frame of reference.* A set of points, lines, or planes used as a system of reference for defining space coordinates.

biaxial: *biaxial.* Having two different optic axes.

Biegung: *flexure.* A strain in which particles or points, normally in a straight line, are displaced into a plane curve, called the curve of flexure or the elastic line.

Biegungsmoment:
Biegemoment: *bending moment, bending torque, flexural moment, flexural torque.* The torque which exists at any point in a bent elastic rod, and to which the bending is due.

Bild: *image.* (1) A real image of an object-point is the point at which light, originating in the object-point, is finally converged after traversing an optical system. (2) A virtual image of an object-point is the point from which light, originating in the object-point, and having traversed an optical system, appears to be diverging. (3) The image, real or virtual, of a finite object is the aggregate of the images of its component points. (4) Also used by analogy in re the reflection of electric waves in conducting networks.

Bildlinie: *image-line.* Syn, focal line.

Bildpunkt: *image-point.* The real or virtual point of intersection of a pencil of rays incident upon an optical system.

Bildpunkskraft: *image force.* The attraction between a charge concentrated upon a small body (esp. an electron) and its electric image in a neighboring conductor (as the metal plate from which the electron has emerged); important in thermionic and photoelectric emission.

Bildungswaerme: *heat of formation.* The heat generated by the formation of a chemical compound per gram or per mol.

Bindung: *linkage.* (1) A mechanical arrangement of solid pieces connected by movable joints, used for imparting motion of a desired character; e.g., in the mechanism which controls the valves of a steam engine. (2) (Magnetic) A measure of the interlocking of a magnetic flux with an electric circuit, viz., the product of the flux by the number of turns of the circuit surrounding it, expressed in maxwell-turns. (3) A chemical bond between atoms and molecules.

Bindungsenergie: *binding energy.* A quantity of energy supposed to be released upon the formation of an atom or a molecule from alpha particles, protons, electrons, etc., at the expense of the total mass.

Bindungskraft: *bonding power.* A measure of the effect, positive or negative, contributed by a shared electron in a molecule to the attraction or repulsion between atoms in the molecule.

Bindungsmoment: *bond moment.* The dipole moment associated with a chemical bond in a polar molecule.

Bindungswaerme: *heat of linkage.* The energy required to break any chemical bond. It includes the heat of dissociation of a diatomic molecule as a special case.

Binnendruck: *internal pressure.* A pressure supposed to exist within a fluid because of its cohesion, and which cooperates with the external pressure to maintain equilibrium against the expansive effect of heat.

Binokularprisma: *prism binocular.* A type of binocular field glass, each telescope of which contains two right-angled prisms (Porro prisms) so placed as to secure at the time the erection of the image, a shorter tube, and greater stereo power than an ordinary binocular.

Biolumineszenz: *bioluminescence.* The emission of light by living organisms, as the firefly, certain fungi, and many marine forms.

Biophysik: *biophysics.* A term used in reference to the physical processes taking place in living organisms.

Biot-Savart'sche Krakt: *Biot-Savart force.* Syn. Lorentz electromotive force.

Biot-Savart'sches Gesetz: *Biot-Savart law.* States that the magnetic intensity due to a current i (abamp) in an infinitely long, straight wire, at a point distant p from the wire, is

$$H = \frac{2i}{p}$$

Bipartitionswinkel: *bipartition angle.* The angle between a beam of X-rays passing through a layer of material and the conical surface (the bipartition cone) which contains paths of half the electrons ejected from the layer by the rays.

Biprisma: *biprism.* A glass prism of almost 180 degrees vertex angle, devised by Fresnel, to produce a

virtual-image double source for Young's interference experiment; applied also to similar devices for producing double-image fields in spectrophotometers, etc.

bipolare Elektrode: *bipolar electrode.* A conducting partition placed across an electrolytic cell, so that one surface acts as an anode, and the other as a cathode.

Biquarz: *biquartz.* A plate made up of two semi-circular pieces, one of dextrogyrate, the other of levogyrate quartz, of equal thickness, and cemented together along the diameter; used for demonstrating polarization tints.

Blackburn Pendel: *Blackburn pendulum.* An apparatus consisting of a pendulum which may swing with different periods in two directions at right angles. Used in studying harmonic motions.

blaues Leuchten: *blue glow.* (1) A type of thermoluminescence emitted by certain metallic oxides, e.g., MgO and BeO, when heated. (2) The bluish luminosity of the gas near the cathode in a Geissler tube, esp. when the gas is air.

Blockierungspotential: *stopping potential.* A p.d. sufficient to stop the outward movement of photoelectrons or thermions, and used in the determination of the speed of the emission.

Blockkondensator: *stopping condenser.* A condenser in series with some branch of a circuit, the purpose of which is to introduce a comparatively high impedance and thus cut down the direct or low-frequency current without materially effecting the h.-f. component.

Bogenspektrum: *arc spectrum.* The spectrum of a substance produced with light from an electric arc into which the substance is introduced.

Bohr-Grotrian'sches Diagramm: *Bohr-Grotrian diagram.* One form of diagrammatic representation of the energy levels in an atom.

Bohr'sche Frequenzregel: *Bohr frequency rule.* Syn. frequency conditions.

Bohr'sches Atom: *Bohr atom.* The atom as conceived, by Bohr and Rutherford, to consist of a positive nucleus about which circulate a number of "orbital" electrons.

Bolograph: *bolograph.* A recording bolometer; or the photographic record produced by it. The latter has also been called a bologram.

Bolometer: *bolometer.* A very sensitive type of metallic resistance thermometer, used for measurements of thermal radiation. Devised by Langley.

Boltzmann'sche Entropiehypothese: *Boltzmann entropy hypothesis.* The assumption that the entropy of a system of material particles is proportional to the logarithm of the statistical probability of the distribution.

Boltzmann'sche Konstante: *Boltzmann constant.* The (molar) ideal gas constant divided by the Avogadro number. Its value is about 1.371×10^{-16} erg/degree.

Boltzmann'sche Maschine: *Boltzmann engine.* An ideal thermodynamic apparatus operating in cycles and having imprisoned radiation corresponding to a working substance; visualized by Boltzmann in the theoretical deduction of the Stefan-Boltzmann law.

Boltzmann'scher Faktor: *Boltzmann factor.* A correction factor applied to calculated line intensities in spectra due to thermal excitation.

Boltzmann'sches Prinzip: *Boltzmann principle.* In re the equilibrium distribution of particles subject to thermal agitation in a field of force: states that the number of particles per unit volume at any point in the field is

$$N = N_0 e - \frac{E}{kT},$$

in which E is the potential energy of a particle at that point, N_0 is the number where E is zero, T is the absolute temperature, and k is the Boltzmann constant.

Bombenkalorimeter: *bomb calorimeter.* A fuel calorimeter in which the combustion takes place inside a "bomb."

Borda Mundstueck: *Borda mouthpiece.* A type of re entrant orifice, viz., a tube extending inward from a discharge orifice, which has the effect of modifying the conditions of flow.

Bosanquet'sches Gesetz: *Bosanquet law.* States that the magnetic flux in maxwells, in a magnetic circuit is equal to the magnetomotive force, in gilberts, divided by the magnetic reluctance, as formerly expressed in oersteds. Also known as the Rowland law.

Bose-Einstein Statistik: *Bose-Einstein statistics.* A system of statistical analysis of the distribution of gas molecules or of radiation quanta and their momenta, based upon the number of elementary compartments of ordinary space and of momentum space having each a given number of the respective entities.

Bouguer Formel: *Bouguer formula.* A formula for the variation of gravity with altitude. If g_0 is the sea-level

value at the latitude of the station, R the radius of the earth at that station, d the local crust density and d_m the mean density of the earth, then the value of gravity at the altitude h is given by

$$g = g_0 \left(1 - \frac{2h}{R} + \frac{3dh}{Rd_m} \right)$$

This formula has been criticized and amended by Faye.

Bourdon'sches Ventil: *Bourdon gauge.* A pressure gauge depending upon the deformation of a curved tube of elastic metal, of elliptic cross-section to the interior of which the pressure is applied.

Boyle-Charles Gesetz: *Boyle-Charles law.* A combination of Boyle's law for the pressure-volume relation and Charles' law for the temperature-volume relation in an ideal gas, viz.,

$$pv = p_0v_0 \ (1 + at).$$

Boyle'sches Gesetz: *Boyle law.* The statement, attributed to Robert Boyle (1662), that in a body of gas maintained at constant temperature, the volume and the pressure vary in inverse ratio, i.e., have a constant product.

Brachistochron: *brachistochrone, brachystochrone.* The path of constraint along which a particle, under the action of a given force, will move from one given point to another given point in the least time.

Brackett Serie: *Brackett series.* A spectral series in the infrared of the hydrogen spectrum, whose frequencies are multiples of

$$\left(\frac{1}{4^2} - \frac{1}{n^2} \right)$$

where $n = 5, 6, 7, \ldots\ldots$

Bragg-Pierce'sches Gesetz: *Bragg-Pierce law.* States that the true atomic absorption coefficient (scattering omitted) of an element of atomic number Z for X-rays of wave length λ is represented by

$$\mu_a = CZ^4\lambda^{5/2}$$

the value of C changing abruptly at wave lengths of absorption lines. Bragg later changed the exponent of λ to 3.

Bragg'sche Reflektion: *Bragg reflection.* The reinforced reflection of X-rays from the successive atomic planes of a crystal, or of electrons from the grating-like structure of its surface.

Bragg'scher Winkel: *Bragg angle.* The glancing angle for X-rays at the reflecting planes of a crystal.

Bragg'sches Gesetz: *Bragg law.* An expression for the condition under which a system of parallel atomic layers in a crystal will reflect a beam of X-rays with maximum intensity. If d is the distance between the layers, Θ the glancing angle, and λ the wave length of the X-rays, the condition is

$$2d\sin\Theta = N\lambda;$$

in which N must be a whole number.

Bravais-Miller'scher Index: *Bravais-Miller index.* One of the four numbers (h, k, f, l) used to designate any set of parallel planes in a crystal belonging to the hexagonal system.

Braun'sche Roehre: *Braun tube.* An early type of cathode-ray oscillograph tube requiring a potential of several thousand volts for operation.

brechbar: *refrangible.* Capable of being refracted, or measurably deviated by refraction.

Brechbarkeit: *refractivity.* The refractive index minus 1.

Brechkraft: *focal power.* In re a symmetrical optical system: a measure of the effect of the system upon the focus of a pencil of rays traversing it. If the rays are incident in air, the focal power is the reciprocal of the focal length for rays coming from the given direction; in general, it is the product of this reciprocal by the refractive index of the medium.

Brechungsindex: *extraordinary index.* See ausserordentlicher Index.

index of refraction, refractive index. The ratio of the speed of a refracted radiation before refraction to its speed after refraction. If the radiation passes from a vacuum into a substance, this ratio is termed the absolute index of the substance; if from one substance into another, the relative index of the two substances.

Brechungswinkel: *angle of refraction.* The angle between the direction of propagation of a refracted emission and the normal to the refracting surface.

Bremspotential: *stopping potential.* See Blockierungspotential.

Bremsvermoegen: *stopping power.* (1) The effect of a layer of matter upon the motion of alpha particles, expressed in terms of the thickness of ordinary air which would have the same effect. (2) The mass per cm^2 of a given filter which is equivalent to 1 cm of air in reducing the speed of alpha particles. (3) For a gas: the ratio of the range of alpha particles in the given gas to that in air at N.T.P.

Brennpunkt: *focal point.* In re a symmetrical optical system: one of the two points on the axis which are conjugate to the axial points at infinity in opposite directions. An incident pencil of paraxial rays through the first focal point emerges as a cylindrical bundle, while an incident cylindrical bundle emerges as a pencil through the second focal point. These points may be real or virtual.

Brennpunktabstand: *focal length.* The distance of either of the two principal points of a symmetrical optical system from the corresponding focal point.

Brennpunktsebene: *focal plane.* The plane passing through either focal point of an optical system, perpendicular to the axis of the system.

Brennpunktskollimator: *focal collimator.* A type of collimator consisting of an objective lens at one end of a tube and a pair of cross hairs placed accurately in its focal plane at the other end.

Brennpunktslinie: *focal line.* One of the two very short lines in the principal sections, i.e., sections made by the principal planes of a narrow astigmatic bundle of light rays; characterized by the fact that (according to Sturm) all of the rays intersect these two lines.

Brewster'sches Gesetz: *Brewster law.* States that the polarizing angle of a reflecting dielectric for light of any wave length is equal to the angle whose tangent is the refractive index of the dielectric for that wave length. Discovered by Brewster in 1815.

Brillianz: *brilliance.* That attribute of any color which permits it to be classed as equivalent to some member of the series of achromatic colors, or grays. Thus bright red is more brilliant than dark red.

Brillouin Effekt: *Brillouin effect.* A pair of spectral satellites appearing in radiation scattered by liquids, one on each side of the unmodified line at a separation of about 0.04 Å. Also known as the Debye-Sears effect.

Brillouin Zone: *Brillouin zone.* A continuous ensemble of all energies and wave functions which may be obtained from one atomic energy level in a metallic-crystal lattice.

Brinnell Haerte: *Brinell hardness.* The hardness of a substance as measured by the force which must be exerted upon it by a rigid sphere of given radius to produce an indentation of given area.

Britische Waermeeinheit: *British thermal unit.* A unit, defined as that quantity of heat which is required to raise the temperature of one pound of water 1 degree Fahrenheit. Equivalent to about 252 (g) cal.

Bronson Widerstand: *Bronson resistance.* A high resistance consisting of two electrodes in a gas made conducting by a constant source of ionization.

Brown'sche Bewegung: *Brownian movement.* An erratic, zigzag motion exhibited by very small particles suspended in a liquid or a gaseous medium, due to thermal agitation of the molecules of the medium. Discovered by Brown (a botanist) in 1827.

Buckley'sches Ventil: *Buckley gauge.* A type of ionization gauge for measuring very low gas pressures.

Bueschelentladung: *brush discharge.* An electric discharge in a gas, intermediate between a glow discharge and a spark, and composed partly of minute sparks.

Bunsenkoeffizient: *Bunsen coefficient.* The solubility of a given gas in a given liquid at N.T.P., expressed in terms of volume of gas absorbed per unit volume of the solution.

Bunsenschirm: *Bunsen screen.* A photometer screen consisting of a diaphragm of paper or parchment with a translucent central spot.

Callendar-Griffiths Bruecke: *Callendar-Griffiths bridge.* A type of slide-wire resistance bridge especially designed for use in resistance thermometry.

Callendar'sche Gleichung: *Callendar equation.* A characteristic equation for steam, given by Callendar in the form

$$v = \frac{RT}{p} + b - c,$$

in which b is a constant and c a function of T.

Campbell-Colpitts'sche Bruecke: *Campbell-Colpitts bridge.* A shielded a.=c. bridge for the measurement of capacitance, using a substitution method.

Candolumineszenz: *candoluminescence.* The luminescence of an incandescent body, as distinguished from the visible radiation due to temperature alone.

Carcel Einheit: *Carcel unit.* A French unit of luminous intensity, defined as one-tenth of the output of the Carcel lamp, which burns colza oil. It is approximately 0.96 international candle.

Carey-Foster'sche Bruecke: *Carey-Foster bridge.* A type of Wheatstone-bridge circuit for measuring the difference between two nearly equal resistances, in which the two ratio arms are coils connected by a slide wire.

Carhart-Clark'sche Zelle: *Carhart-Clark cell.* A modification of the Clark cell, having a lower temperature coefficient.

Carnot-Clausius'sche Gleichung: *Carnot-Clausius equation.* The equation $\phi\, dq/T = 0$, in which dq is the quantity of heat taken in by a body, or a system, during an infinitesmal, reversible change of state and T is the absolute thermodynamic temperature of the system while it is receiving dq. The changes of the state form a reversible closed cycle.

Carnot'sche Lehrsaetze: *Carnot theorems.* Two propositions of thermodynamics: (1) No heat engine working between two temperatures can have greater efficiency than a reversible engine working between those temperatures. (2) The efficiency of any reversible heat engine working between two temperatures is independent of the nature of the engine or of the working substance and depends only upon the temperatures.

Carnot'scher Kreisprozess: *Carnot cycle.* A closed cycle of reversible changes in the state of a body, consisting of an isothermal expansion, an adiabatic expansion, an isothermal compression, and an adiabatic compression in the cyclic order stated. The concept was introduced by Carnot in 1824.

Carnot Theoreme: *Carnot theorems.* See Carnot'sche Lehrsaetze.

Cassegranischer Spiegel: *Cassegranian mirror.* A convex second mirror placed in front of the concave objective in one form of reflecting telescope. It produces an image in a tube inserted at the center of the objective mirror, where the eyepiece is located.

Cauchy'sche Dispersionsformel: *Cauchy dispersion formula.* An approximate empirical formula for the refractive index n as a function of the wave length, λ:

$$n = A + \frac{B}{\lambda^2} + \frac{C}{\lambda^4} + \ldots,$$

in which A, B, C, . . ., are constants depending upon the refracting medium.

Cavendish'scher Versuch: *Cavendish experiment.* The measurement of the gravitation constant by means of a torsion balance, originally carried out by Cavendish.

Celsius Skala: *Celsius scale.* The original of the centigrade scale, but inverted, i.e., with freezing point at 100 degrees and boiling point at 0 degrees.

Cent: *cent.* A musical interval, or ratio between frequencies, whose value is the 1200th root of 2. It follows that the interval between any two successive notes of the equally tempered scale is the 100th power of the cent (expressed as 100 cents).

C. G. S.-System: *c.g.s. system.* The centimeter-gram-second system of physical units, i.e., those based upon these fundamental units of length, mass, and time. E.g., the erg is a c.g.s. unit of work.

Chadwick-Goldhaber'scher Effekt: *Chadwick-Goldhaber effect.* The dissociation of an atomic nucleus by the absorption of gamma rays.

charakteristische Flaeche: *characteristic surface.* The (three-dimensional) graph of a characteristic equation.

charaktertistische Gleichung: *characteristic equation.* An equation connecting the variables used to define the physical state of a body, such as volume, pressure, and temperature, e.g., the van der Waals equation, with constants characteristic of the gas.

charakteristische Leitfaehigkeit: *characteristic conductivity.* In re a photoelectric cell: the value of

$$\frac{di/dE}{i},$$

where E is the voltage on the cell and i is the current

at constant illumination; expressed as the percentage increase in current per volt increase in impressed e.m.f.

charakteristische Temperatur: *characteristic temperature.* The temperature at which the atomic heat of a simple cubic crystal attains the value 5.67 calories per degree. According to Einstein, it is given by the formula $T_D = h\nu_m/k$, in which ν_m is the maximum frequency in the vibration spectrum (atomic frequency), h is the Planck constant, and k is the Boltzmann constant. First introduced in connection with the variation of specific heat with temperature.

Charles'sches Gesetz: *Charles' law.* States that the coefficients of expansion of all perfect gases are equal, their common value being such as to indicate that the volume varies in direct proportion to the absolute temperature. First discovered by Charles in 1787.

Chattock'scher Manometer: *Chattock gauge.* A type of differential manometer, utilizing the difference in pressure of two columns of liquid of nearly equal density.

Chemilumineszenz: *chemiluminescence, chemicoluminescence.* Luminescence produced by chemical action; e.g., the emission of light due to the slow oxidation of phosphorus at ordinary temperatures.

chemisches Aequivalent: *chemical equivalent.* The atomic weight of an element, or the radicular weight of an ion, divided by its valence.

Chladni'sche Platte: *Chladni plate.* A metal plate of regular form, which, when set into vibration by means of a violin bow or otherwise, exhibits nodal lines in various symmetrical patterns.

Christiansen Filter: *Christiansen filter.* A device consisting of a coarse powder of some homogeneous, isotropic, transparent solid between parallel glass plates, the interstices being filled with a liquid whose refractive index is equal to that of the powder for a certain wave length. This wave length only is then transmitted without deviation and can be brought to a focus by a lens.

chromatische Farbe: *chromatic color.* A color which exhibits hue.

chromatische Skala: *chromatic scale.* Syn. equally tempered scale.

Chromel: *chromel.* An alloy of nickel and chromium, of high resistivity and high melting point; used for resistance coils.

Chronograph: *chronograph.* A mechanism for recording time signals on a revolving drum or moving tape; used for the precise measurement of time intervals.

Chronoskop: *chronoscope.* (1) A type of chronograph which measures short intervals of time by comparison with the period of a tuning fork or similar vibrator. (2) Any short-interval timer, as a stop watch.

Clairot-Helmert'sche Formel: *Clairot-Helmert formula.* A formula for the variation of gravity with latitude λ:

$$g = 978.00\ (1 + 0.005310\sin^2\lambda)$$

Clapeyron'sche Gleichung: *Clapeyron equation.* A formula expressing the latent heat H of a vapor with the increase in volume during vaporization, in work units, thus:

$$H = \frac{T\delta p}{\delta T}\,(v - v_0);$$

$v - v_0$ is the increase of volume, p and T are pressure and temperature. Also called the Clausius-Clapeyron equation.

Clark'sche Zelle: *Clark cell.* A standard cell for measurements of e.m.f., having positive and negative electrodes of mercury and zinc amalgam, respectively with zinc sulphate as electrolyte.

Clausius-Clapeyron'sche Gleichung: *Clausius-Clapeyron equation.* See Clapeyron'sche Gleichung.

Clausius-Mosotti'sches Gesetz: *Clausius-Mosotti law.* A relation between the density d and the dielectric constant k of a given dielectric:

$$\frac{k - 1}{(k + 2)d} = \text{constant.}$$

It is closely connected with the polarizability, and is allied to the Lorenz-Lorentz relation.

Clausius'sche Gleichung: *Clausius equation.* (1) A differential equation connecting the specific heat at constant pressure, C_p, of a fluid body, with its volume v:

$$\left(\frac{\delta C_p}{\delta p}\right)_\Theta = -\,\Theta\left(\frac{\delta^2 v}{\delta \Theta^2}\right)_p,$$

in which p is the pressure and θ the (Kelvin) absolute temperature. An analogous and equally important relation is

$$\left(\frac{\delta C_v}{\delta v}\right)_\Theta = -\,\Theta\,\frac{\delta^2 p}{\delta \Theta^2}_v,$$

(2) An equation relating to equilibrium between a liquid and its saturated vapor:

$$s' - s = \Theta\,\frac{d}{d\Theta}\left(\frac{H}{\Theta}\right),$$

in which s and s' are the specific heats of liquid and vapor, respectively, and H is the heat of vaporization. (3) An empirical, characteristic gas equation, of the form

$$\left[p + \frac{a}{T(v + c)^2}\right](v - b) = RT,$$

which has been found to represent the behavior of some gases somewhat better than either the Boyle or the van der Waals equation.

Cleanup: *cleanup.* The gradual disappearance of gases from a discharge tube during its operation.

Coehn'sches Gesetz: *Coehn law.* States that in the phenomenon of electric osmosis between dielectric, the substance having the greater dielectric constant becomes charged to a potential higher than that of the other by an amount proportional to the difference in their dielectric constants.

Compoundwicklung: *compound-wound.* In re the field magnet of a motor or a generator: having its windings partly in series and partly in parallel with the external or line circuit.

Compton Effekt: *Compton effect.* A phenomenon of scattering of X-rays or gamma rays by the electrons in matter, in which the scattered radiation is characterized by a systematically smaller frequency of quantum value with increasing deviation from the original direction. A spectrum line whose frequency is less altered is called a modified line, while that part of the radiation of any frequency which is scattered without change of frequency gives rise to an unmodified line of the Compton spectrum.

Compton Elektron: *Compton electron.* An electron having momentum due to the impact of a high-energy radiation quantum.

Compton Gleichung: *Compton equation.* An expression for the Compton shift, viz.,

$$\Delta\lambda = \frac{h}{mc}(1 - \cos\Theta),$$

in which Θ is the scattering angle, m the electronic mass, h the Planck constant, and c the electromagnetic constant.

Compton Verschiebung: *Compton shift, C. wave length.* The change in wave length of an X-ray quantum upon scattering by impact with an electron.

Coolidge Roehre: *Coolidge tube.* A type of X-ray tube, the distinctive feature of which is a cathode containing a hot filament to furnish cathode-ray electrons by thermionic emission.

Corbino Effekt: *Corbino effect.* A form of the Hall effect in which, when a current is sent from center to circumference of a metal disk through a magnetic field normal to the disk, there is also a current flowing circumferencially. Discovered by Corbino in 1911.

Coriolis Beschleunigung: *complimentary acceleration.* An acceleration which must be vectorially added to the sum of the acceleration of a moving particle with respect to a body of reference and the absolute acceleration of the body of reference, to give the absolute acceleration of the particle. It is equal to twice the vector product of the angular velocity of the body of reference and the linear velocity of the particle with respect to it (theorem of Coriolis).

Coriolis Kraft: *Coriolis force.* The force corresponding to the complimentary acceleration to which Cariolis theorem refers.

Coriolis Lehrsatz: *Coriolis theorem.* See Coriolis Beschleunigung.

Cornu'sche Spirale: *Cornu spiral.* The limiting curve approached by a succession of vector lines whose lengths and directions represent, respectively, the amplitudes and phases of the light vibrations reaching any point from successively more remote areas of a wave front.

Cornu'sches Prisma: *Cornu prism.* A 60 degree quartz prism divided into halves, of right- and left-handed quartz, respectively, in order to neutralize the effect of optical rotation.

Cotton-Mouton'scher Effekt: *Cotton-Mouton effect.* The acquisition of double refraction by some pure liquids when subjected to a magnetic field whose direction is transverse to the beam of light, a magneto-optical effect investigated by Cotton and Mouton in 1905.

Cotton-Mouton'sches Gesetz: *Cotton-Mouton law.* If n_p and n_s are the refractive indices for light polarized in planes parallel and perpendicular, respectively, to the magnetic intensity H, then

$$n_p - n_s = C\lambda H^2.$$

Here C is constant for any fixed temperature and any fixed (air) wave length λ; it is called the Cotton-Mouton constant for the given substance, wave length, and temperature, and maye be (+) or (−).

Cotton'sche Waage: *Cotton balance.* An apparatus

for measuring magnetic intensity. A horizontal wire carrying a known current is suspended, at right angles to the horizontal field, from one arm of a balance, and the resulting vertical force on the wire thus measured.

Coulomb: *coulomb.* The practical unit of quantity of electricity. The absolute coulomb is 1/10 of the abcoulomb. The international coulomb is the international ampere-second, i.e., that quantity of electricity whose transfer accompanies the electrolytic deposit of 0.001118 g of silver from a solution of silver nitrate. The ratio of the international to the absolute coulomb is about 0.99995, and either is approximately equal to 3×10^9 e.s.u. charge.

Coulombmeter: *coulombmeter, coulometer.* An instrument for the measurement of a quantity of electricity by the amount of electrodeposition produced from an electrolyte.

Coulomb'sches Feld: *Coulomb field.* An electric field due to a charge acting as if concentrated at a point, so that the field intensity is inversely proportional to the square of the radial distance from the point.

Coulomb'sches Gesetz: *Coulomb law.* A law which expresses the attraction or repulsion between two electric charges or two magnetic poles as proportional to the product of the charges or pole strengths and inversely proportional to the square of the distance between them.

Coulomb'sche Torsionswaage: *torsion balance.* One of a variety of instruments which measure small torques by their torsional effect upon elastic filaments or wires.

Crookes'scher Dunkelraum: *Crookes dark space.* Syn. Cathode dark space.

Crookes'sche Roehre: *Crookes tube.* One of various early forms of vacuum tube, used by Sir William Crookes in his studies of electrical discharge at low pressures.

Crookes'scher Strahlungsmesser: *Crookes radiometer.* An apparatus consisting of a set of vanes polished on one side, blackened on the other, and delicately pivoted to rotate by the inequality of gas pressure on opposite sides when exposed to radiation.

Crookes'scher Radiometer: *Crookes radiometer.* See Crookes'scher Strahlungsmesser.

Crova'sche Wellenlaenge: *Crova wave length.* That wave length in the spectrum of a radiator at any given temperature T whose intensity i_λ varies at the same relative rate as does the intensity I of the total radiation or of a specified portion of it; i.e., the value of λ for which

$$\frac{di_\lambda/dT}{i_\lambda} = \frac{dI/dT}{I}$$

Curie: *curie.* A unit quantity of radium emanation or radon, defined as that quantity which is in equilibrium with 1 g Ra. Its volume at N.T.P. is about 0.63 mm^3.

Curie Punkt: *Curie point.* The temperature chosen to characterize the change from ferromagnetic to paramagnetic behavior, when this does not correspond to an allotropic transformation. It may be interpreted graphically in terms of the temperature-magnetization curve or as a constant temperature in the Curie-Weiss law.

Curie'sche Konstante: *Curie constant.* The product of the atomic or molar magnetic susceptibility of a paramagnetic substance obeying the Curie law by the absolute temperature.

Curie'sches Gesetz: *Curie law.* States that the magnetic susceptibility of a paramagnetic substance varies inversely as the absolute temperature. (P. Curie, 1895.) Not generally valid.

Curie'sche Waage: *Curie balance.* A torsion balance used to measure the force on a nonferromagnetic body in the non-uniform magnetic field. Devised by P. Curie (1895).

Curie-Weiss'sches Gesetz: *Curie-Weiss law.* States that the magnetic susceptibility of a paramagnetic substance varies inversely as the excess of its temperature above a certain fixed temperature characteristic of the substance, viz., the Curie point. It is valid only for temperatures above this point. (P. Weiss, 1907).

d-Elektron: *d-electron.* An orbital electron whose energy state is denoted by the azimuthal quantum number 2.

D Linien: *D lines.* The principal lines of the sodium spectrum, which form a doublet; distinguished as D_1 (5895.93Å) and D_2 (5889.96Å) in air.

D-Zustand: *D-state, D-level.* The state of an atom in which the azimuthal quantum number is 2.

Daempfungsfaktor: *damping factor.* The ratio of the amplitude of any one of a series of damping oscillations to that of the following one.

Daempfungskoeffizient: *damping coefficient.* (1) In re a train of damped oscillations: the logarithmic decrement divided by the period, or multiplied by the frequency. (2) The force required, per unit speed, to propel a particle, an ion, an electron, etc., through a resisting medium.

Daempfungskonstante: *damping constant.* A constant factor appearing in the exponent of the time function of an exponentially damped variable. E.g., the current in an inductive circuit after the sudden removal of a steady e.m.f. is

$$i = i_0 e^{-\frac{Rt}{L}};$$

here the damping constant is R/L.

d'Alembert'sches Prinzip: *d'Alembert principle.* (1) States that all the forces acting upon parts of a system form, with the inertia reactions against acceleration, an equilibrating set of forces on the system as a whole. Newton's third law may thus be regarded as applying to cases in which there is acceleration, the reactions due to inertia functioning as opposing forces and setting up a condition of kinetic equilibrium. First explicitly stated by d'Alembert in 1742. (2) The principle that any displacement of a particle subject to constraints is necessarily perpendicular to the resultant of the constraining reactions.

Dalton'sches Gesetz: *Dalton law.* States that when several gases which have no chemical action upon each other are mixed in the same enclosure, the pressure of the mixture is equal to the sum of the pressures which the gases would separately exert if each in turn were confined in the same space; and further, the saturated vapor pressure of two or more liquids exposed separately in the same closed space, each in equilibrium with its liquid, is, within limits, equal to the sum of the separate vapor pressures. Based upon the experiments of Dalton (1802).

Dampf: *vapor.* A gaseous substance at a temperature below the critical temperature.

Dampfdichte: *vapor density.* (1) The density of a vapor in the usual mass and volume units. (2) The ratio of the density of a vapor or of a gas to that of hydrogen at the same temperature and pressure.

Dampfdruck: *vapor pressure.* The pressure of the vapor of the liquid kept in confinement so that the vapor can accumulate above it. At any temperature it approaches a fixed maximum limit, called the maximum vapor pressure or saturated v.p., dependent only upon the liquid and the temperature.

Dampfdruckkonstante: *vapor-pressure constant.* A constant term which appears in the formula for the logarithm of the vapor pressure of a liquid in terms of temperature in accordance with thermodynamic theory.

Dampfdruckmesser: *tensimeter.* An apparatus for measuring vapor pressure.

vaporimeter. An instrument for measuring vapor pressures of volatile liquids.

Dampfdruckthermometer: *vapor-pressure thermometer.* A thermometer whose indications are based upon the maximum vapor pressure of a liquid.

Dampfkalorimeter: *steam calorimeter.* A calorimeter in which a known quantity of heat is imparted by the condensation of a known mass of steam. Developed by Joly.

Dampfmaschinenindikator: *steam-engine indicator.* An instrument which, connected with the cylinder of a steam engine, automatically draws a trace of the volume-pressure cycle.

Dampftabelle: *steam table.* A table giving certain properties of steam as functions of the temperature or the pressure; including usually the density, specific volume, heat or vaporization, etc.

Darcy'sches Gesetz: *Darcy law.* States that the velocity of flow of a fluid in a porous medium, due to inequality of pressure, is proportional to the pressure gradient.

d'Arsonval'sches Galvanometer: *d'Arsonval galvanometer.* A form of d.—c. galvanometer, consisting of a narrow, rectangular coil freely suspended so as to turn between the poles of a fixed, permanent magnet.

Darwin-Ewald-Prins'sches Gesetz: *Darwin-Ewald-Prins law.* A somewhat complicated expression for the dif-

fraction pattern formed by the reflection of X-rays from a crystal; developed independently but in essentially equivalent forms by Darwin and Ewald and subsequently modified by Prins.

Davisson-Germer'scher Versuch: *Davisson-Germer experiment.* An experiment in which was first observed the diffraction of a stream of electrons at the surface of a metallic crystal, thus providing evidence in support of the wave-mechanical theory of electrons.

de Broglie Frequenz: *de Broglie frequency.* The frequency associated with the energy of the moving electric particle, and equal to that energy divided by the Planck **constant.**

de Broglie Gleichung: *de Broglie equation.* An expression for the wave length of the de Broglie wave associated with a moving electron:

$$\lambda = \frac{h}{mv} = 10^{-8}\text{cm}\sqrt{\frac{150 \text{ volts}}{V}};$$

in which V is the potential drop, in volts, necessary to give the electron its speed and energy, mv is the momentum of the electron, and h is the Planck constant.

de Broglie Welle: *de Broglie wave.* A wave or wave group assumed in wave mechanics to be associated with an elementary particle (electron, proton).

Debye Effekt: *Debye effect.* A selective absorption of Hertzian waves in certain dielectric media, due presumably to the existence of molecular dipoles.

Debye Faktor: *Debye factor.* The quantity M appearing in the Debye relation $F = fe^{-M}$ between the F-value and the f-value of an atom in a crystal. Debye's calculation of M was later modified by Waller.

Debye Funktion: *Debye function.* An expression for the specific heat of a monatomic crystalline solid at absolute temperature T, viz.,

$$C_v = 9nk\left(\frac{T}{T_D}\right)^3 \int_0^{\frac{T_D}{T}} \frac{x^4 e^x dx}{(e^x - 1)^2}$$

in which n is the number of atoms, k the Boltzmann constant, and T_D the Debye characteristic temperature.

Debye'sche charakteristische Temperatur: *Debye characteristic temperature.* See charakteristische Temperatur.

Debye-Scherrer Ring: *Debye-Scherrer ring, D.-S. circle.* Syn. powder pattern, Hull ring.

Debye-Sears Effekt: *Debye-Sears effect.* Syn. Brillouin effect.

Debye Temperaturfaktor: *Debye temperature factor.* Syn. Debye-Waller factor.

Debye-Waller'scher Faktor: *Debye-Waller factor.* See Debye Faktor.

Deformation: *strain.* (1) The change in the relative positions of the particles of a substance, which accompanies the deformation of the body or specimen of the substance in question. Strains may be analyzed into certain elementary types, as elongation, rectilinear compression, shear, torsion, volume expansion, and volume compression. (2) Syn. deformation, and applied to the external form rather than to the substance.

Deformationsachsen: *strain axes.* Three mutually perpendicular lines through any point of an elastic solid, which remain mutually perpendicular when the solid is subjected to strain.

Deformationsdruck: *stress.* A quantity measured by the force per unit area exerted by one portion of a strained elastic substance upon a contiguous portion, and which is due to the external forces responsible for the deformation; e.g., tensile stress, compressive s., shearing s., pressure, etc.

Deformationskraeftepaar: *stress couple.* A couple due to the integrated stress over any cross section of a bent elastic rod or beam; equal and opposite to the bending moment.

Deformationsellipsoid: *strain ellipsoid.* The ellipsoid resulting from the strain of a small portion of matter which, in its unstrained condition, was spherical.

Deformierbarkeit: *deformability.* The electric or dipole moment induced in a molecule by an electric field of unit intensity.

degeneriertes System: *degenerate system.* (1) A vibratory physical system, one or more of whose periodic variables have ceased to vary through an increase of its period to infinity. (2) In quantum mechanics, a system which has several distinct wave functions corresponding to the same energy level.

Dehnungswaerme: *heat of elastic extension.* The heat generated per unit mass per unit change of tensile strain in the stretching of an elastic solid.

Dekadenbruecke: *decade bridge.* A type of Wheatstone bridge in which the values of the ratio coils are decimal multiples of an ohm, so that when the bridge is balanced, the value of the unknown is a decimal multiple or a decimal fraction of the bridge reading.

Dekantieren: *levigation.* See Abschlemmen.

Deklination: *declination.* (1) (Mag.) The angle between the horizontal component of the earth's magnetic field at any point and the geographic meridian through that point, measured east or west from the north. (2) (Astron.) The angle made by a line from the observer to any celestial object, as a star, with the plane of the celestial equator; positive if north, negative if south.

Deklinationsmesser: *declinometer.* An instrument for measuring magnetic declination, consisting essentially of a delicately suspended magnet in connection with a transit for obtaining the true meridian.

Dekrement: *decrement.* A decrease in the value of a variable quantity; a negative increment. Syn., damping factor.

Dekrementfaktor: *decrement factor.* The exponential factor, diminishing with time, which appears in an equation representing a damped oscillation. E.g., the discharge current of a condenser with initial charge Q is

$$i = \frac{a^2 + b^2}{b} Qe^{at} \sin bt,$$

in which a and b are constants. Here e^{at} is the decrement **factor.**

Dekrementmanometer: *decrement gauge.* A pressure gauge in which the pressure or the density of a gas is measured by its effect in damping the movements of an oscillating disk or fiber.

Dekrementmesser: *decremeter.* An instrument for measuring the logarithmic decrement of an electric oscillation.

Delta Funktion: *delta function.* A function δ (x) arbitrarily defined by Dirac as having the property of being zero for all values of x other than zero, and also the property that its definite integral from minus infinity to plus infinity is unity. The operative symbol appears in many equations relating to modern quantum mechanics.

Delta Strahlen: *delta rays.* The name given by J. J. Thomson to electrons emitted by substances when bombarded with alpha particles.

Densitometer: *densitometer.* A form of photometer used especially for measuring the density of silver deposits on photographic plates or films.

Deslandres Diagramm: *Deslandres diagram.* The frequency matrix of a spectrum band system, i.e., a table in which the frequencies are arranged according to ascending values of the quantum numbers n', n'' of the upper and lower energy states. All frequencies in a row have the same value of n', all in a column the same value of n''.

Despretz'sches Gesetz: *Despretz law.* States that the temperature of maximum density of water is lowered below 4 degree centigrade by the addition of a solute, by an amount proportional to the concentration of the solution.

Detektor: *detector.* An apparatus which, acting as a rectifier or a relay, serves to detect or render audible radio-wave modulations or signals.

Detektorverstaerkungsfaktor: *detection coefficient.* The approximately constant ratio of the intensity of a detector signal, e.g., the increase of plate current from a triode detector, to the square of the impressed h.-f. e.m.f. causing it.

Deuteron: *deuteron, diplon.* The nucleus of the hydrogen isotope, deuterium, of atomic weight approximately 2.

Dewar'sches Gefaess: *Dewar flask.* A flask surrounded by a vacuum space for the purpose of thermal insulation; a principle utilized in the thermos bottle.

dextrogyr: *dextrogyrate.* Having the property of rotating the plane of polarization of a beam of transmitted, plane-polarized light in the right-handed or clockwise direction, as viewed by one looking in the direction in which the light travels.

Dezibel: *decibel.* A power-interval unit equal to 1/10 bel, therefore corresponding to the power ratio $10^{1/10}$: 1 equals 1.259. Commonly used in expressing acoustic sensation level differences.

Diagrammlinie: *diagram line.* (1) An X-ray spectrum line which corresponds to one of the quantum transitions derivable from the energy-level diagram for the atom from which it comes; whether such transition is in accordance with the selection rules or not. (2) An X-ray spectrum line which fits into the scheme graphically represented by the Moseley curves.

Diakaustik: *diacaustic.* A caustic produced by refraction.

Dialyse: *dialysis.* The separation of a colloid from a true solute by diffusion of the latter through a porous membrane, in a manner analogous to osmosis. The apparatus is called a dialyzer.

diamagnetisch: *diamagnetic.* Having a negative magnetic susceptibility, e.g., copper, silver, and bismuth.

diatherman: *diathermanous.* Highly transparent to infrared.

diatonische Skala: *just scale, diatonic scale.* A musical scale in which the frequencies making up the chords have certain simple ratios.

Dichroismus: *dichroism.* (1) Pleochroism in respect to two axes only. (2) The property, exhibited by certain colored transparent bodies, of showing different colors of transmitted light, depending upon the thickness traversed or the concentration of the coloring matter; or of exhibiting one color by reflected and another by transmitted light. (3) (Circular.) The unequal absorption of the two circular components of plane-polarized light in an optically active (rotatory) medium, as in certain organic solutions. First observed by Cotton.

Dichroskop: *dichroscope.* An instrument used in studying the dichroism (1) of crystals.

Dichte: *density.* (1) The ratio of the mass of a specimen of a substance to the volume of the specimen. (2) In general, a term expressing the closeness of any space distribution; as electron density (number of electrons per unit volume), etc. (3) (Phot.) A term used to specify the light-absorbing power of the silver image in photographic materials; defined as the negative common logarithm of the transmission factor.

Dichtemesser: *densitometer.* See Densitometer.

Dickfluessigkeit: *viscidity.* That combination of cohesion and viscosity in a liquid which results in its being "sticky" and capable of being drawn out into fine threads, e.g., glue.

Dielektrikum: *dielectric.* A substance capable of sustaining an electric field and of undergoing electric polarization. All electric insulators are dielectrics.

dielektrische Absorption: *dielectric absorption.* See Absorption (3).

dielektrische Kohaesion: *dielectric cohesion.* The force with which the molecules of a dielectric oppose an electric field tending to ionize them; a term due to Bouty.

dielectrische Konstante: *dielectric constant, permittivity.* (1) The ratio k of the electric displacement to the electric intensity in the same region. (2) It has also been defined as a quantity whose measure (in c.g.s. e.s.u.) is 8π times the electric energy density in the said region, divided by the square of the potential gradient in the direction of the displacement.

dielektrische Kraft: *insulating strength, dielectric strength.* A measure of the ability of an electric insulator to withstand electric stress without breakdown; defined as p.d. per unit thickness of the insulator necessary to initiate a disruptive discharge through it. Usually expressed in volts per cm.

dielektrische Polarisation: *dielectric polarization, polarization.* In re a polarized dielectric: the electric moment per unit volume.

dielektrischer Verlust: *dielectric loss.* Loss of power due to electric hysteresis.

Dielektrizitaetskonstante: *dielectric constant.* See dielektrische Konstante.

Dieterici Gleichung: *Dieterici equation.* An empirical, characteristic gas equation:

$$p(v - b)e^{\frac{a}{RTv}} = RT;$$

in which a and b are the characteristic constants.

Differenzbande: *difference band.* A spectral band arising in transition from an excited state, rather than from the ground state.

Differenzialgalvanometer: *differential galvanometer.* A galvanometer having two similar, opposed coils, the currents in which tend to neutralize each other's effect, and which gives a zero reading when the currents are equal.

differenzielle magnetische Permeabilitaet: *differential magnetic permeability.* The derivative of the magnetic induction with respect to the magnetic intensity in the same region, viz., dB/dH. Here both dB and dH are taken as postive; if reversed the ratio may be different, on account of hysteresis.

Differenzton: *difference tone.* A combination tone whose pitch corresponds to a frequency equal to the difference of the frequencies of the two components.

Diffraktion: *diffraction.* See Beugung.

Diffraktionsevolute: *diffraction evolute.* A term referring to the law that when an object illuminated by a point source produces a diffraction pattern within its shadow, the predominant diffraction figure is the evolute of the boundary of the geometrical shadow.

Diffraktionsgitter: *diffraction grating.* See Beugungsgitter.

Diffraktionswinkel: *diffraction angle.* See Beugungswinkel.

diffuse Reflektion: *diffuse reflection, d. refraction, d. transmission.* Reflection, refraction, or transmission in all directions, not in any sharply defined path.

diffuse Serie: *diffuse series.* One of several spectral series in the characteristic spectrum of an element; so called because of the relatively large half-width of the lines.

Diffusion: *diffusion.* (1) The permeation of any region by a fluid, due to the thermal agitation of its molecules. (2) Syn. scattering.

diffusivity, diffusion coefficient, diffusion constant. The constant D in the Fick law of diffusion.

Diffusionsindikatrix: *diffusion indicatrix.* A graph, in polar co-ordinates, showing the candle power of a given element of an illuminated diffusing surface as viewed from various directions in a plane perpendicular to the element.

Diffusionskoeffizient: *diffusion coefficient.* See Diffusion.

Diffusionskonstante: *diffusion constant.* See Diffusion.

Diffusionspumpe: *diffusion pump.* A type of air pump which operates by virtue of the large momentum of mercury vapor or other heavy molecules, which, in a stream or jet, carry other gas molecules before them.

Dilatometer: *dilatometer.* (1) An instrument resembling a large-bulbed thermometer, used for measurements of the expansion of liquids. (2) Any device for the measurement of thermal expansion.

Dimensionsanalyse: *dimensional analysis.* An analysis of a relationship between concrete quantities with reference to their physical dimensions. It is always of a partial character, and in particular does not give numerical factors. Thus, the kinetic energy of a moving body must be proportional to the square of the speed, because of the dimension formula ML^2T^{-2} for energy; but the factor $\frac{1}{2}$ is not thereby revealed.

Dimensionsformel: *dimension formula.* In re any physical magnitude: a symbolic representation of its definition in terms of fundamental magnitudes; e.g., for example, area equals L^2, force equals MLT^{-2}, etc.

Dimensionshomogenitaet: *dimensional homogeneity.* Equality of physical dimensions in the terms of a formula or physical equation. E.g., in the Einstein photoelectric equation.

$$\frac{1}{2}mv^2 = hv - p,$$

each term represents energy and has the dimension formula ML^2T^{-2}.

Dimensionskonstante: *dimensional constant.* A factor, the numerical value of which depends upon the fundamental definitions and the size of the fundamental units, but not upon the particular physical system to which it is applied. E.g., the gravitation constant G in the Newtonian formula Gm_1m_2/r^2 is dimensional; but in the formula for the circumference of a circle, $p = \pi d$, π is not dimensional, as it has the same value whatever the unit of length used for d and p.

dinerisch: *dineric.* A term descriptive of a solution in which there are two immiscible solvents with a single solute soluble in each.

Diode: *diode.* A two-electrode vacuum tube.

Diopter: *diopter.* A unit of focal power, corresponding to the focal length of one meter.

Dioptrie: *dioptry.* See Diopter.

Dipol: *dipole.* (1) A system composed of two equal electric charges of opposite sign, separated by a finite distance, e.g., the nucleus or orbital electron of a hydrogen atom. (2) A similar system composed of two equal but opposite magnetic poles.

Dipolmoment: *dipole moment.* The electric or magnetic moment of a dipole.

Dipolpolarisation: *dipole polarization.* The type of electric polarization exhibited by homogeneous polar dielectrics, and ascribed to the orientation of the permanent molecular dipoles.

Dirac'sche Funktion: *Dirac function.* See Delta Funktion.

Dirac'sche Gleichung: *Dirac equation.* (1) A formula based upon relativity-quantum theory which gives the mass absorption coefficient of a substance for radiation quanta in terms of their energy and of the constants relating to the atoms of the substance. (2) One of a set of four similar differential equations involving the components $\psi 1$, $\psi 2$, $\psi 3$, $\psi 4$ of a four-dimensional vector.

Dirac'sches Elektron: *Dirac electron.* The physical concept of the electron as expressed by Dirac in terms of relativistic wave mechanics.

Dirichlet'sches Prinzip: *Dirichlet principle.* States that there is one and only one function F of the coordinate variables x, y, z which fulfills the following conditions: (1) that F and its derivatives are continuous and single valued throughout a given closed space S. (2) that F satisfies the Laplace equation throughout this region,

and (3) that F may be made to assume any given set of boundary values all over the surface of S, provided these values are continuous over the surface. Important in the theory of potential.

diskontinuierliche Absorption: *absorption discontinuity.* A discontinuity in the absorption coefficient of a substance as a function of wave length, corresponding to a spectral absorption line and often associated with anomalies in other variables such as the refractive index.

Dispersion: *dispersion.* (1) The process of separating or sorting an emission, in accordance with some characteristic such as frequency, wave length, or energy, into components which usually are given different directions; as a prism or a grating disperses white light, or a magnetic field sorts electrons of different speed. (2) Quantitatively, a general measure for any such dispersion is the derivative of the deviation with respect to that variable (wave length frequency, etc.) which is considered responsible for the separation; but some writers define refractive dispersion as the derivative of the refractive index with respect to wave length or frequency. (3) The production of the disperse phase in a disperse system.

Dispersionsformel: *dispersion formula.* One of a number of equations essaying to express the refractive index of a substance as a function of wave length or of frequency, e.g., the Cauchy formula. Characteristic constants in such a formula are dispersion constants for substance.

Dispersionsfrequenz: *dispersional frequency.* The frequency corresponding to the anomalous dispersion at an absorption discontinuity.

Dispersionsphase: *disperse phase.* That constituent of a disperse system which corresponds to the solute in a crystalloidal solution.

Dispersionssystem: *disperse system.* Any colloidal solution having two phases separated by relatively large surfaces.

Dispersionsvermoegen: *dispersive power.* In re any refractive medium: the value of the ratio

$$\frac{n_1 - n_2}{n_m - 1},$$

in which n_1 and n_2 are the refractive indices for the ends of the spectrum range considered, while n_m is that for some arbitrarily chosen wave length, often the mean of n_1 and n_2. Commonly n_1 and n_2 are taken for F and C Fraunhofer lines, respectively, and n_m for the D (sodium) line. The reciprocal of the dispersive power is the Abbe nu-value.

Dispersoid: *dispersoid.* A highly dispersed colloidal suspension, such as an emulsion.

Dissonanz: *dissonance.* (1) (Acoust.) Musical discord. (2) (Opt.) The formation of maxima and minima by the superposition of two sets of interference fringes from light of two different wave lengths, i.e., what may be called stationary beats or secondary interference.

Dissoziationswaerme: *heat of dissociation.* The quantity of heat evolved in the chemical dissociation of 1 g or 1 mol of an electrolyte.

Divergenz: *divergence.* A scalar differential operator, which, applied to a vector point function F, is denoted by the symbol $\Delta \cdot F$ and read "divergence of F" or "del dot F". If F_1, F_2, F_3 are the magnitudes of the three components of F, the divergence of F is expressed by the equation

$$\Delta \cdot F = \frac{\delta F_1}{\delta x} + \frac{\delta F_2}{\delta y} + \frac{\delta F_3}{\delta z}.$$

Doma: *doma.* A primitive crystalline form consisting of two plane surfaces forming a dihedral angle, which is bisected by a third plane surface.

Doppelbildprisma: *double-image prism.* An apparatus, one type of which, devised by Wollaston, consists of two wedges of doubly refracting crystal fitted together to form a rectangular block or prism, and with their axial directions at right angles. When a narrow beam of unpolarized light enters normally at one surface, it emerges from the other in two separate beams, plane-polarized at right angles to each other.

Doppelbrechung: *birefringence, double refraction.* A phenomenon observed when light traverses certain types of crystal or other aeolotropic medium; manifested by the separation of the light into two components, polarized at right angles to each other, having different velocities within the medium, and, in general, taking different directions. These two components are termed the ordinary and the extraordinary rays.

Doppler Effekte: *Doppler effects.* The effects produced upon the frequency with which the waves of an undulatory emission reach the observer, by the motion of the source toward or away from the observer, or of the observer toward or away from the source, or both. Observed in the case of sound by Doppler in 1842.

Doppler-Fizeau'sches Prinzip: *Doppler-Fizeau principle.* The principle underlying the Doppler effects as applied by Fizeau to the shifting of the spectrum lines.

Doppler Verbreiterung: *Doppler broadening.* The broadening of a spectrum line due to the Doppler effect

of the radial component of thermal motion in the emitting particles, which gives the line a width (Doppler width) superimposed upon that due to other causes.

Doppler Verschiebung: *Doppler shift.* The displacement of spectral lines caused by the relative radial motion of source and observer.

Dorn'scher Effekt: *Dorn effect, sedimentation potential.* A p.d. set up by the falling of a particle through a liquid.

Dosis: *dosage.* A measure of the time integral of irradiation, equal to the product of the intensity by the duration of exposure; a term used especially in radiology.

Doublett: *doublet.* (1) (Electr.) The ideal limiting case of an electric dipole consisting of two equal, opposite charges, $+q$, $-q$, when the distance d between the charges is diminished and the charges increased so as to keep the electric moment qd finite and constant; a concept useful in dielectric theory. (2) (Magnetic.) Definition similar to (1), but with opposite magnetic poles, $+p$, $-p$ substituted for the two charges.

Drehungsmoment: *torque.* Moment of a force with respect to any axis: the product of the perpendicular distance r from the axis to the line of action of the force by that component of the force which is perpendicular to the axis and to the radius r; or the integrated resultant of such moments, e.g., that arising from a system of forces equivalent to a couple.

dreifaches Vektorprodukt: *triple vector product.* In re three vectors, p, q, r: any of the identical vector quantities

$$(p \times q) \times r = -r \times (p \times q) =$$
$$r \times (q \times p) = -(q \times p) \times r.$$

dreifach skalares Produkt: *triple scalar product.* In re three vectors p, q, r: any of the identical scalar quantities

$$(p \times q) \cdot r = r \cdot (p \times q) =$$
$$-r \cdot (q \times p) = -(q \times p) \cdot r.$$

Dreikoerperproblem: *three-body problem.* A famous kinetic problem, dealing with the motions of three particles or spherical bodies under their mutual gravitational attraction.

Dreiphasengleichgewicht: *three-phase equilibrium.* The equilibrium which may exist, at a suitable temperature and pressure, among all three phases of a pure substance, solid, liquid, and vapor. The triple point on the temperature-pressure diagram corresponds to this condition.

Dreiphasenstrom: *three-phase current.* A polyphase current delivered through three wires, the components in which differ in phase successively by one-third cycle; each wire serving as the return for the other two. A three-phase generator supplies, and a three-phase motor is operated by, such a current.

Drillpendel: *torsion pendulum.* A pendulum actuated by the torsion of an elastic wire.

Drosseln: *throttling, wiredrawing.* The irreversible process of a fluid flowing through an opening from a higher to a lower pressure region.

Drosselspule: *choke coil.* A coil of low resistance and comparatively small reactance, usually coreless, introduced in a circuit to retard transients.

Drosselung: *throttling.* See Drosseln.

Druckdiagram: *stress diagram, s. sheet.* An adaptation of the Maxwell diagram to the computation of stresses in a framed structure.

Druckerniedrigung des Schmelzpunktes: *regelation.* The fusion and resolidification of ice below the normal freezing point, due to variations in pressure.

Druckkoeffizient: *pressure coefficient.* (1) The ratio of the change in pressure per degree of temperature, in a gas kept at constant volume, to the pressure at the scale zero of temperature. It is very nearly equal to the (volume) expansion coefficient. (2) The increment of any quantity, which is a function of the pressure, due to unit change of pressure.

Druckmodul: *bulk modulus.* The ratio of the pressure to which an elastic substance is subjected to the decrease in volume per unit volume.

stress modulus. The ratio of the stress to the strain for any kind of elastic deformation.

druckoptischer Koeffizient: *stress-optical coefficient.* The difference, per unit stress, between the refractive indices for two beams of light traversing a photoelastic medium, one polarized in and the other perpendicular to the direction of stress.

Druckverbreiterung: *pressure broadening.* An increase in the half-width of a line in the spectrum of a gas, when the source is under high pressure. It is often asymmetrical, the asymmetry being associated with a pressure shift.

Druckverschiebung: *pressure shift.* A change in the wave length of the lines of a spectrum, when the source is under high pressure.

Druckverstaerker: *intensifier.* A device for stepping up a high pressure, by means of a double free piston with two unequal areas, the larger of which is exposed to the lower pressure.

Druckzentrum: *center of pressure.* In re a surface exposed to pressure, e.g., when immersed in a fluid: the point of application of the single resultant force to which the effect of the pressure is equivalent.

Duane-Hunt'sche Beziehung: *Duane-Hunt law, D.-H. relation.* States that the maximum frequency in the beam of X-rays issuing from a tube, multiplied by the Planck constant, is equal to the energy acquired by one of the cathode electrons in traversing the tube. The law is expressed by the Planck-Einstein equation.

Duane-Hunt'sches Gesetz: *Duane-Hunt law.* See Duane-Hunt'sche Beziehung.

Dubuat'sches Paradoxon: *Dubuat paradox.* Refers to the fact that the forces exerted by a fluid moving through a channel or conduit upon a body held at rest in it differ from those exerted when the liquid is at rest in the channel, and the body is moved through it with the same relative velocity as before. This is due to the effect of the irregularities of the walls of the channel, and of wall friction, upon the motion of the liquid.

Duesenpumpe: *jet pump.* A type of suction pump dependent upon the Bernoulli principle of reduced pressure at a narrow constriction in a current of air or liquid, or upon the imprisonment of bubbles in a turbulent stream through a narrow tube. Filter pumps and aspirators are commonly of this type.

Dulong-Petit Gesetze: *Dulong-Petit laws.* At least two well-known laws are attributed to Dulong and Petit: (1) The specific heats of elements are inversely proportional to their atomic weights. (2) The rate at which the temperature of the body approaches that of its surroundings by radiation is proportional to the difference between two powers of the same constant whose exponents are, respectively, the absolute temperatures of the body and of its surroundings. The law is entirely empirical.

Dumas'scher Kolben: *Dumas bulb.* A form of apparatus, on the principle of the pycnometer, for measuring the densities of vapors, and hence, indirectly, their molecular weights.

Dunkelentladung: *dark discharge.* An electrical discharge (in a gas) which has no visible luminosity.

Dunkelstrom: *dark conduction.* Residual electrical conduction in a photosensitive substance when not illuminated.

durchdringende Bahn: *penetrating orbit.* An outer or valence electron orbit which passes inside the atomic Rumpf.

durchdringende Strahlung: *penetrating radiation, cosmic radiation, c. rays.* A type of very penetrating radiation of unknown origin, apparently traversing interplantetary space in all directions, and detected by the ionization which it produces in electroscopes, ion counters, etc.

Durchdringungskoeffizient: *penetrance coefficient.* A quantity which measures the tendency of a liquid to penetrate a given material which it wets; defined as half the product of the surface tension by the fluidity coefficient.

Durchlaessigkeit: *transmittance.* The fraction of the radiant energy entering a layer of a medium which reaches its further boundary.

Durchlaessigkeitsfaktor: *transmission factor, attenuation factor.* A measure of transparency of a layer of absorbing medium for an emission traversing it. It is the ratio of the flux density I of the emergent emission to the flux density I_0 of the incident emission. For an exponentially absorbed emission, the value of the factor, for the thickness x of a medium whose absorption coefficient is μ, is $e^{-\mu x}$.

Durchlaessigkeitsgrenze: *transmission limit.* A limiting wave length or frequency, above (or below) which a given type of radiation is practically all absorbed by a given medium. If the limits are sharply defined, the medium acts as a radiation filter.

Durchlaessigkeitskoeffizient: *transmission coefficient.* (1) In re the separation of radiation into parts at the interface between two media: the ratio of the amplitude of the transmitted radiation to that of the incident radiation. (2) In re the passage of radiation through an absorbing medium: one minus the absorption coefficient.

Durchlaessigkeitsmesser: *transmissometer.* An instrument for measuring the transmission factor of semitransparent bodies.

Durchlassebene: *transmission plane.* The plane of vibration of polarized light which will pass through a given polarizer, e.g., a Nicol prism.

Durchlassvermoegen: *transmissivity.* See Durchlaessigkeitskoeffizient (2).

Dyn: *dyne.* The absolute, c.g.s. unit of force, defined as the force which, acting upon the free mass of one gram, would impart to it an acceleration of 1 cm/sec^2.

Dynamik: *dynamics.* That branch of physics which treats of forces and their action upon material bodies.

dynamisches Aequivalent: *dynamic equivalent, mechanical equivalent.* The equivalent of a unit quantity of any form of energy in terms of the ordinary dynamic or work units. E.g., the mechanical equivalent of heat is 4.1852×10^7 ergs/cal; the mechanical equivalent of light is about 1.6×10^4 ergs/lumen-sec.

dynamische Stabilitaet: *dynamical stability.* A quantity whose measure is the torque, equal to the work necessary to produce a list or tipping of a floating body, divided by the angle through which it is tipped; a term applied especially to ships.

Dynamometer: *dynamometer.* (1) An instrument for measuring force, such as a spring balance. (2) Syn. electro-dynamometer.

Dynatron: *dynatron.* A triode in which the grid and plate potentials are so chosen that the plate current decreases as the plate potential increases. This characteristic is due to secondary electron emission from the plate, and because of it a dynatron can be used as an oscillator.

dystektisch: *dystectic.* In re any mixture or solution: in such proportions as to have the maximum melting point of all mixtures of the same substances.

Eagle mounting: *Eagle mounting.* A mounting for concave gratings, so arranged that the angles of incidence and diffraction are nearly equal.

Earnshaw'sher Lehrsatz: *Earnshaw theorem.* States that an electric charge cannot be in stable equilibrium in an electric field unless acted upon by forces other than those due to the field. Analogous statements hold for magnet and gravitational fields or combinations of them.

Ebene: *plane.* A surface, real or imaginary, in which if any two points are taken, the straight line that joins them lies wholly in that surface.

Ebulliskop: *ebulliscope, ebullioscope.* An instrument for determining the concentration of a solution by means of its boiling point.

Echelette: *echelette.* A coarse diffraction grating ruled on metal to resemble a reflecting echelon of very small steps. Devised by R. W. Wood.

Echelon: *echelon.* A type of diffraction grating capable of producing spectra of very high order and dispersion. The grating spaces are formed by building a minature stairway out of glass plates of exactly equal thickness. Devised by Michelson.

Edison Effekt: *Edison effect.* A thermionic current, discovered (1892) by Edison, who connected a galvanometer between a terminal of one of his incandescent lamp filaments and an auxiliary electrode placed in the bulb.

effektive elektromotorische Kraft: *effective electromotive force.* The value of that constant e.m.f. which would yield the same average power as an actual variable e.m.f. in the same non-inductive circuit. It is equal to the r.m.s. of the variable e.m.f.

effektive interferometrische Wellenlaenge: *effective interferometric wave length.* That monochromatic wave length which, on being substituted for heterochromatic radiation, will give the same system of fringes in an interferometer.

effektive Ionenmasse: *effective ionic mass.* A quantity used to represent the ionic mass in connection with a heteropolar molecule. If M_1 and M_2 are the masses of the two ions, the effective ionic mass is

$$M = \frac{(M_1 M_2)^{3/2}}{(M_1 + M_2)^2}$$

effektive Komponente: *effective component.* That vector component of a given force whose direction is that of the actual motion of the point of application of the force in question. E.g., if a body slides down an inclined plane under the action of gravity, the effective component of its weight is parallel to the plane.

effektive Molekulargeschwindigkeit: *effective molecular speed.* That speed which each molecule of a pure gas would have, were their speeds all equal and the temperature unchanged. It is equal to the r.m.s. of the actual speeds, and is about 1.086 times the mean speed.

effektive Quantenzahl: *effective quantum number.* A number appearing in spectral terms for non-hydrogen atoms, and analogous to the azimuthal quantum number for hydrogen. It is not, however, an integer, and is not properly a quantum number but merely a convenient square root of the energy.

effektiver Durchmesser: *effective diameter.* In re molecules, atoms, ions, etc.: an average value of the diameters (or radii) of such particles, which, if they were of spherical shape, would result in the production of such scattering effects, mean-free-path phenomena, etc., as are actually observed with the type of particle in question.

effektiver Schalldruck: *effective sound pressure.* The r.m.s. value of the instantaneous sound pressure during a complete cycle, at any point of a medium traversed by sound waves. Sometimes abbreviated to sound pressure.

effektiver Stossradius: *effective collision radius.* See effektiver Durchmesser.

effektiver Widerstand: *effective resistance.* The resistance of a conductor to a periodic current, as measured by the ratio of rate of dissipation of energy to square of effective current. It differs from the true (steady-current) resistance because of skin effect.

effektive Temperatur: *effective temperature.* In re a source of thermal radiation: the temperature to which an ideal black body must be heated in order to give it the same emissive power as the source in question.

effektive Wellenlaenge: *effective wave length.* In re a beam of nonhomogenous radiation in a given medium: the wave length of a homogenous beam having the same penetration in the same medium.

Effektivladung: *effective charge.* An electric charge such that, if multiplied by the actual distance between the two atoms of a heteropolar, diatomic molecule, the result is equal to the actual dipole moment.

Effektivstrom: *effective current.* The value of that constant current which would have the same average power as an actual variable current in the same circuit. It is equal to the r.m.s. of the variable current.

Ehrenfest'sche Formel: *Ehrenfest formula.* A modification of the Sackur equation for the entropy of a gas, in which allowance is made for the molecular symmetry number.

Eigenenergie: *eigenenergy.* A quantity of energy just corresponding to an actual atomic state. Used in quantum mechanics. The term has also been used for proper energy.

proper energy. The energy which, according to relativity theory, is equivalent to a given mass m, and is equal to mc^2, where c is the electromagnetic constant.

Eigenfeld: *self-consistant field.* The central field used by Hartree in the calculation of atomic wave functions.

Eigenfrequenz: *characteristic frequency.* See Atomfrequenz.

Eigenfunktion: *eigenfunction, characteristic function.* (1) A function which, among various possible forms, fulfills certain required conditions. Used in quantum mechanics. (2) The optical length of a ray in an optical instrument, expressed as a function of the coordinates of its end points.

Eigenkapazitaet: *self-capacitance.* Distributed capacitance of an electric circuit due to its containing closely wound coils of insulated wire, the adjacent turns of which have a condenser effect.

Eigenkapazitaetseffekt: *proximity effect.* One of the results of winding a wire in a coil with closely adjacent turns, e.g., self-capacitance, the increase in effective resistance for h.-f. currents, etc.

Eigenveraenderung: *individual change.* Any dynamic process in which the attention is fixed upon the behavior of a single particle, followed throughout all its course, changes in its motion being noted; in contradistinction to local change, q.v.

Eigenwert: *eigenvalue, characteristic number, c. value.* A particular solution satisfying specified conditions. Used in quantum mechanics.

einachsig: *uniaxial.* Having but one optic axis.

Einfallswinkel: *incidence angle.* The angle between the direction of an approaching emission and the normal to the surface upon which it is incident.

Einflussphaere: *sphere of influence.* The region surrounding a gas molecule, within which its van der Waals force of attraction exerts an appreciable effect upon other molecules.

Eingangsoeffnung: *entrance-port.* The image of the field stop of an optical system formed by the part of the system which is anterior to the field stop. If the field stop is in front of the system, it is identical with the entrance-port.

Eingangspupille: *entrance pupil.* A real or imaginary stop (usually circular) which controls the apertures of the bundles of incident rays in an optical instrument for a given position of the focal plane. The entrance-pupil of the eye is a little in front of the actual pupil.

einheitliche Feldtheorie: *unified field theory, unitary f.t.* A phase of the general relativity theory which seeks to treat gravitational, electric, and magnetic fields as aspects of a single entity.

Einheitsebene: *unit planes.* In re a symmetrical optical system: One of two planes perpendicular to the axis, such that any incident paraxial ray meets the first, and the same ray upon emergence meets the second, in points on a line parallel to the axis. The magnification ratio for these two planes being $+1$, they are sometimes called the unit planes.

Einheitsflaechenwinkel: *spheradian, steradian.* The unit solid angle, which cuts unit area from the surface of a sphere of unit radius centered at its vertex.

Einheitskristall: *unit crystal.* The simplest geometric figure which includes all the characteristics of, and is repeated indefinitely to form, the lattice structure of a crystal.

Einheitspol: *unit pole.* An ideal magnetic point pole, two of which, at a distance of 1 cm apart in a vacuum, would exert a mutual repulsion (or attraction) of 1 dyne. Such a pole gives rise to 4π maxwells of free magnetism. Actual magnetic poles are often treated quantitatively as if made up of a number of unit poles equal to the "pole strength."

Einheitspunkte: *unit points, principal points.* Two points at which the principal planes of a symmetrical optical system intersect the axis.

Einheitszelle: *unit cell, elementary cell.* See Einheitskristall.

Einkristall: *monocrystal.* A body of appreciable size composed of a crystalline substance and formed with

one continuous crystalline structure throughout, not as a mass of small crystals having various orientations.

einphasisch: *single-phase.* Utilizing a single a.c., as a single-phase motor.

einpolige Induktion: *unipolar induction.* The generation of an e.m.f. by a continuous cutting of magnetic flux in one direction, without reversal or cyclic action; e.g., as in a metal disk rotating continuously between the poles of a magnet.

Einstein-de Haas Effekt: *Einstein-de Haas effect.* An angular momentum imparted to a free body by suddenly magnetizing it; the converse of the Barnett effect.

Einstein'sche photo-elektrische Gleichung: *Einstein photoelectric equation.* Expresses the kinetic energy of an escaped photoelectron as

$$E_R = hv - p,$$

in which hv is the energy quantum of the incident radiation and p is the photoelectric work function for the metal concerned.

Einstein'sche Verschiebung: *Einstein shift.* A shift toward the red in the spectral lines of light which, according to the relativity theory, has its frequencies slightly reduced upon emerging from a strong gravitational field, such as that of a dense star.

Einstein'sche Koeffizienten: *Einstein coefficients.* Quantities which represent the probabilities of the emission or of the absorption of radiation quanta by an atom within a unit of time.

Einthoven Galvanometer: *Einthoven galvanometer, string galvanometer.* A type of galvanometer in which the current is measured by the lateral displacement of a wire carrying the current across a strong magnetic field. Devised by Einthoven.

Eiskalorimeter: *ice calorimeter.* A calorimeter in which quantities of heat are measured by the quantity of ice melted. Developed by Black, Bunsen, and others.

Eispunkt: *ice point.* The freezing point of water, viz., 0 degree C. or 273.18 degrees K.

elastische Dehnungswaerme: *heat of elastic extension.* See Dehnungswaerme.

elastische Streuung: *elastic scattering.* Scattering by elastic impact, i.e., without loss of kinetic energy.

elastischer Nacheffekt: *elastic aftereffect.* The persistence of a strain, though gradually diminishing, after the stress has been removed from an elastic body.

elastischer Nachwirkungseffekt: *elastic aftereffect.* See elastischer Nacheffekt.

elastischer Stoss: *elastic collision, e. impact.* An encounter between moving bodies or corpuscles, subject to the ideal condition that the total kinetic energy of translation is the same after the impact as it was before; i.e., none of the energy is transformed into rotational or other form.

Elastizitaet: *elasticity.* That property of a body or a substance, by virtue of which it develops stresses when subjected to strain, and therefore tends to resume its original configuration. Kelvin defines a perfectly elastic body as one in which a given state of strain always corresponds to the same distribution of stress, however prolonged or however often repeated, provided the temperature remains unchanged.

Elastizitaetsgrenze: *elastic limit, proportional limit, P-limit, limiting stress.* The stress required to produce, in a given material, a permanent deformation of measurable amount, and at which the Hooke law ceases to hold.

Elastizitaetsmesser: *elasmometer.* An instrument for the study of Young's modulus and other elastic constants, esp. by optical methods.

Elastizitaetsmodul: *elastic modulus.* See Druckmodul, Young'scher Modul.

Elektret: *electret.* A dielectric which exhibits dielectric absorption, i.e., still retains part of its electric polarization after the removal of the external field.

elektrische Abschirmung: *electric screening.* The device of completely surrounding any object or region by a closed metallic shell or casing, in order to exclude all extraneous electrostatic influence.

elektrische Absorption: *electric absorption.* See dielektrische Absorption.

elektrische Achse: *electric axis, piezo-electric axis.* One of the directions in a crystal in which either tension or compression will cause it to develop piezo-electric charges.

elektrische Dichte: *electric density.* The quantity of electricity per unit volume in any part of a space charge.

elektrische Doppelbrechung: *electric double refrac-*

tion. An electro-optical effect; viz., certain transparent, normally isotropic substances become doubly refracting when subjected to an electric field transverse to the beam of light.

elektrische Doppelschicht: *electric double layer, Syn. Helmholtz double layer.* A limited region which includes the surface of a metal in contact with an electrolytic medium, and contains a layer of positive metallic ions in the electrolytic medium and an adjacent layer of negatively charged metal. The term is due to Helmholtz.

elektrische Faellung: *electric precipitation.* The collection of dust or other finely divided matter by means of the inductive action of an electric field.

elektrische Induktion: *electric induction.* A redistribution of electricity which takes place in a conductor when placed in an electric field.

elektrische Konvektion: *electric convection.* An electric current consisting of electric charges carried by means of charged bodies of appreciable size, as by the "carriers" of a static machine or by electrified drops of liquid.

elektrische Kraft: *electric force, e. intensity.* A vector quantity pertaining to the electric field, the measure of which, at any point in a vacuum, is the force per unit charge which would act upon a charged particle placed at that point. It is closely related to electric displacement.

elektrische Polarisation: *electric polarization.* (1) See dielektrische Polarisation. (2) (v.) To produce an electrical separation or orientation, esp. in the molecules of a dielectric.

elektrischer Durchschlag: *electric breakdown.* An electric discharge which takes place by reason of a transformation within the dielectric, rendering it, at least temporarily, a conductor; a disruptive discharge.

elektrischer Fluss: *electric flux.* The surface integral, over any specified area, of the normal component of the electric displacement.

elektrischer Hammer: *interrupter.* A device for rapidly and periodically breaking and closing an electric circuit, as that of the primary of an induction coil.

elektrischer Niederschlag: *electric precipitation.* See elektrische Faellung.

elektrischer Vektor: *electric vector.* That component of the electromagnetic field associated with electromagnetic radiation which is of the nature of an electric field; supposed to coexist with, but to act at right angles to, the magnetic vector.

elektrischer Wind: *electric wind.* A current of air or other gas repelled from an electrified, pointed conductor, or carried along by streams of ions moving in the electric field.

elektrisches Bild: *electric image.* A fictitious distribution of electricity, mathematically equivalent in its effect to an actual distribution induced on a conductor, and related to the inducing charge in a manner somewhat analogous to the relation of a virtual image to the source of light.

elektrische Schwingung: *electric oscillation.* An a.c. having a natural frequency dependent upon the nature of the circuit, rather than upon the alternating character of the impressed e.m.f. Or, in general, any h.–f. a.c.

elektrisches Moment: *electric moment.* That vector, associated with a system having electric displacement, whose vector product by the electric intensity of the field in which the system is placed gives the resulting torque upon the same, the electric intensity considered being exclusive of any component contributed by the system itself. For a dipole with concentrated charges the electric moment is approximately the product of the magnitude of either charge by the distance between them, and its direction is that of the line drawn from the negative to the positive charge.

elektrisches Potential: *electric potential.* (1) A scalar point function, the measure of which is the energy per unit charge involved in the transfer of an infinitesimal quantity of positive electricity, from an infinite distance to the point in question. More briefly: The line integral of the electric intensity from the point to infinity. The potential is positive or negative according to whether work must be expended to bring the positive charge from infinity or to carry it to infinity from the given point. Any arbitrary zero, as the potential of the earth, may, however, be used. (2) Sometimes loosely applied to p.d. or to e.m.f.

elektrische Streckung: *electric stress.* The condition within a dielectric which is brought about by electric polarization, and under which the dielectric tends to recover its normal condition when the cause of the polarization is removed.

elektrische Suszeptibilitaet: *electric susceptibility, Syn. dielectric susceptibility.* The ratio of the polarization in a dielectric to the electric intensity responsible for it.

elektrische Verschiebung: *electric displacement.* A vector quantity usually associated with the condition of a substance in an electric field. When a dielectric is placed in the field, the dielectric polarization and the electric intensity in the substance are both proportional to the displacement, their ratios to it depending upon the dielectric constant.

elektrische Welle: *electric wave.* (1) A wave of varying electric density and potential in a conductor, such as the telephone line. (2) Electromagnetic radiation produced by the oscillations of electricity in a conductor; e.g., radio waves. First demonstrated by Heinrich Hertz in 1888 and known as Hertzian radiation or Hertzian waves.

elektrochemische Konstante: *electrochemical constant, Faraday electrolytic constant.* The quantity of electricity which, in electrolysis, is required to liberate a gram atom of any univalent element; viz., approximately 96,494 international coulombs per gram equivalent.

elektrochemisches Aequivalent: *electrochemical equivalent.* The mass of a substance liberated in electrolysis, per unit quantity (coulomb) of electricity passing through the electrolyte.

Elektrode: *electrode.* A surface of contact between a metallic and a non-metallic conductor (metallic includes such conductors as carbon).

elektrodenlose Entladung: *electrodeless discharge.* A luminous discharge in a gas confined in a closed tube without internal electrodes, due to subjecting the gas to a rapidly alternating electric field through the condenser action of the tube wall or to the inductive action of the current in a neighboring h.–f. circuit.

Elektrodialyse: *electrodialysis.* Dialysis under the influence of an electric potential gradient; analogous to electroosmosis.

Elektrodynamik: *electrodynamics.* That branch of physics which deals with the forces and energy transformations related to electric currents and the magnetic fields associated with them.

Elektrodynamometer: *electrodynamometer.* An instrument for measuring electric current by means of the interaction between parts of a single circuit carrying the current.

Elektroendosmose: *electro-endosmosis.* Cataphoresis, i.e., the movement of solid particles in liquid suspension under the action of an e.m.f., esp. when the liquid component of the suspension migrates, while the solid remains stationary.

elektrographisch: *electrographic.* A term applied to the effect of cathode rays on a metal surface, in which the metal becomes less subject to the action of corrosive vapors, and which may be used to produce developable cathode-ray images.

Elektrokapillaritaet: *electrocapillarity.* The effect of an electric current upon the equilibrium of the interface between two liquids in a capillary tube, consisting apparently in a modification of the surface tension.

Elektrokinetik: *electrokinetics.* That branch of physics which deals with electricity in motion.

elektrokinetisches Potential: *electrokinetic potential.* The p.d. which exists across the Helmholtz double layer at the interface between a solid and a surrounding liquid; a term due to Freundlich. Syn., zeta potential.

Elektrolyse: *electrolysis.* A chemical process which occurs at the interface between an electrode and an electrolyte when an unidirectional current passes from one to the other.

Elektrolyt: *electrolyte.* (1) A conducting medium in which the current consists of charges borne by carriers of atomic or molecular dimensions (ions). (2) A substance which conducts ionically either in the pure state or when dissolved in a suitable medium.

Elektrolytgleichrichter: *electrolytic valve.* An electric current rectifier based on the nonsymmetrical resistance of certain electrolytic cells.

elektrolytische Kapazitaet: *electrolytic capacitance.* The capacitance of a cell acting as an electrolytic condenser.

elektrolytischer Kondensator: *electrolytic condenser.* A polarized electrolytic cell used as a condenser of large capacitance.

electromagnetische Einheit: *electromagnetic unit.* Any electric unit based primarily upon the magnetic effect of the electric current. The fundamental c.g.s. unit in the system is the abampere.

elektromagnetische Induktion: *electromagnetic induction, magnetoelectric induction.* The production of an e.m.f. by the cutting of magnetic flux (whether the moving conductor cuts the flux or vice versa), e.g., in an electric generator. First observed by Faraday in 1831.

elektromagnetische Konstante: *electromagnetic constant.* A natural constant, having the dimensions of linear speed, which appears in the expressions for many relations between electric and magnetic quantities, and

is commonly denoted by c. E.g., the abcoulomb is equal to c times the e.s.u. charge. c plays its most familiar role as the speed of electromagnetic radiation in a vacuum. Its value is about 2.9977×10^{10} cm per second.

elektromagnetische Masse: *electromagnetic mass.* The mass associated with a moving electric charge by reason of the fact that the energy of the magnetic field which it produces is proportional to the square of the speed. The mutual electromagnetic mass of two like charges moving side by side is greater than the sum of their separate electromagnetic masses.

elektromagnetisches Feld: *electromagnetic field.* A region of space which is the seat of electromagnetic energy, by virtue of a rapidly moving electric field which sets up a coincident, moving magnetic field at right angles to the lines of electric force and to their direction of motion. This condition is believed to exist in the space traversed by electromagnetic radiation.

elektromagnetisches Moment: *electromagnetic momentum.* A momentum which, according to the theories of Maxwell and J. J. Thomson, exists in an electromagnetic field, and whose magnitude per unit volume is equal to the product of the electric and the magnetic field intensities divided by the electromagnetic constant c.

elektromagnetische Strahlung: *electromagnetic radiation.* See Ausstrahlung (1).

elektromagnetische Waage: *electromagnetic balance.* An instrument which measures electromagnetic forces by balancing them against gravity, e.g., the Kelvin balance.

elektromagnetische Wellen: *electromagnetic waves.* Waves of electromagnetic radiation.

Elektromagnetismus: *electromagnetics.* That branch of physics which treats of the mutual relationships existing between electric currents and the attendant magnetic fields.

Elektromechanik: *electromechanics.* (1) A branch of electrical engineering which deals with machines producing or operated by electric currents, as generators and motors. (2) See Elektrodynamik.

Elektrometer: *electrometer.* An instrument for detecting or measuring p.d. by means of electrostatic forces exerted between electrically charged bodies; a calibrated electroscope.

elektromotorische Gegenkraft: *counter electromotive force, back electromotive force.* An e.m.f. which affects a circuit in the direction opposite to that of the current; due to such influences as self-induction, electrolytic polarization, etc.

elektromotorische Kraft: *electromotive force.* That which tends to alter the motion of electricity or to maintain its motion against resistance. Its measure is the energy per unit charge imparted to the electricity as it traverses the region in which the e.m.f. is operative; the units commonly employed being those of electric potential, e.g., joules per coulomb (volts).

elektromotorische Reihe: *electromotive series.* A series of different electrodes arranged in the order of their p.d.'s with normal solutions of their ions. There are two such series, one for positive and one for negative ions.

Elektron: *electron.* The negative elementary charge. (Most writers confine the term to this, though some refer to both negative and positive electrons.) The mass of an electron at rest is approximately 9×10^{-28} g.

Elektronenaffinitaet: *electron affinity.* (1) The tendency of an atom or molecule to attach free electrons and form negative ions. Its measure is the energy liberated upon the formation of the ion. (2) The p.d. corresponding to the energy necessary to separate an electron from a metal, as in photoelectric emission.

Elektronenbande: *electron band.* A molecular spectrum band, usually in the visible or the ultraviolet, due to electron transitions within the molecule; as distinguished from rotational and vibrational transitions, which give bands in the infrared.

elektronenberaubtes Atom: *stripped atom.* An atom which has in some manner lost most of its outer electrons.

Elektronengas: *electron gas.* An aggregation of electrons to which a kinetic theory may be applied, in some respects similar to the kinetic theory of gases.

Elektronenkanone: *electron gun.* A device for projecting a narrow stream of electrons in any desired direction, e.g., a slender tube closed at one end and with a thermionic filament at the bottom of the bore, the whole being negatively charged.

Elektronenleitung: *electronic charge, Syn. elementary charge.* The natural unit or quantum into which electric charges, positive or negative, appear to be subdivided. Its value has been found by electrical methods to be about 4.77×10^{-10} e.s.u.; X-ray and electron-wave data indicate a slightly higher value.

Elektronenlehre: *electronics.* That branch of physical science which treats of electrons and of phenomena as

explained in terms of them, i.e., the electron theory; applied by some writers esp. to electronic vacuum-tube phenomena.

Elektronenlinse: *electron lens.* An electric field, such as that about a circular opening in a charged metal plate, which acts upon an electron stream in a manner analogous to the action of a lens upon a beam of light.

Elektronenmikroskop: *electron miscroscope.* A device for producing effects on streams of electrons, analogous to those produced on light rays in a microscope; a non-uniform magnetic or electric field being employed for the purpose.

Elektronenoptik: *electron optics.* A system of controlling beams or rays of electrons by means of suitably adjusted electric or magnetic fields, the electron rays being thus made to imitate the rays of light in an optical instrument.

elektronenoptische Blende: *electro-optical shutter.* A device for controlling or cutting off a beam of light by means of the Kerr electro-optical effect.

Elektronenquantenzahl: *electron quantum number.* One of a set of numbers which serve to describe the quantum states of electrons within atoms and molecules or the state of the electron system as a whole, and including a variety of special types.

Elektronenrohr: *electron gun.* See Elektronenkanone.

Elektronenroehre: *electron tube.* A vacuum tube in which the motion of electrons is especially important, e.g., a thermionic, a photoelectric, or an X-ray tube.

Elektronenteleskop: *electron telescope.* A device by means of which an infrared image of a distant object, focused upon a photosensitive cathode, gives rise to an enlarged electron image on a fluorescent screen.

Elektronenuebergang: *electron promotion.* An increase in the principal quantum number of an electron, which may take place when the atom to which it belongs combines with another atom to form a diatomic molecule. Since it involves an increase in energy, such promotion renders the influence of the electron in question unfavorable to the union.

Elektronvolt: *electron-volt, volt electron, equivalent volt.* A unit of energy, equal to about 1.591×10^{-12} erg, and defined as the change in energy experienced by 1 electronic charge on passing through a p.d. of 1 volt.

Elektronenwelle: *electron wave, de Broglie wave.* See de Broglie-Welle.

Elektrononwellenlaenge: *electron wave length.* The wave length associated with a moving electron.

Elektronenniederschlag: *electrodeposition.* The depositing of a substance upon an electrode by electrolysis, as in electroplating.

Elektronik: *electronics.* See Elektronenlehre.

Elektronogen: *electronogen.* A molecule or group of molecules which, according to the Kowalski theory of luminescence, emit electrons under the influence of light.

Elektroosmose: *electric osmosis.* The contact electrification of two dielectrics or of a dielectric and a conductor or semiconductor.

electro-osmosis, electromosis. The movement of liquids through membranes or capillary tubes under the influence of an e.m.f.

Elektrophor: *electrophorus.* An apparatus consisting of an electrified plate of some dielectric such as vulcanite, and, resting upon it, a metal disk provided with an insulating handle; used as a convenient means of generating, by induction, an indefinite succession of nearly equal electric charges.

Elektrophorese: *electrophoresis.* The migration of particles or ions in a fluid under the influence of an electric field.

Elektrophotophorese: *electrophotophoresis.* A propulsive effect of an intense beam of light upon very small particles (of the order of 1 micron in diameter) in suspension in the air; the particles moving in the either toward or away from the light source. The effect becomes less as the pressure increases. In electrophotophoresis (photophoresis in an electric field) and in magnetophotophoresis (photophoresis in a magnetic field) the particles have a component of motion in the direction of the field.

Elektroskop: *electroscope.* Any one of several types of instrument for the detection of small charges of electricity.

Elektrostriktion: *electrostriction.* A deformation of a dielectric caused by subjecting it to an electric field.

Elektrostatik: *electrostatics.* That branch of physics which treats of the properties of electricity which do not depend upon its motion.

elektrostatische Analyse: *electrostatic analysis.* (1) The separation of a stream of electrified particles by an electric field in accordance with their mass, their

charge, or their speed, as in a mass spectrograph. The apparatus used for this purpose is called an electrostatic analyzer. (2) In general, any process of separation or sorting by an electric field.

elektrostatische Einheit: *electrostatic unit.* Any electric unit based primarily upon the mutual dynamic interaction of electric charges. The fundamental c.g.s. unit in this system is the electrostatic unit charge which, if concentrated upon a small sphere, would repel a similar charge 1 cm distant in a vacuum with a force of 1 dyne.

elektrostatischer Generator: *electrostatic generator.* One of several recent designs of static machine, commonly employing endless belts of insulating material which discharge inside the hollow terminals.

elementares Wirkungsquantum: *elementary quantum of action, Planck constant.* A constant h having the dimensions of action (energy × time) and appearing in many physical formulas; approximate value, 6.547×10^{-27} erg-sec. In particular it represents the ratio of the energy of any radiation quantum to its frequency. First recognized by Planck in 1900.

Elementarladung: *elementary charge.* See Elektronenladung.

Elementarzelle: *elementary cell, unit cell, unit crystal, lattice unit.* See Einheitszelle.

Ellipsenzirkel: *trammel.* A mechanism consisting of a movable, straight bar, two relatively fixed points of which are constrained to move along grooves or tracks intersecting at right angles. Used for drawing ellipses, and in the Rowland mounting for concave gratings.

elliptische Polarisation: *elliptic polarization.* Polarization in which the cycle is an ellipse.

Emanation: *emanation.* A term applied by Rutherford to the gaseous radioactive products formed by the expulsion of an alpha particle from radium, from thorium X, or from actinium X; now internationally designated as radon, thoron, and actinon, respectively.

Emissionsspektrum: *emission spectrum.* The spectrum of a substance, as displaying the radiation which it emits; in contrast to the absorption spectrum.

Emissionsstaerke: *emissive power, intrinsic radiance.* The time rate of emission of radiant energy, in all directions, per unit surface area of a radiating body at a given temperature. The amount thus radiated within an infinitesimal wave length range $d\lambda$ is $\epsilon_\lambda d\lambda$, in which ϵ_λ may be termed the monochromatic emissive power, as distinct from the total emissive power just defined.

Emissionsstaerke: *emissivity.* The ratio of the total emissive power of a surface to that of a black body at the same temperature. If confined to the radiation within an infinitesimal wavelength range, it may be called monochromatic emissivity. It varies somewhat with temperature.

Emissionsvermoegen: *emissive power, radiating power.* See Emissionsstaerke.

Emissionswaerme: *heat of emission.* The additional heat energy that must be supplied to a surface which is emitting electrons, in order to maintain it at a constant temperature; analogous to heat if vaporization.

Emission von positiven Ionen: *positive-ion emission.* Thermionic emission of positive particles; ions either of the metal itself or, commonly, due to some impurity.

Empfindlichkeit: *sensitiveness, sensibility, sensitivity.* (1) A term applied to various measuring instruments, defined as the change in reading per unit of measured quantity. (2) (Phot.) The rate of chemical response of a photographic plate or film to light or other actinic emission.

Emulsion: *emulsion.* (1) The photographically sensitive coating which is applied to glass or celluloid in the preparation of photographic plates or films. (2) A colloidal solution, esp. one in which the suspended particles are an oily liquid.

enantiomorph: *enantiomorphic, enantiomorphous.* In re two crystalline or molecular structures: having a bilateral symmetry with respect to each other, but incapable of being superposed; after the manner of a right and a left shoe.

enantiotrop: *enantiotropic, monotropic.* Occurring in two solid modifications, either of which is transformable into the other at a definite temperature.

Endgeschwindigkeit: *terminal velocity.* The equilibrium velocity attained by a body or a particle moving in a field of force through a resisting medium, e.g., the velocity finally attained by a body falling freely through the air, when the frictional resistance becomes equal to the weight of the body.

Endkorrektion: *end correction.* A modification of the computed frequency of an organ pipe or similar acoustic apparatus, necessary because of the effect of the open end.

Endosmose: *endosmosis.* The unidirectional diffusion of fluids through membranes or porous partitions, which results in osmotic pressure. The phenomenon is termed

endosmosis when the diffusion is inward, toward the interior of the osmotic cell.

endotherm: *endothermic, endothermal.* Involving the taking in of energy, esp. of heat energy, e.g., the melting of ice.

Endprodukt: *end product.* The final, nonradioactive element of a radioactive series.

Energie: *energy.* A physical entity, capable either of direct association with matter or (apparently) of independent existence. Energy is transferred from one body to another whenever the one does work on the other. This affords an expedient measure of energy, viz., the quantity of work done in the process of transfer; work units are thus also commonly used as energy units. According to the relativity theory, matter and energy are interconvertible in the ratio c^2 absolute units of energy to 1 unit of mass (c being the electromagnetic constant).

Energiebande: *energy band.* In re a crystal: the set of energy values corresponding to the wave functions belonging to one or more of the Brillouin zones of the crystal.

Energiedichte: *energy density.* The quantity of energy per unit volume in a given region.

Energieellipsoid: *energy ellipsoid, Poinsot ellipsoid.* An ellipsoid drawn with reference to a rigid body in free rotation (under no external torque) about a changing instantaneous axis, and used to illustrate the constancy of the rotational energy.

Energiegleichung: *energy equation.* (1) An equation which expresses the energy of a system in terms of a system in terms of variables defining its configuration. (2) An integral equation connecting the variables relating to the motion of a particle, which results from the solution of the differential equations expressing the components of force acting upon the particle.

Energieniveau: *energy level, quantum state.* One of the several discrete states in which an atom or a molecule may exist, permanently or momentarily, transitions between which are thought to cause the emission of distinct radiation frequencies and quanta, corresponding to lines of the spectrum.

Energiestufe: *energy level.* See Energieniveau.

Energiestufendiagramm: *centroid diagram.* A diagrammatic scheme for the comparison of atomic electron energy levels in successive elements.

Energiewall: *energy wall, potential barrier.* A region in which the electric potential is such that moving electric charges attempting to traverse it encounter opposition and may be turned back.

entgasen: *outgas, degas.* To free from occluded or adsorbed gases by the application of heat.

Entglasung: *devitrification.* Crystallization of a vitreous or amorphous substance upon subjection to a suitable temperature; sometimes accompanied by a considerable evolution of heat.

Enthalpie: *enthalpy.* A term applied by H. K. Onnes to the Gibbs function $x = u + pv$ and superseding total heat, heat content, and heat of formation. (2) For a fluid system subject to no outside forces except a uniform, normal pressure, it is the thermodynamic potential for constant entropy and pressure. A process in which this quantity is constant is said to be isenthalpic.

Entladungskoeffizient: *discharge coefficient.* The correction factor by which the theoretical rate of (volume) discharge through an orifice, $\pi r^2\sqrt{2gh}$, must be multiplied to give the actual rate as determined by experiment.

Entladungsroehre: *discharge tube, vacuum tube.* A general term applying to tubes or bulbs supplied with electrodes between which electric discharge takes place, and operated at pressures ranging from slightly below atmospheric to the lowest attainable Radio tubes and other triodes are also included.

Entladungsschalter: *discharge key.* A device for suddenly switching the connections of a condenser from the charging circuit to a circuit through which it discharges.

Entladungsstrahlen: *Entlagungsstrahlen, discharge rays.* A radiation from spark discharges, which produces marked ionizing and thermoluminescent effects and is absorbed by fluorite. When produced in air at atmospheric pressure, the wave-length range extends from 400 to 1000 Å, with shorter wave lengths at lower pressures.

Entmagnetisierungsfaktor: *demagnetizing factor, demagnetizing coefficient.* The factor by which the magnetization must be multiplied to give the oppositely directed magnetic intensity associated therewith (demagnetizing field). In an ellipsoid with uniform magnetization, this factor has the same value at every point.

Entmagnetisierungsfeld: *demagnetizing field.* That component of the magnetic intensity in a ferromagnetic body which is due to the magnetization of the body

itself and which depends only upon its magnetization and shape.

Entmodulator: *demodulator.* A detector for h.–f. carrier telephone signals.

Entropie: *entropy.* A quantity introduced by Clausius. The entropy associated with an isolated physical system has the characteristic property that, as the system spontaneously settles into a final, steady state, the entropy approaches a maximum. It may be regarded as a measure of the degree in which the energy of the system is unavailable.

Entropiefunktion: *entropy function.* An expression for the entropy of a body as a function of the temperature. For a gas it takes the form of the Sackur equation.

Eoetvoes'sche Waage: *Eoetvoes balance.* A form torsion balance especially designed for the detection and measurement of local irregularities in gravity.

Eoetvoes-Ramsey-Shield'sches Gesetz: *Eoetvoes-Ramsey-Shields law.* An empirical rule which states that the surface tension of a liquid is proportional to $T_c - T - 6^o$, in which T is the absolute temperature of the liquid and T_c the absolute value of its critical temperature.

Epstein'scher Apparat: *Epstein apparatus.* A type of transformer used primarily for the measurement of core losses. Devised by J. Epstein (1911).

Erdinduktor: *earth inductor.* A coil, the sudden rotation of which in the earth's magnetic field causes a surge of electricity and thus affords a means of measuring the intensity of the field.

Erg: *erg.* The absolute c.g.s. unit of energy and work, whose length and force factors are the centimeter and the dyne; i.e., the centimeter-dyne.

Ergometer: *ergometer.* An apparatus for measuring energy as it is transferred, e.g., from one machine to another. It commonly takes the form of a friction brake and a speed indicator.

Erg-Sekunde: *erg-second.* The c.g.s. absolute unit of action.

Erhaltung: *conservation.* The preservation of a constant amount, as of mass, of momentum, or of energy.

Erhoehen: *step-up.* A term relating to the increase of voltage by a transformer or equivalent device.

erlaubte Abweichung: *tolerance.* The maximum error, or variation from the standard, permissible in a measuring instrument, e.g., a weight.

Ermuedung: *fatigue.* The gradual decrease of some characteristic property due to external causes; e.g. of the photoelectric sensitivity of certain surfaces upon prolonged exposure to light.

Ermuedungsgrenze: *fatigue limit.* The range of stress to which an elastic material may be subjected a stated number of times in succession without fracture.

Ermuedungsstaerke: *fatigue strength.* See Ermuedungsgrenze.

Erniedrigen: *step down.* A term relating to the decrease of voltage by a transformer or equivalent device.

Eriometer: *eriometer.* An apparatus, due to Young, for measuring the diameters of very small objects by diffraction.

Ersetzen einer Ecke oder Kante durch Flaechen: *replacement.* The occurrence of crystal faces which develop in place of edges or apexes, thus apparently truncating the latter. If such a face makes equal angles with two adjacent faces which would otherwise form an edge, it is said to be a bevel face.

erster Dunkelraum: *primary dark space.* A narrow, nonluminous region which appears between the cathode and the cathode glow in certain gases.

erstes (u.s.w.) Funkenspektrum: *first (etc.) spark spectrum.* The spectrum of a singly (doubly, etc.) ionized element.

erzwungene Doppelbrechung: *forced double refraction.* Double refraction produced in an otherwise isotropic medium as a result of strain.

erzwungene Schwingung: *forced vibration.* A nonresonant vibration imposed upon a body or a system by some external agency, by which the frequency is also controlled.

Esclangon'scher Effekt: *Esclangon effect.* The deviation of a ray of reflected light, due to the motion of the mirror in a direction oblique to its surface.

Etalon: *étalon.* A type of interferometer for producing interference effects by means of multiple reflection between fixed parallel, half-silvered glass plates. Devised by Fabry and Perot.

Ettingshausen'scher Effekt: *Ettingshausen effect.* A difference of temperature which develops between the

two edges of a strip of metal, in which an electric current is flowing longitudinally, when the plane of the strip is set perpendicularly across a magnetic field.

Euler'sche Formel: *Euler formula.* A formula for the load P which an elastic column of length l, sectional moment of inertia I, and Young modulus E, will sustain; viz.,

$$P = \frac{4\pi^2 EI}{l^2}$$

Euler'sche Gleichungen: *Euler equations.* Three differential equations of motions of a rigid body, referred to the principal axes through the c.m. as coordinate axes (X, Y, Z). They are:

$$I_x \frac{dw_x}{dt} - w_y w_z (I_y - I_z) = Q_x,$$

$$I_y \frac{dw_y}{dt} - w_z w_x (I_z - I_x) = Q_y,$$

$$I_z \frac{dw_z}{dt} - w_x w_y (I_x - I_y) = Q_z;$$

in which I is the moment of inertia, w is the angular velocity component, and Q is the torque component, about the corresponding principal axis.

eutektisch: *eutectic.* In re a mixture or a solution: in such proportions that all ingredients solidify or liquify at the same temperature; which is also the minimum solidification temperature for all, mixtures of the same substances.

eutektoid: *eutectoid.* Similar to eutectic, except that it has reference to a solid solution, which resolves into separate components while in the solid state. Certain kinds of steel have this property.

Eve'sche Konstante: *Eve constant.* The number of ions produced per cm^3 per sec in air at N.T.P., at a distance of 1 cm from a source of radium C in equilibrium with 1 curie of radon. Its value is approximately 3.56×10^9.

Exosmose: *exosmosis.* The unidirectional diffusion of fluids through membranes or porous partitions, which results in osmotic pressure. The phenomenon is termed exosmosis when the diffusion is outward, toward the exterior of the osmotic cell.

exotherm: *exothermic, exothermal.* Involving the giving out of energy, esp. of heat energy; e.g., the condensation of steam.

expandierendes Universum: *expanding universe.* See ausdehnendes Universum.

Expansionskammer: *expansion chamber, cloud chamber, fog c.* A closed space containing saturated water vapor which, upon sudden expansion, reveals the presence of condensation nuclei by the visible droplets formed upon them; or in which rapidly moving particles are revealed by the streaks of droplets, or tracks.

Expansionskoeffizient: *expansion coefficient, expansivity.* See Ausdehnungskoeffizient.

Explosionsspektrum: *explosion spectrum.* The spectrum of the light produced by an explosive reaction or by electrically "exploding" a metallic wire or filament by a heavy current.

Extinktion: *extinction.* (1) The decrease of intensity in radiation due to both absorption and scattering by the medium traversed. (2) Specifically, the shielding of inner layers of atoms in a crystal from incident X-rays by the outer layers.

Extinktionskoeffizient: *extinction coefficient, total absorption coefficient.* In re any type of radiation traversing a material medium: the absorption coefficient plus the scattering coefficient.

Extinktionsphotometer: *extinction photometer.* A photometer in which the luminous intensity of a source of light is judged by the thickness of a given absorbing material necessary to render it invisible.

Extraktionsenergie: *extraction energy.* See Ablosungsenergie.

extrapolieren: *extrapolate.* To estimate the value of a function for values of the variable lying outside the range in which values of the function are known; as by extending the graph of the function beyond the actually plotted points.

f-Elektron: *f-electron.* An orbital electron whose energy state is denoted by the azimuthal quantum number 3.

f-Wert: *f-value.* The atom form factor, taken with reference to the center of the atom.

F-Wert: *F-value.* A symbol used by some writers for the atom form factor taken with reference to the lattice point corresponding to the atom, rather than to the center of the atom itself.

F-Zustand: *F-state, F-level.* The state of an atom in which the azimuthal quantum number is 3.

Fabry-Perot Interferometer: *Fabry-Perot interferometer.* A multiple-reflection instrument of very high resolving power, simpler than the Michelson type. It resembles an étalon, but with the distance between the plates variable by means of a micrometer screw.

Fadenkreuz: *reticle, reticule.* A network or a single pair of cross hairs placed in the focal plane of an optical instrument to serve as a reference system.

Fadenmesser: *fathometer.* An instrument devised by H. G. Dorsey for supersonic ocean sounding. A neon tube, which rotates as an index around a circular dial, indicates the depth directly in fathoms by flashing upon the arrival of the echo.

Fadenmikrometer: *filar micrometer.* A micrometer, the screw of which moves a fine wire or filament across the focal plane of a microscope or a telescope, and which can thus be used to measure the size of, or the angle subtended by, the object under examination.

Faerbung: *hue.* That attribute of certain colors which permits them to be classed as reddish, yellowish, greenish, or bluish.

Fajans und Soddy'sche Gesetze: *Fajans and Soddy laws.* The radioactive "displacement laws," which state that, upon the disintegration of a radioactive atom, (1) the emission of an alpha particle results in a new radioactive element with atomic number 2 units less, and (2) the emission of a beta particle results in a new element with atomic number 1 unit more, than the disintegrating atom.

Fallbeschleunigung: *Acceleration of gravity.* The acceleration of a freely falling body due to the attraction of gravity, expressed as the rate of increase of velocity per unit of time; usually denoted by g. Its value varies slightly in different localities, being 980.621 cm (32.17 feet) per second per second at the sea level in latitude 45 degrees.

falsche Linie: *ghost.* A false line appearing in a grating spectrum, due to some defect of the grating.

Farad: *farad.* A unit of capacitance corresponding to 1 coulomb per volt and equal to 10^{-9} abf, named from Faraday. A more convenient unit is the microfarad, or 10^{-6}f.

Farad'sche Bruecke: *farad bridge.* A capacitance bridge arranged to read capacitances directly in microfarads.

Faraday: *faraday, faraday electrolytic constant.* Objectionable because of its resemblance to farad.

Faraday elektrolytische Konstante: *Faraday electrolytic constant, Faraday electrochemical constant.* The quantity of electricity which, in electrolysis, is required to liberate a gram atom of any univalent element; viz. approximately 96,494 international coulombs per gram equivalent.

Faraday'sche Gesetze: *Faraday laws.* Two laws of electrolysis, which state: (1) That the mass of any substance liberated by electrolytic action is in proportion to the quantity of electricity passing through the cell. (2) The masses of different substances liberated upon the electrolytic conduction of equal quantities of electricity are in proportion to the combining equivalents of those substances. Also: (3) The law of magneto-electric induction, viz., the e.m.f. induced in a circuit by the variation of the magnetic linkage with that circuit is proportional to the rate of variation of the linkage.

Faraday'sche Konstante: *Faraday constant.* See elektrochemische Konstante.

Faraday'scher Dunkelraum: *Faraday dark space.* The nonluminous region separating the negative glow from the positive column in a Crookes tube at moderate pressure.

Faraday'scher Effekt: *Faraday effect, magnetic rotation, magneto-optical.* A magneto-optical phenomenon, viz. the rotation of the polarization plane of polarized light by an otherwise isotropic medium subjected to a magnetic field coincident in direction with the beam of light; discovered in 1845.

Faraday'scher Kaefig: *Faraday ice pail.* A hollow, closed or nearly closed, insulated metal receptacle, used to demonstrate that when a charge is communicated to the inside of a hollow conductor it appears on the outside. (Faraday originally used a tin ice pail for this purpose.)

Faraday'sche Roehre: *Faraday tube, tube of force.* A

region in a field of force, of tubular form, having its lateral surface made up of lines of force, so that the intensity at any point of that surface is tangential to it, and the flux is the same through all cross sections.

Faraday'scher Zylinder: *Faraday cylinder, F. collector.* A hollow, insulated metal cylinder, nearly closed, and placed so as to catch charged particles, the whole charge of which then appears upon its surface.

Farbe: *color.* A term used in re those attributes of visual sensation which do not depend upon shape, size, or other spatial characteristics of the image. Thus if two uniform circular disks of equal size and at equal distances do not look alike, that fact is due to a difference in one or more of the three attributes of color, namely, hue, saturation and brilliance.

Farbentemperatur: *color temperature.* In re a source of radiation: the temperature of a black body in color match with it. A definite color temperature can be assigned only to radiators whose energy distribution does not differ greatly from that of a black body.

faserig: *funicular.* Pertaining to, or made up of, rope or cord under tension; e.g., a funicular polygon.

Fatamorgana: *looming.* A type of mirage in which images of objects below the horizon appear in distorted form.

Fatamorganabild: *mirage.* An optical phenomenon produced by the presence of a stratum of heated air of varying density, across which the observer sees reflections, usually inverted and distorted, of distant objects.

Fedorov'sche Koordinaten: *Fedorov co-ordinates.* The distances, measured along the Cartesian co-ordinate axes (not necessarily rectangular) to the projections of the given point in space upon those axes. If the axes are rectangular, these co-ordinates are identical with the Cartesian co-ordinates, otherwise not. Used in crystallography.

Feld: *field.* (1) A region under the influence of some physical agency, e.g. gravitation, magnetism, etc. (2) Syn. field intensity. (3) The area or solid angle visible through an optical instrument.

Feldemission: *field emission, f. current, autoelectronic emission, cold emission.* The emission of electrons resulting from the application of intense electric fields.

Feldgleichung: *field equation.* One of the equations which specify the properties of a field of force; e.g., the Maxwell equations for the electromagnetic field.

Feldinduktionsspule: *flip coil.* A coil which may be suddenly rotated through 180 degrees in a magnetic field; the resulting current surge, measured by a ballistic galvanometer, indicates the intensity of the field.

Feldintensitaet: *field intensity.* A vector denoting the magnitude and the direction, at any point, of an influence distributed through a field.

Feldlinse: *field lens.* The anterior of the two lenses of the ocular of a telescope or a microscope, the effect of which is to enlarge the field of view.

feldlose Emission: *zero-field emission.* The thermionic emission from a hot conductor surrounded by a region of uniform electric potential.

Feldmagnet: *field magnet.* A magnet used to produce a magnetic field in some selected region, as in a motor or a generator.

Feldpunkt: *field stop.* An opening, usually circular, in an opaque screen, which determines the field of view of an optical instrument.

Feldspule: *field coil.* One of the coils used to excite a field magnet.

Feldstrom: *field emission, f. current, autoelectronic emission, cold emission.* See Feldemission.

Fehler: *fault.* An interruption in the continuity or a defect in the insulation of an electrical conductor, such as a telephone line or a cable.

Fehlergleichung: *error equation.* An equation expressing the probability of the occurrence of an error x:

$$p = \frac{h\Delta}{\sqrt{\pi}} e^{-h^2x^2}$$

h is the precision index or measure of precision, Δ the error interval, i.e., the smallest scale unit used in expressing the results of measurement and hence in expressing the errors.

Fehlstelle: *fault.* See Fehler.

Feinstruktor: *fine structure.* Refers to the occurrence of spectral lines as doublets, triplets, etc.

Feinstrukturkonstante: *fine-structure constant.* The quantity $2\pi e^2/ch$, in which e is the electronic charge, c the electromagnetic constant, h the Planck constant. The dimensions of these factors are such that the fine-structure constant is abstract. Its value is about 7.283

$\times 10^{-3}$ or 1/137. It plays a fundamental role in quantum theory and spectroscopy.

Feinstrukturquantenzahl: *fine quantum number, hyperfine quantum number.* The quantum number associated with the quantization of the resultant of nuclear and extranuclear angular momenta. Its name arises from its relation to hyperfine structure.

Fermat'sches Gesetz: *Fermat principle, F. law.* A principle, announced by Fermat about 1665, which states that when light passes from a point A to another point B, the time required for its passage is either a maximum or a minimum with respect to other adjacent, arbitrary paths. For points in two homogeneous media separated by a plane surface, or for reflection in a single homogeneous medium by a plane surface, the time is a minimum, in which case the law is commonly known as the principle of least time.

Fermat'sches Prinzip: *Fermat principle, F. law.* See Fermat'sches Gesetz.

Fermi-Dirac Statistik: *Fermi-Dirac statistics.* Differs from the Bose-Einstein statistics (q.v.) in that it imposes a specified upper limit to the number of molecules or quanta which may be contained in any one elementary compartment of the momentum space.

Fermi-Thomas Feld: *Fermi-Thomas distribution, F.–T. field.* The approximate theoretical distribution of the electric potential within and about an atom, based upon certain physical and statistical assumptions. If the local density matrix is represented by plane waves, it is the closest approximation to this potential; otherwise Hartree's self-consistent fields is closer.

Fermi-Thomas Verteilung: *Fermi-Thomas distribution, F.–T. field.* See Fermi-Thomas Feld.

Fernpunkt: *far point.* That point on the axis of the eye which is at such distance as to be seen distinctly when the accommodation is completely relaxed. i.e., when the focal power of the crystalline lens is least.

ferromagnetisch: *ferromagnetic.* A term used to characterize substances which have, at ordinary temperatures, a combination of magnetic properties including the following: their susceptibility is positive as in paramagnetic substances; but they exhibit appreciable remanence and hysteresis. The magnetization has a measurable saturation limit, ordinarily far in excess of any magnetization attainable by paramagnetic substances; and even when unmagnetized they appear to have small regions (domains) throughout each of which there is definite magnetization. Iron, nickel, cobalt, gadolinium, and many alloys are ferromagentic.

feste Loesung: *solid angle.* A portion of the whole of space about a given point, bounded by a conical surface with vertex at that point and measured by the area cut by the bounding surface from the surface of a sphere of unit radius centered at that point.

Feuchtigkeit: *humidity.* (1) (Absolute.) The percentage, by weight, of water vapor in the air. (2) (Relative.) The fraction of saturation of the water vapor in the air.

Feuchtigkeitsmesser: *Wet- and dry-bulb thermometer, psychrometer.* A hygrometer consisting of two identical thermometers, the bulb of one of which is kept wet with water supplied by a wick. The lowering of the temperature by evaporation indicates the relative humidity of the air.

Fick'sches Gesetz: *Fick law.* Expresses the rate of diffusion of a substance in solution as follows:

$$\frac{dm}{dt} = - Ds \frac{dC}{dx};$$

in which m is the mass diffused in time t through cross section s normal to the direction x, C is the concentration, and D is the diffusion coefficient.

fiktive Ladung: *fictitious charge, fictive c.* A term used to characterize the phenomena exhibited by a dielectric in an electric field, in contradistinction to the "true" induced charges on a conductor under the same conditions.

Filter: *filter.* (1) Any device which separates one or more of the ingredients of a mixture from the others. In particular: (2) (Radiation.) A selectively transparent body, which transmits only certain wave-length ranges. (3) (Electric.) A portion of a h.-f. circuit, which, by means of suitable inductances and capacitances, suppresses certain frequencies in a complex electric wave. (4) (Acoustic.) A device which acts on a sound in a manner analogous to an electric wave filter, by cutting out certain frequencies.

Fitzgerald-Lorentz'sche Kontraktion: *Fitzgerald-Lorentz contraction, Lorentz-Fitzgerald contraction, relativity contraction.* A hypothetical shrinkage of all matter in the direction in which it moves through the ether, such that all dimensions in this direction are reduced in the ratio

$$\sqrt{1 - \frac{u^2}{c^2}} : 1;$$

where u is the speed of the motion and c, the speed of light.

Fixierung: *fixation.* The act of orienting the eye so that a given point of the retinal image falls upon that point of the retina at which it may be most distinctly seen. The corresponding point of the actual object is the fixation point.

Flackern: *flicker.* The sensation produced by a fluctuation in brightness at a rate comparable to the reciprocal of the period of persistence of vision.

Flaechendichte: *surface density.* The quantity per unit area of anything distributed over a surface, e.g. of an electric charge.

Flaechenerhaltung: *conservation of areas.* A general principle of kinematics, illustrated by Kepler's second law of planetary motion.

Flaechenreduktion: *reduction of area.* The percentage ratio of the difference between the original and the broken area of cross section of a rod which has been pulled apart, to the original area.

Flaechenpolarisation: *plane polarization.* Polarization in which the cycle is a straight line, corresponding to a rectilinear vibration.

Flaechentraegheitsmoment: *angular impulse.* The time integral of a torque, esp. when applied for a short time; measured by the change in angular momentum which it would impart to a free mass if acting about a principal axis.

Flaechenwinkel: *interfacial angle.* The dihedral angle between two adjacent faces of a crystal.

flaechenzentriert: *face-centered.* In re a unit cell of crystal structure: having an atom at the center of each face.

Flaechenzentrum: *center of area.* In re a plane figure: that point which corresponds to the center of mass of an infinitely thin, uniform plate whose boundaries coincide with those of the plan figure.

Flammenbogen: *flaming arc, flame a.* An electric arc produced between carbons which have been impregnated with chemical salts.

Fleming-Kennelly'sches Gesetz: *Fleming-Kennelly law.* States that the reluctivity of a ferromagnetic material is a linear function of the magnetic intensity, as magnetic saturation is approached. Equivalent to the relation expressed by the Froehlich equation.

Fliehkraft: *centrifugal force.* The kinetic reaction exerted by a body under the influence of a force directed toward a fixed center.

Fliesspunkt: *yield point, y. value.* A value of the tensile stress, somewhat greater than the elastic limit, for which a rod of elastic material under tension begins to exhibit plasticity and stretches irregularly. Sometimes applied also to the corresponding shearing stress.

fluessiger Kristall: *liquid crystal.* A liquid that has optical anisotropy and other properties similar to those of a crystal, e.g., para-azoxyanisole. Such a substance is said to be in a liquocrystalline or mesormorphic state.

Fluechtigkeit: *fugacity.* A term employed in thermodynamics to denote quantitatively the tendency of a substance to escape or to disappear by some chemical process from the phase in which it is. The ratio of the fugacities if a substance in two different phases may be measured by the excess of free energy per mol in the one phase over that in the other.

Fluessigkeitsdruck: *Fluid pressure.*

Fluessigkeitsmanometer: *piezometer.* (1) A glass bulb, the stem of which is closed by a plug of mercury, and in which liquids may be placed for the purpose of studying their behavior under great pressure. (2) A simple liquid manometer.

Fluoreszenz: *fluorescence.* A type of luminescence, characterized by the fact that it is observable only so long as the stimulus responsible for it is maintained.

fluoreszenzerregender Stoff: *fluorogen.* A substance which promotes the fluorescence of another when mixed with it. Syn. activator.

Fluoreszenzmesser: *fluorometer.* (1) An instrument for the measurement of fluorescence. (2) A apparatus for photometric measurement in the ultraviolet by means of the fluorescence produced by it; devised by Winther.

Fluoroskop: *fluoroscope.* An instrument provided with a suitably mounted fluorescent screen, and used for detecting and studying X-rays or other emissions capable of exciting it.

Fluss: *flux.* (1) A term used in connection with fields of force, the flow of fluids, various types of emission, etc., and designating in general the surface integral of normal field intensity, or the quantity of fluid or of emitted energy per unit time, over a specified area. (2) A substance used to facilitate the fusion of a metal and to protect it from oxidation while in the fused state.

Flussbrechung: *flux refraction.* A change in the direction of the magnetic induction at the interface between two media of different permeability, or of the electric displacement at the interface between two dielectrics of different dielectric constant.

Flussdichte: *flux density, intensity.* (1) (Magnetic.) Syn. magnetic induction. (2) (Electric.) Syn. electric intensity. The flux through unit area of a surface normal to the direction of propagation; or, for a diffuse emission, the flux per unit solid angle per unit area normal to a specified direction.

Flusselastizitaet: *fugitive elasticity.* Maxwell's conception of viscosity as the limiting case of elasticity, in substances just breaking down under shear and beginning to flow.

Flusslinie: *line of flow, streamline.* The path followed by any one particle of fluid when flowing.

Flussmesser: *fluxmeter.* A ballistic galvanometer having negligible mechanical control of the position of the moving system; used primarily in conjunction with a suitable exploring coil for the measurement of magnetic flux.

Flussroehre: *tube of flow, stream tube.* A portion of a moving fluid bounded by lines of flow.

Flussverbindung: *flux-turns, linkage, turn-flux.* A measure of the interlocking of a magnetic flux with an electric circuit, viz., the product of the flux by the number of turns of the circuit surrounding it, expressed in maxwell-turns.

Fokus: *focal spot, anode spot, cathode s.* The small area of an X-ray tube target upon which the cathode rays are concentrated and from which the X-rays proceed.

Fokusmesser: *focometer.* An instrument for measuring the focal length of a lens or of an optical system.

Folge-Gesetz (Kossel-Somerfeld): *alternation law.* See Alternationsgesetz.

Form (Kristallebenengruppe): *form.* A group of plane-families which, although represented by different permutations of the same Miller indices, are crystallographically indistinguishable. E.g., in a cubic crystal, the (110) form is composed of the plane-families (110), (101), (011), $(\bar{1}10)$, $(1\bar{1}0)$, and $(0\bar{1}1)$.

Formfaktor: *multiplicity factor, form factor.* A factor of the intensity of an X-ray beam reflected from a crystal, which depends upon the number of planes parallel to one face of the crystal form which are jointly responsible for the reflection, and hence upon the character of the form.

Fortrat'sches Diagramm: *Fortrat diagram.* A parabolic diagram by means of which the component lines of molecular bands may be represented graphically.

fortschreitende Bewegung: *translation.* A displacement of a body or a figure in which the line joining any two points remains parallel to its original direction and its length remains unchanged.

fortschreitende Reihe: *progression.* A set of spectral bands having a common upper (or lower) rotational state, but differing by steps of unity in the vibrational quantum number of the lower (or upper) state.

Foucault Pendel: *Foucault pendulum.* A pendulum consisting of a very heavy mass suspended by a very long wire, the plane of vibration of which appears to change gradually owing to the rotation of the earth; as first demonstrated by Foucault in 1851 at Paris.

Fourier Integrale: *Fourier integral.* A double definite integral which constitutes a limiting case of the Fourier series, and the form of which is

$$f(x) = \frac{1}{\pi} \int_{-\infty}^{+\infty} f(r)\, dr \int_{0}^{+\infty} \cos s(r-x)\, ds$$

Fourier'scher Lehrsatz: *Fourier theorem.* States that any finite, periodic motion may be analyzed into components, each of which is a simple harmonic motion of definite and determinate amplitude and phase.

Fourier'sche Reihe: *Fourier series.* A series of the form

$$f(x) = a_0 + a_1 \sin\frac{2\pi x}{l} + a_2 \sin\frac{4\pi x}{l} + a_3 \sin\frac{6\pi x}{l} + \ldots + b_1 \cos\frac{2\pi x}{l} + b_2 \cos\frac{4\pi x}{l} + b_3 \cos\frac{6\pi x}{l} + \ldots;$$

in which the coefficients have the values

$$a_o = \frac{1}{l}\int_0^l f(x)\, dx,$$

$$a_n = \frac{2}{l}\int_0^l f(x) \sin\frac{2\pi n x}{l}\, dx,$$

$$b_n = \frac{2}{l}\int_0^l f(x) \cos\frac{2\pi n x}{l}\, dx.$$

In series representing a physical function, these coefficients may be obtained from the results of experiment.

Franck-Condon'sches Prinzip: *Franck-Condon principle.* A theoretical interpretation of the relative intensity of spectral bands of a given system on the basis of electronic transitions within the molecule, and the vibrations which result from them.

Fraunhofer'sche Linien: *Fraunhofer lines.* The dark absorption lines of the solar spectrum, the more prominent of which were first studied by Fraunhofer in 1814 and designated by letters A, B, ..., H.

freie Energie: *free energy.* (1) That part of the thermodynamic potential of a system which is internal, i.e., the thermodynamic potential at constant volume. It is expressed by the Gibbs Ψ function. The term is due to Helmholtz. (2) Syn. available energy.

freier Kolbenmanometer: *free-piston gauge.* A gauge for high pressures, in which the unknown pressure is applied to a small piston, the resulting force being small enough to be conveniently measured.

freier Magnetismus: *free magnetism.* (1) The magnetic flux through an area of the surface of a body bounded by that closed line for which this flux is a maximum. On a magnet this line is the magnetic equator; in an electric circuit it is the outermost current streamline. (2) The pole strength corresponding to (1).

freies Elektron: *free electron.* An electron within a substance but not permanently attached to any one atom and not restricted by potential gradients within the substance.

Freiheitsgrad: *degree of freedom.* One of the independent ways in which a body or a system may alter its position, the configuration of its parts, or more generally, its state. A system has as many degrees of freedom as there are independent variables required to define its position or condition. E.g., a system composed of two points has six degrees of freedom, one for each of the three co-ordinates of each point.

Frequenz: *frequency.* (1) The number of occurrences of a periodic process per unit time. (2) The number of values of a statistical variable which lie within a specified range.

Frequenzbruecke: *frequency bridge.* An arrangement resembling a Wheatstone bridge, and used for the measurement of a.-c. frequencies.

Frequenzmesser: *frequency meter.* Any instrument for measuring the frequency of an a.c. or of electric oscillations.

Frequenzniveau: *frequency level.* The logarithm to the base 2 of the tone interval between a given musical frequency and a specified keynote or reference frequency. For an interval of one octave, the frequency level is unity.

Frequenzverhaeltnis: *frequency ratio.* The ratio of the frequency impressed upon a vibrating system (as a circuit) to the natural or resonant frequency of the system. For perfect resonance, the ratio is unity.

Frequenzverteilung: *frequency distribution.* A mathematical expression indicating the relative frequency with which the value of a statistical variable may be excepted to lie within any specified interval.

Frequenzzustand: *frequency condition.* The condition upon which an atom or a molecule may emit radiation of given frequency; viz., it must undergo a change of energy equal to that frequency multiplied by the Planck constant h.

Fresnel, Einheit der Frequenz: *fresnel.* A unit of frequency, equal to 10^{12} cycles per second.

Fresnel'sche Formel: *Fresnel formula.* An expression for the loss of light perpendicularly incident at an interface between two transparent media. If the relative refractive index is n, the fractional loss is

$$\left(\frac{n-1}{n+1}\right)^2$$

Fresnel'scher Mitnahmekoeffizient: *Fresnel coefficient of drag.* The ratio, according to Fresnel, of the velocity of the ether in a moving transparent medium to the velocity of the medium itself; supposed to have the value

$$1 - \frac{1}{n^2}$$

where n is the refractive index of the medium.

Fresnel'scher Rhombus: *Fresnel rhomb.* A rhombic glass prism, so shaped that a ray of plane-polarized light entering by one face emerges from the opposite face after two internal reflections, and is thereby elliptically polarized.

Fresnel'sche Spiegel: *Fresnel mirrors.* A pair of mirrors placed side by side at a very obtuse angle, so that they produce two adjacent images of a point or line source of light from which interference bands may be formed.

Fresnel'sche Zone: *Fresnel zone, half-period element, Huygens zone.* One of the zone-like or annular areas, cut out from an advancing wave front by a succession of ideal, spherical surfaces concentric at any point of observation in the path of the oncoming wave and separated by radial distances each equal to one-half wave length; an analysis commonly employed in the theory of wave propagation and diffraction.

Friktionskegel: *cone of friction.* A conical surface, within which always lies the line of the resultant of the friction between two surfaces and the normal force pressing them together. Its half-angle is the angle of friction.

Friktionswinkel: *angle of friction, angle of repose.* (1) The angle whose tangent is the friction coefficient. (2) The angle of inclination assumed by the surface of a loose material, such as sand in a pile, when in equilibrium with gravity.

Froehliche Gleichung: *Froehlich equation.* An empirical formula for the magnetic induction in terms of magnetic intensity H:

$$B = \frac{H}{a + bH},$$

in which a and b are constants. Approximately valid as saturation is approached.

fuenfseitiges Prisma: *penta prism.* A five-sided optical prism, of which one angle is 90 degrees and the other four are 112 degrees 30 minutes each. A ray entering at one of the faces adjacent to the 90-degree edge emerges from the other, after two internal reflections, at right angles to its original direction.

Fulcher'sche Banden: *Fulcher bands.* The first known regularities in the spectrum of the hydrogen molecule, discovered by G. S. Fulcher in 1912.

Funkenspektrum: *spark spectrum.* The spectrum of a substance produced with light from a spark between terminals composed of that substance, or in an atmosphere of that substance.

Funkenverzoegerung: *spark lag.* A time interval between the attainment of the sparking voltage and the passage of a spark.

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g-Faktor: *g-factor, g-value, interval rule* (*Landé*). States that if the levels of a spectral multiplet are arranged in the order of their J value, the separations of the lines of successive pairs of adjacent components are proportional to the larger of the two J values for the respective pairs. The constant of proportionality is called the Landé factor, splitting f., separation f., g-factor or g-value.

g-Wert: *g-value.* See g-Faktor.

Galilaei'sches Teleskop: *Galilean telescope.* A form of telescope, devised originally by Lippershey (Holland) and improved by Galileo, which has a divergent lens for ocular and in which no real image is formed. Now used in the opera glass.

Galitzin'sches Pendel: *Gelitzin pendulum.* A type of seismograph, the essential feature of which is a heavy pendulum with its axis of rotation almost vertical.

Galton'sche Pfeife: *Galton pipe.* A small whistle with an adjustable resonance chamber, for producing very high pitches of known frequency.

Galvanolumineszenz: *galvanoluminescence.* The property, exhibited by the anode in certain electrolytic cells, of emitting a feeble glow when the cell is in operation.

galvanomagnetisch: *galvanomagnetic.* Pertaining to the influence of a magnetic field upon the movements of electricity within a conductor, e.g., as in the Hall effect.

Galvanometer: *galvanometer.* One of a variety of instruments, whose function is to indicate and measure relatively small electric currents, usually in terms of an arbitrary scale.

Gamma, Einheit der magnetischen Feldstaerke: *gamma.* A unit of magnetic intensity, viz., 10^{-5} oersted; used for very weak fields, such as those superposed on the terrestrial field by local or transient causes.

Gammastrahlen: *gamma rays.* A component of the emission from radioactive substances, thought to be electromagnetic radiation of very short wave length (viz., of the order of 10^{-8} mm) and of nuclear origin. A distinction is recognized between true gamma rays and the X-rays produced by the readjustments of extra-nuclear electrons disturbed by alpha, beta, and gamma rays from the nucleus.

Gammawert: *gamma value, interval factor.* A quantity relating to the angular momentum levels in the Zeeman effect, introduced by Landé, and denoted by γ.

Gang: *pitch.* The distance between the successive threads of a screw.

Gangumkehrprinzip: *path-reversal principle.* See Bahnumkehrprinzip.

Gangunterschied: *path difference.* The difference between the distances traversed by two co-initial wave trains between the point of separation and the point of subsequent reunion, as in an interferometer; or, if in different media, the difference between their equivalent paths in a vacuum or in air.

ganzzahlige vielfache Resonanz: *submultiple resonance.* The excitation of resonance of a frequency which is a submultiple of that of the exciting impulses.

Gas: *gas.* Matter in which the cohesion is so negligibly small that it will diffuse throughout any enclosure in which it is placed; specifically, when the substance is at a temperature above its critical temperature.

Gaskonstante: *gas constant, ideal gas constant.* The constant R appearing in the equation representing the ideal gas law. Its value is about 8.3136×10^7 ergs/mol °C.

Gasthermometer: *gas thermometer.* A thermometer the indications of which depend upon changes in the pressure or the volume of an enclosed gas.

Gaswaage (bestimmter Dichtemesser fuer Gase): *dasymeter.* A thin glass bulb used in determining the density of gases by observing the buoyant force upon it as a sinker is used with liquids.

Gauss: *gauss.* (1) The practical c.g.s. electromagnetic induction (by international agreement in 1932). (2) Prior to 1932, the practical c.g.s. electromagnetic unit of magnetic intensity, now called oersted. The term is still frequently used in this sense. If magnetic induction and magnetic intensity are taken as having the same dimensions, both are consistently expressed in gausses. If a linear conductor moves laterally with a speed of 1 cm/sec across a region in which the magnetic induction (or intensity) is 1 gauss, and at right angles to the direction of the induction (or intensity) vector, an e.m.f. of 1 abvolt is produced in each centimeter of length thereof. (3) the c.g.s. electromagnetic unit of magnetomotive force.

Gauss'sche Einheit: *Gaussian unit.* An absolute unit of force, such as the dyne or the poundal, defined in terms of its accelerating effect upon a given mass.

Gauss'scher Lehrsatz: *Gauss theorem.* States that the surface integral of the normal component of the gravi-

tational field due to any distribution of matter, taken over any closed surface, is equal to $4\pi G$ times the mass of that portion of the distribution which lies within the closed surface, and is independent of that which lies without. G denotes the gravitation constant. Analogous propositions may be stated in reference to electrical and magnetic fields.

Gauss'sches Okular: *Gaussian eyepiece.* An eyepiece provided with a pair of cross hairs, illuminated by light from a side aperture reflected by a transparent glass plate extending obliquely across the axis of the instrument. The Huygens form of eyepiece is usually employed for this purpose.

Gauss'sche Verteilung: *Gaussian distribution, normal distribution.* A statistical distribution defined by the equation

$$p = ce^{-k^2x^2}$$

in which x is the statistical variable. It is a limiting form approached by many statistical phenomena under suitable extreme conditions; hence a valuable approximation. Accidental errors of measurement and similar phenomena theoretically follow this law.

Gay-Lussac'sches Gesetz: *Gay Lussac Law, Charles law.* But stated independently by Gay Lussac in 1802. States that the coefficients of expansion of all perfect gases are equal, their common value being such as to indicate that the volume varies in direct proportion to the absolute temperature. First discovered by Charles in 1787.

Gefrierpunkterniedrigung durch Druck: *regelation.* See Druckerniedrigung des Schmelzpunktes.

Gefrierpunktsgesetz: *freezing-point law.* States that the freezing point of any solvent is lowered below its normal value by an amount proportional to the quantity of solute present; and that the constant for any solvent is the same for all solutes, provided the concentration is expressed in mols per unit volume. Ascribed to Blagden (1788).

gegenseitige Induktion: *mutual inductance, mutual induction.* A (not necessarily constant) characteristic of a pair of coupled circuits, defined like inductance; except that the current, constant or variable, in one circuit (primary) and the linkage thereby produced, or the e.m.f. induced, in the other (secondary) are now referred to. The inducing of an e.m.f. in one circuit by the variation of the current in a neighboring circuit.

gegenseitiges Potential: *mutual potential.* A quantity of the nature of gravitational or electric potential, which is represented by the work expended upon two or more masses, or the work done by two or more electric charges, as they are displaced from their initial positions to an infinite distance apart. It is the negative of the potential energy of such masses or charges in any configuration, the zero of energy being that corresponding to an infinite separation.

Gegenstandspunkt: *object-point.* The real or virtual point of intersection of a pencil of rays incident upon an optical system.

Gegenteil von Stossionisation: *detailed balancing.* The process by which the energy of an ionized atom is imparted to a free electron or other particle when the atom is neutralized and the particle is sent off with additional velocity; the inverse of ionization by impact.

Geiger-Mueller Zaehler: *Geiger-Mueller counter.* A metallic cylindrical sheath with a slender wire running axially through it, and used in a manner somewhat similar to the Geiger counter.

Geiger-Nuttall Gesetz: *Geiger-Nuttall law.* States that for different radioactive elements emitting alpha rays, the logarithm of the range of the alpha particles and the logarithm of the disintegration constant bear a linear relation to each other.

Geigerzaehler: *Geiger counter.* A type of counting tube, consisting of a highly charged needle inside a metallic cylinder. Devised by Geiger for detecting and counting ionizing particles in the air.

Geissler Pumpe: *Geissler pump.* A type of air pump utilizing the principle of the Torricellian vacuum. Also known as the Toepler pump.

Geissler Roehre: *Geissler tube.* Any two-electrode discharge tube giving a glow discharge at low pressures. One useful form has a narrow constriction of straight tubing, in which the glow is concentrated and can thus be brought conveniently before the slit of a spectroscope.

Gel: *gel.* A jelly-like substance formed by partial drying or by cooling certain colloidal solutions, such as those of soap or gelatin in hot water.

Generator: *generator (electric).* A machine which utilizes mechanical energy to produce an electric current.

geomagnetische Breite: *geomagnetic latitude, magnetic latitude.* Latitude reckoned from the magnetic, instead of from the geographic, equator.

geometrische Optik: *geometrical optics.* Regards light simply as an emission traveling in straight lines and

traces its course in "rays" through reflecting and refracting systems.

Geophysik: *geophysics.* That branch of science which deals with physical phenomena related to the earth, esp. those aspects studied by strictly physical methods.

gequantelt: *quantized.* (1) Composed of, or associated with, quanta of energy; e.g., quantized radiation. (2) Expressed in terms of the general quantum theory.

gerader (oder ungerader) Term: *even (or odd) term.* A spectral term arising from one, two, three, ..., nuclear electrons, the sum of whose respective azimuthal quantum numbers l_1, l_2, l_3, ..., is an even (or odd) number.

geradsichtiges Prisma: *direct-vision prism.* See Amici' sches Prisma.

geritztes Fadenkreuz: *graticule.* A reticle composed of lines scratched upon a plate of glass, instead of the usual spider threads or wires.

geritztes Gitter: *echelette.* See Echelette.

Geschwindigkeit: *speed, velocity.* (1) The scalar time rate at which distance is covered by a moving point or body, without reference to direction. (2) (Phot.) A value used to specify the sensitiveness of a photographic material to light, and computed according to any one of several methods. (3) (Of an objective.) A quantity determining the shortness of exposure adequate for taking a photograph under given conditions. Its most appropriate measure is the inverse square of the relative aperture or F-number. Velocity. (1) (Linear.) A vector quantity which denotes at once the time rate and the direction of a linear motion. (2) (Angular.) A vector quantity which denotes both the time rate and the direction of the axis of a rotation. Syn. rotational velocity. (3) A general term for time rate, e.g., the velocity of a chemical reaction.

Geschwindigkeitsmesser: *tachometer, tachymeter.* Any instrument for measuring linear or angular speeds, or the rates of flow of liquids.

Geschwindingkeitspotential: *velocity potential.* A function ϕ associated with the motion of a fluid and such that when the motion is referred to three coordinate axes x, y, z and the respective velocity components are denoted by u, v, w, then

$$-\frac{\delta\phi}{\delta x} = u, \quad -\frac{\delta\phi}{\delta y} = v, \quad -\frac{\delta\phi}{\delta z} = w.$$

Geschwindigkeitsraum: *velocity space.* Defined in the same manner as momentum space (q.v.) but with velocity substituted for momentum.

Geschwindigkeitsspektrograph: *velocity spectrograph, v. analyzer.* An apparatus for separating an emission of electrically charged particles into distinct streams in accordance with their speeds, by means of magnetic or electric deflection.

Gesetz des Potentialfalles: *law of fall of potential.* States that the difference in electric potential between points on a conductor is in proportion to the amount of electric energy transformed into other forms between the points in question. For simple ohmic resistance, it is proportional to the resistance between the points.

Gesetz der korrespondierenden Zustaende: *law of corresponding states.* Expresses the approximate fact that if two of the three reduced variables of state are equal for two different bodies of gas, the third will also be equal for these bodies. Such gaseous bodies are said to be in corresponding states.

Gesetz der rationalen Indizes: *rational index law, Haüy law.* States that the parameters, and hence the Miller indices, of a crystal are always rational numbers.

Getter: *getter.* A volatile metal, e.g., magnesium, vaporized in and sublimated upon the walls of a discharge tube to remove traces of gas.

Gewicht: *weight.* (1) (n.) The force which a mass experiences because of being in a gravity field, esp. that of the earth. (2) A body of known mass, used in measuring the masses of other bodies by weighing. (3) One of the abstract numbers sometimes assigned to each of a set of data, such as results of measurements, to denote their relative importance or reliability, and taken into account in averaging or adjusting them. (4) (v.) To apply or assign a weight, e.g., a weighted float, the weighted mean of several measurements, etc.

Gibbs'sches Adsorptionsgesetz: *Gibbs adsorption law.* A law relating to systems of several (n) components, and expressed by the differential equation

$$\delta\gamma = -\sum_{1}^{n} (\Gamma\delta\mu);$$

in which γ is the interfacial free energy, the μ's are the partial free energies of the different components, and the Γ's are the masses of those respective components which must be added, per unit increase of interface, to maintain the μ's constant.

Gibbs'sche Funktionen: *Gibbs functions, heat func-*

tions. Three thermodynamic quantities, expressed as follows:

$$\psi = u - Ts \text{ (free energy)},$$
$$\chi = u - pv \text{ (enthalpy)},$$
$$\zeta = u - Ts + pv.$$

In these, u is internal energy, T is temperature, v is volume, p is pressure, s is entropy. The quantities usually pertain to unit mass of working substance.

Gibbs-Helmholtz'sche Gleichung: *Gibbs Helmholtz equation.* An equation connecting the open-circuit e.m.f. of a reversible electrolytic cell with the heat of formation H of the compounds formed within it and with the absolute temperature T:

$$E = H + T \frac{\delta E}{\delta T}.$$

Gibbs'sche (thermodynamische) Oberflaeche: *Gibbs (thermodynamic) surface.* The (three-dimensional) graph of the equilibrium values of volume, energy, and entropy for a given pure substance.

Gift: *poison.* A substance whose effect on a luminescent material is the opposite of that produced by a phosphorogen. E.g. iron is a poison to certain phosphorescent materials prepared from zinc sulphide.

Gilbert: *gilbert.* The c.g.s. electromagnetic unit of magnetic potential or of magnetomotive force, equivalent to $5/2\pi$ amp.–turns.

Gilbert pro Zentimeter (Oersted, Gauss): *gilbert per centimeter, oersted, gauss.* i.e., the practical c.g.s. unit of magnetic intensity or magnetic potential gradient. It is sometimes used in analogy to the volt per centimeter for electric potential gradient, or to avoid the ambiguous term oested.

Gitter: *grid, lattice, grating.* (1) An electrode consisting of a wire mesh placed between the cathode and the anode in a thermionic tube so that the thermions must pass through it, and used as a control of the thermionic current by means of variations in the negative grid potential. (2) The metallic (commonly lead) part of either of the electrodes of a storage cell. (3) An arrangement of points in space, representing the relative positions of corresponding atomic, molecular, or ionic centers in the elementary cells or structure units of a crystal. See also Beugungsgitter.

Gitterabstand: *grating constant, g. space.* (1) The distance between successive rulings of a diffraction grating. (2) In re a crystal: syn. lattice constant.

Gitterbatterie: *grid battery, C-battery.* A battery used to maintain a potential of the desired sign upon the grid of a vacuum tube.

Gittereinheit: *lattice unit, unit cell, elementary cell.* See Einheitskristall.

Gitterenergie: *lattice energy.* The energy which depends upon the configuration of the atoms in a crystal lattice, and which changes when any change is made in that configuration through mechanical stress, electric forces, or otherwise.

Gitterglimmroehre: *grid-glow tube.* A thermionic relay similar to a thyratron.

Gitterkondensator: *grid condenser.* A small condenser interposed between the grid terminal of a thermionic vacuum tube and the source of grid potential control.

Gitterkonstante: *lattice constant.* The distance between successive planes of a specified plane-family in a crystal. For the (111) planes of calcite it is taken as 3.028×10^{-8} cm.

Gitterkonstante: *grating constant, grating space.* See Gitterabstand.

Gitterstrom: *grid current.* A current flowing to or from the grid of a vacuum tube.

Gittervorspannung: *bias.* A permanent negative potential applied to the grid of a vacuum tube.

Gitterwiderstand: *grid leak.* A very high resistance placed in parallel with a grid condenser to prevent an overaccumulation of negative charge upon the grid and thus to keep its mean negative potential approximately constant during operation.

Gladstone-Dale'sches Gesetz: *Gladstone-Dale law.* States that the refractivity of a medium is proportional to its density as the latter varies under changing conditions of pressure or temperature; i.e., that the specific refractivity is constant.

Glanzwinkel: *glancing angle.* The complement of a very large incidence angle; i.e., the very small angle between the incident emission and the surface upon which it is incident.

Glan-Thompson'sches Prisma: *Glan-Thompson prism.* A form of polarizing prism of Iceland spar, resembling a Nicol prism but differing somewhat in design. The light enters and leaves this prism normal to the faces, and the parts are separated by a glycerine film.

Glanzmesser: *glossimeter, glossmeter.* An instrument for measuring the ratio of the light regularly or specularly reflected from a surface to the total light reflected.

vom gleichen Moment: *equimomental.* In re two or more bodies: having equal mass and equal moments of inertia about corresponding axes.

gleichfarbig: *homiochromatic, isochromatic, orthochromatic.* In re different areas or different parts of the same area: having the same color, or a uniformity of color. Pertaining to any variation of factors in connection with radiation, in which the wave length or frequency is constant. A line connecting points of constant shearing stress in an elastic body; so called because such lines correspond to lines of uniform color in the photoelastic test method.

gleichfoermiger Fluss: *uniform flow.* A condition of flow in which the cross section of every stream tube remains constant, each particle moving along its streamline with constant speed.

Gleichgewicht: *equilibrium.* (1) A condition of balance among the forces operating upon or within a physical system, such that no accelerated motions exist among the parts of the system. The equilibrium is stable when a slight change in the configuration of the system gives rise to a condition tending to restore the original configuration; unstable when the change tends to increase; neutral when equilibrium persists regardless of the change. (2) The mutual state of two or more simultaneous, continuous processes such that their net result is equivalent to a constant condition; e.g., the evaporation and condensation at the surface between a liquid and its saturated vapor.

Gleichgewichtskurve: *equilibrium curve, transformation c, phase diagram.* A graph representing the relation between values of two variables of state, as temperature and pressure, for which there is equilibrium between two states or phases. E.g., the fusion curve follows the equilibrium between solid and liquid states; the vaporization or saturation c., that between liquid and saturated vapor states; and the sublimation c., that between solid and vapor.

Gleichgewichtslehre: *statics.* That branch of dynamics which deals with bodies at rest relative to some given frame of reference and with the interaction of forces between them.

Gleichgewichtspotential: *equilibrium potential.* The potential d. between an electrolyte and an electrode immersed in it, when they have come to equilibrium.

gleichrichten: *rectify.* (1) To change from alternating to unidirectional, as an electric current. Any device for securing this result is a rectifier. (2) To replace (an inverted image by one which is erect, as by the rectifying system in a field glass.

Gleichrichter: *valve.* A controlled inlet or outlet, esp. one permitting only a unidirectional flow. (2) An electric current rectifier, esp. of the electrolytic or thermionic type.

Gleidchung: *Equation.* An expression of equality between two magnitudes or operations, the sign = being placed between them.

Gleichverteilung der Energie: *equipartition of energy, Maxwell-Boltzmann law.* A principle, enunciated by Boltzmann, which states that the mean kinetic energy of the molecules of a gas is equally divided among the various degrees possessed by the molecules. The average molecular energy associated with any degree of freedom is one-half the product of the absolute temperature by the Boltzmann constant.

Gleitebene: *gliding plane, glide plane, slip surface.* (1) A plane within a crystal along which occurs a displacement of the crystal structure, i.e., a slipping of one lattice layer past the adjacent layer, when the crystal is subjected to shear. (2) The common plane of the two axes of a twin crystal. (3) A surface (often approximately plane) along which a solid under severe stress tends to crack or shear. The traces of such surfaces at an external face of the specimen are slip lines.

Gleitflaeche: *gliding plane.* See Gleitebene.

Gleitkoeffizient: *slip coefficient.* A quantity connected with the slipping of a fluid at the surface of a capillary tube; defined as the ratio of the speed of slip to the transverse velocity gradient in the fluid. It is equal to the viscosity coefficient divided by the friction coefficient at the surface.

Glimmen: *glow, g. discharge.* The most frequent form of initial electric discharge in a gas, often emitting a hissing sound but with no distinct sparks. It sometimes develops into a brush discharge.

Glimmentladung: *glow, g. discharge.* See Glimmen.

Glimmpotential: *glow potential.* The voltage at which a glow discharge begins in a vacuum tube as the voltage is gradually increased.

Globulit: *globulite, spherolite.* A microscopic crystal of globular shape, without definite plane faces, due to strong surface tension effects at the time of formation of the crystal.

gnomonische Projektion: *gnomonic projection.* A method of geometric projection used in the interpretation of Laue diffraction patterns.

Goldpunkt: *gold point.* The melting point of gold, viz., about 1064 degrees C; commonly used as a reference point in pyrometry.

Goniometer: *goniometer.* An instrument for measuring the angles between the faces of crystals, prisms, etc., usually by utilizing beams of light reflected from those faces.

grader Strahl: *pencil.* A homocentric bundle of rays, corresponding to a train of concentric waves.

Gradeinteilung: *scale.* Anything graduated, esp. when used as a measure or rule or marked by lines at regular intervals.

Gradient: *gradient.* The vector which represents the linear derivative of a scalar point function S at any point, in a direction normal to the surface of equal values of S through this point; e.g., of temperature in a direction normal to the isothermal surface. Denoted by grad S.

Gradientmesser: *gradiometer.* An instrument for measuring the gradient of the earth's gravity field in any locality.

Gradiometer: *gradiometer.* See Gradientmesser.

Graham'sches Gesetz: *Graham law.* States that the rate of efflux or of diffusion of different gases (volume per unit time) are, under similar conditions, inversely proportional to the square roots of the densities of the gases.

Gramm: *gram, gramme.* A metric unit of mass, defined originally as the mass of 1 cm^3 of pure water at its maximum density (4 degrees C.). But for practical purposes it is now defined as one-thousandth of the mass of the standard platinum kilogram at Sèvres; which is 1.000027 times the original, ideal value.

Grammatom: *gram atom.* That mass of an element which, in grams, is numerically equal to the atomic mass of the element. The gram atom of every element thus contains the same number of atoms, viz., about 6.06×10^{23} (Avogadro number).

Gramme'scher Ring: *Gramme ring.* A form of electromagnet in which the core is a continuous iron ring. Used in certain forms of generator armature.

Grammolekuel: *gram molecule.* That mass of a pure substance which, in grams, is numerically equal to the molecular mass of the substance. The gram molecule of every pure substance thus contains the same number of molecules, viz., about 6.06×10^{23} (Avogadro number). Syn. mol or mole.

grau: *gray, grey.* (1) An achromatic color. (2) The property of a radiating surface such that, while its radiation has the same spectral energy distribution, its emissive power is less at any temperature than that of a black body; and such that, while not black, its absorptivity is nonselective.

Gravitationseinheit: *gravitational unit.* A unit of force, pressure, work, power, or other magnitude, which involves in its measure the factor of terrestrial gravity e.g., the gram of force or the foot-pound.

Gravitationskonstante: *gravitation constant, Syn. Newtonian constant.* A constant G which appears in the expression for the Newtonian law of gravitational force between two concentrated masses m_1, m_2 separated by distance r:

$$f = G \frac{m_1 m_2}{r^2}.$$

Approximately equal to 6.664×10^{-8} cm^3 g^{-1} sec^{-2}.

Gravitationspotential: *gravitational potential, Newtonian potential, mass p.* A point function analogous to electric potential, but always positive. Its value at any point is the line integral of the intensity of the gravitational field due to all matter, taken from that point to infinity.

Gravitationsradius: *gravitational radius.* A quantity, having the dimensions of a length, associated in the relativity theory of gravitation with any particle of matter, and equal to Gm/c^2; in which m is the mass of the particle, G the gravitation constant, and c the electromagnetic constant.

Grotthus-Draper'sches Gesetz: *Grotthus-Draper law.* States that light is photochemically active only when it is absorbed by the material affected.

Grundbeleuchtung: *priming illumination.* A small, steady illumination applied to a photoelectric cell to render it more sensitive to the (superposed) variations in illumination which the cell is being used to measure or record.

Grundflaeche: *basal plane.* A plane in a crystal parallel to the principal plane of symmetry.

Grundform: *ground form.* The crystalline form of any crystal system which is bounded by natural faces, all of

which intersect the crystal axes. E.g., the ground form of the isometric system is the regular octahedron.

Grundlinie: *parent.* A spectrum line which represents a normal quantum process, unaffected by such influences as are responsible for satellite lines, as in the Zeeman effect.

Grundsatz: *axiom.* An established principle in some art or science, which though not a necessary truth, is universally received.

Grundspektrum: *persistent spectrum.* The spectrum of a substance which results from only the most moderate excitation. The most persistent lines, which remain when all others have subsided or when the quantity of the substance is diminished to a trace (but which are not always the brightest in the complete spectrum), are called the "raies ultimes," a term due to de Gramont.

Grundton: *fundamental.* (1) (n.) The simple harmonic component of a composite vibration or musical tone which has the lowest frequency. (2) (adj.) Sometimes used in connection with three-phase equilibrium; e.g., fundamental point, syn. triple point, etc.

Grundzustand: *ground state.* That configuration of an atom which corresponds to the lowest energy level and hence has greatest stability.

Gruppe: *ensemble.* A group comprising a great number of independent systems, identical in nature but differing in their configuration and velocity, e.g., the molecules of a pure gas.

Gruppengeschwindigkeit: *group velocity.* The velocity of propagation of the resultant displacement maxima or minima constituting an interference wave form, in wave motion made up of two or more component wave trains of different frequency, i.e., a wave group. If the components have different individual speeds, it may be quite different from the velocity of propagation of any one component.

Gruppenphaenomen: *group phenomena.* Properties of the crystalline state which apparently cannot be considered as properties of single atoms, but arise from the agglomeration of atoms into groups, each consisting of a definite number of atoms (10^7 to 10^9). The stability of the atoms thus arrayed is greater than that among the groups.

Gudden-Pohl'sches Gesetz: *Gudden-Pohl law.* States that the number of electrons liberated in the photoconductive action of selenium is equal to the number of radiation quanta absorbed.

Guillaume'sche Legierung: *Guillaume alloy, G. metal.* An alloy of about 66 percent Fe and 34 percent Ni, which has the unusually low expansion coefficient 10^{-6} per °C.

gyromagnetisch: *gyromagnetic.* Pertaining to the magnetic properties of rotating electric charges, esp. of electrons moving within atoms.

gyromagnetisches Verhaeltnis: *gyromagnetic ratio.* The ratio of the magnetic moment of a specimen of a substance to the angular momentum of its atoms.

Gyroskop: *gyroscope.* An instrument resembling a spinning top, used to demonstrate precession, etc.

Gyrostat: *gyrostat.* Syn. gyroscope, but with emphasis upon the stabilizing effect of rotation.

H-Funktion: *H function.* A function of the coordinates describing the motion of the molecules of a gas, which represents the cologarithm of the probability of a given thermodynamic state of the gas; a concept due to Boltzmann.

H-Strahl: *H-ray, H-particle.* A positive hydrogen ion, or proton, which results from the bombardment of hydrogen or a hydrogen compound by alpha rays or by swiftly moving positive ions of any kind, or from the bombardment and disintegration of certain other elements, e.g. nitrogen, by alpha rays. First observed by Marsden in 1914.

H-Teilchen: *H-ray, H-particle.* See H-Strahl.

H-theorem: *H-theorem.* A theorem based upon the Maxwell-Boltzmann principle of equipartition of energy. States that if there are N_1 molecules in one state or phase, N_2 in another, etc., the quantity $H = \Sigma (N \log N)$ tends to a minimum and reaches its equilibrium value only when the condition of equipartition of energy is fulfilled.

Haarroehrchenkraft: *capillarity.* A class of phenomena dependent upon the interaction of molecular forces at the junction of the interface between a liquid and a gas or between two liquids, with a solid surface; e.g., the elevation or depression of a liquid in a capillary tube.

Haerte: *hardness.* (1) Resistance to surface abrasion or indentation, as of steel or diamond. (2) in re X-rays or gamma rays, it denotes high penetration or low absorption coefficient, corresponding to short wave length and high quantum energy.

Haertemesser: *penetrometer, sclerometer, scleroscope.* (1) An instrument for testing the hardness of more or less plastic solids. (2) An instrument for indicating the quality or "hardness" of X-rays. (3) An apparatus for measuring the hardness of a substance by the rebound of a hammer falling upon it from a given height.

Haftspannung: *penetration tension.* In re a liquid in a capillary tube: the product of the surface tension of the liquid by the cosine of the angle of contact.

halbdurchlaessige Membran: *semipermeable membrane.* A membrane through which osmosis can take place, but which prevents the free mixing of the fluids.

Halbperiodenelement: *half-period element, Huygens zone, Fresnel zone.* See Fresnel'sche Zone.

Halbquantenzahl: *half-quantum number.* One of the values of the angular momentum assumed for an atom or a molecule, each equal to a whole multiple of $\frac{1}{2}$ $(h/2\pi)$, in which h is the Planck constant.

Halbschatten: *penumbra.* That part of a shadow from which the light from only a portion of the source is excluded by the opaque obstacle.

Halbschattenanalysator: *half-shade analyzer.* A device used in polarimeters for determining the polarization plane. It may be a Jellet-Cornu prism, a Lippich prism, or an opening partly covered by a half-wave plate.

Halbwertsbreite: *half-width (of spectrum line), width-at-half-maximum.* In re any line in the spectrum of a gas or vapor: the wave length or wave number interval throughout which the intensity equals or exceeds one-half its maximum value (value at the line peak).

Halbwertsperiode: *half-decay period, half-value period.* The time required for any variable whose value undergoes decay in accordance with the exponential law to fall to one-half of its original value; equal numerically to 0.6931 divided by the decay coefficient.

Halbswertsschicht: *half-value layer.* In re the absorption of radiation by any given substance: the thickness of that substance which will reduce the intensity to one-half its initial value. It is equal to 0.6931 divided by the (linear) absorption coefficient.

Halbzelle: *half-cell.* Consists of an electrode inserted into an electrolytic solution in order to set up a definite, though not actually determinable, potential difference.

Hall'scher Effekt: *Hall effect.* A p.d. which develops between the two edges of a strip of metal, in which an electric current is flowing longitudinally, when the plane of the strip is set perpendicularly across a magnetic field. Discovered by Hall in 1879.

Hall'scher Koeffizient: *Hall coefficient.* The transverse electric potential gradient produced in a conducting strip exhibiting the Hall effect, per unit current density per unit magnetic intensity.

Halo: *halo.* (1) One of several different atmospheric phenomena, manifested by the appearance of faintly colored rings surrounding the sun or the moon, and caused by refraction due to minute ice crystals suspended in the upper air. (2) (Phot.) A ring surrounding the photographic image of a bright source, due to one of several causes.

Hallwachs'scher Effekt: *Hallwachs effect.* The discharge of a negatively charged body in a vacuum due to the incidence of ultraviolet; discovered by Hallwachs in 1888. It is a type of photoelectric effect.

Hamilton'sche Gleichungen: *Hamilton equations.* A set of differential equations relating to a dynamic system, one pair for each of the n degrees of freedom corresponding to the generalized coordinates $q_1, q_2, \ldots \ldots \ldots, q_n$ and generalized momenta $p_1, p_2, \ldots \ldots p_n$. If H denotes the Hamiltonian function, each pair of equations has the form

$$\frac{dq_r}{dt} = \frac{\delta H}{\delta p_r}, \qquad \frac{dp_r}{dt} = -\frac{\delta H}{\delta q_r}$$

$(r = 1, 2, \ldots \ldots \ldots, n.)$ They are equivalent to the Legrange equations.

Hamilton-Jacobi'sche Gleichung: *Hamilton-Jacobi equation.* A partial differential equation used in the dynamics of conservative systems, in the form of a Hamiltonion function:

$$H\left(\frac{\delta S_1}{\delta q_1} \ldots \ldots \frac{\delta S_f}{\delta q_f}, q_1 \ldots \ldots q_f\right) = E;$$

in which the q's are generalized coordinates, S's are actions, f is the number of degrees of freedom and E is the constant total energy of the system.

Hamilton'sche Funktion: *Hamiltonian function.* A function of the r generalized coordinates $q_1 \ldots \ldots q_r$ and generalized momenta $p_1 \ldots \ldots p_r$, defined by

$$H = \sum_1^r p\dot{q} - L;$$

in which L is the Lagrangian function. H satisfies the differential equations

$$\frac{\delta H}{\delta p} = \dot{q}, \qquad \frac{\delta H}{\delta q} = -\dot{p}.$$

$$\dot{q} = \frac{dq}{dt}, \qquad \dot{p} = \frac{dp}{dt}.$$

In many problems, H represents the energy of a conservative system expressed in terms of q's and p's.

Hamiltonoperator: *Hamiltonian.* The vector differential operator

$$i\frac{\delta}{\delta x} + j\frac{\delta}{\delta y} + k\frac{\delta}{\delta z};$$

sometimes abbreviated by ∇.

Hamilton'sches Prinzip: *Hamilton principle.* A principle relating to any dynamic system, the total kinetic energy and potential energy of which are, respectively, E_k and E_p; expressed by the equation

$$\delta \int_{t_0}^{t_1} (E_k - E_p)\, dt = 0.$$

harmonisch: *harmonic.* (1) (n.) An overtone or partial bearing a simple frequency ratio to the fundamental. (2) (adj.) Capable of being expressed in terms of sine or cosine functions, and hence analogous to musical sound.

harmonische Analyse: *harmonic analysis.* The expression of a function in terms of sine and cosine terms involving the variables, with such coefficients as to render the resulting series approximately equal to the given function for corresponding values of the variables.

harmonischer Analysator: *periodometer.* A type of harmonic analyzer developed by C. G. Abbot for the study of solar radiation and meteorological data.

harmonic analyzer. An apparatus which mechanically, electrically, or otherwise, evaluates the coefficient of the Fourier series corresponding to any function subject to harmonic analysis.

harmonisches Band: *harmonic band, overtone band.* A spectral frequency which bears a relation to a given spectral frequency analogous to that of an acoustic overtone to its fundamental.

harmonische Bewegung: *harmonic motion.* A vibration in which the acceleration is proportional to the displacement from the mean or zero position but with opposite sign, as the vibration of a string; or which is the resultant of any number of such motions. If there is but one component, the motion is termed simple harmonic.

harmonisches Echo: *harmonic echo.* An echo in which there is a selective action on the frequencies of the incident sound, usually resulting in the suppression of the fundamental and other low-frequency components.

harmonischer Oszillator: *harmonic oscillator.* A particle, esp. an electric particle, oscillating with harmonic motion; a concept often used in radiation theory.

harmonische Schwingung: *harmonic motion.* See harmonische Bewegung.

Hartley'sches Gesetz: *Hartley law.* States that the separations of the components in any one series of doublet or of triplet spectral lines, expressed in frequencies or in wave numbers (not in wave lengths), are equal.

Hartmann'sches Test: *Hartmann test.* A photographic method of testing large lenses for spherical aberration.

Hartmann'sche Untersuchung: *Hartmann test.* See Hartmann'sches Test.

Hartree'sche Einheit: *Hartree unit.* A unit of wave length used in connection with the theory of diffraction of electrons by crystals, and equal to $h^2/4\pi^2me^2$, in which h is the Planck constant and m and e are the electronic mass and charge. Its value is about 5.3×10^{-19} cm.

Hartree'sche Funktion: *Hartree function.* A wave function applying to a single electron in a central field, as developed by Hartree.

Hauy'sches Gesetz: *Haüy law, rational index law.* States that the parameters, and hence the Miller indices, of a crystal are always rational numbers.

Hauptachse: *principal axis.* A line so chosen with reference to a rigid body, that the body may rotate about it without developing a centrifugal torque in any plane containing that line. Through any point there are in general three such lines, which are axes of maximum or minimum moment of inertia.

Hauptazimut: *principal azimuth.* The azimuth of the elliptically polarized beam produced when plane-polarized light, with an azimuth of 45 degrees with the plane of incidence is reflected at the principal angle of incidence from a metallic surface.

Hauptbogen: *primary bow.* The inner and brighter of the two rainbows sometimes visible.

Hauptbrennpunkt: *principal focus, focal point.* See Brennpunkt.

Hauptdruecke: *principal strains and p. stresses.* The components of strain, and the corresponding components of stress, in the directions of the strain axes at any point of an elastic solid under deformation.

Hauptebene: *principal plane.* (1) In re a ray of light traversing a doubly refracting crystal: the plane determined by the direction of the ray and the axial direction of the crystal. (2) In re a symmetrical optical system: one of two planes perpendicular to the axis, such that any incident paraxial ray meets the first, and the same ray upon emergence meets the second, in points on a line parallel to the axis. The magnification ratio for these two planes being + 1, they are sometimes called the "unit planes."

Hauteffekt: *skin effect.* A concentration of current density toward the surface of an a.-c. conductor, due to selfinduced counter e.m.f., and resulting in an increase in effective resistance. The phenomenon is especially noticeable at higher frequencies.

Haupteinfallswinkel: *principal angle of incidence.* The angle at which a ray of planepolarized light must be incident upon a reflecting metallic surface in order that the components of the elliptically polarized reflected ray, parallel and perpendicular to the plane of reflection, shall differ in phase by one-quarter cycle.

Hauptgeschwindigkeit: *principal velocity.* One of the three velocities which, taken by twos, correspond to the velocities of propagation of the two plane-polarized light waves traveling outward from a point source within a birefringent crystal in directions parallel to the three axes of dielectric symmetry. In a uniaxial crystal, two of the three principal velocities are equal, viz., in the direction of the optic axis.

Hauptlinie: *principal line.* The first and strongest line of a spectral series.

Hauptpunkte: *cardinal points, principal points.* The focal points, the principal points, and the nodal points of a lens or of a symmetrical optical instrument. (See also Einheitspunkt.)

Hauptquantenzahl: *principal quantum number, total quantum number.* The sum l + l' of the azimuthal and the radial quantum number in the Bohr theory, or l + l' + 1 in the new quantum mechanics (since in the latter l is one less). So called because the energy of a quantum state depends primarily upon it. The principal quantum number is usually denoted by n.

Hauptschatten: *umbra.* That part of a shadow from which light from the source is completely excluded by the opaque obstacle.

Hauptserien: *principal series.* A spectral series corresponding to transitions from a low S-state to higher P-states. This gives the strong, persistent lines of the alkalis and alkaline earths but not, in general, of other elements.

Haupttraegheitsmoment: *principal moment of inertia.* The moment of inertia of a body with respect to one of its principal axes.

Hauptzuege: *principal strains and p. stresses.* See Hauptdruecke.

Heaviside'sche Bruecke: *Heaviside bridge.* An arrangement somewhat resembling a Wheatstone bridge, but used for measuring mutual inductances.

Heaviside-Lorentz Einheit: *Heaviside-Lorentz unit, rationalized unit.* One of a system of electric and magnetic units proposed by Heaviside and Lorentz for convenience in theoretical discussions.

Heaviside-Hertz'sche Gleichung: *Heaviside-Hertz equations.* A set of electromagnetic field equations for a medium of dielectric constant κ, permeability μ, and electric conductivity γ, in which the magnetic intensity is H and the electric intensity E:

$$\text{curl } H = \frac{1}{c}\left(4\pi\gamma E + \kappa\frac{\delta E}{\delta t}\right),$$

$$\text{curl } E = -\frac{\mu}{c}\frac{\delta H}{\delta t}$$

$$\text{div } \mu H = O, \text{ div } \kappa E = O.$$

Heaviside Schicht: *Heaviside layer, ionosphere, Kennelly-Heaviside layer.* A stratum of the upper atmosphere which is believed to be more highly ionized than that at the earth's surface, and because of this, to be capable of reflecting radio waves and thus directing their propagation, in a general way, parallel to the ground.

Hefner Einheit: *Hefner unit.* A German unit of luminous intensity, defined as the light output of a standard Hefner amyl acetate lamp in a particular direction. It is equal to about 0.90 of the international candle.

Heisenberg'sche Kraefte:
Heisenberg'sche Wechselwirkung: *Heisenberg forces, H. interactions.* Attractive forces between nuclear particles, due to the exchange energy of the type postulated by Heisenberg. This energy is now regarded as a part of the Majorana exchange energy.

Heliostat: *heliostat.* An arrangement of mirrors driven by clockwork, used to reflect a beam of sunlight in a fixed direction as the sun moves across the sky.

Helligkeit: *brightness.* "The quotient of the luminous intensity of a surface measured in a given direction, by the area of this surface projected on a plane perpendicular to the direction considered."

Helmert'sche Formel: *Helmert formula.* An empirical formula for the value of gravity at a given latitude l and altitude h (in meters), published by Helmert in 1901:

$$g = g_{45}\,(1 - 0.002644\cos 2l + 0.000007\cos^2 2l) - 0.0003086h;$$

in which g_{45} is the value of g at $l = 45$ deg and $h = 0$.

Helmholtz'sche Doppelschicht: *Helmholtz double layer, electric double layer.* See elektrische Doppelschicht.

Helmholtz'sche Gleichung: *Helmholtz equation, Lagrange-Helmholtz equation.* (1) (Dioptrics.) An equation of the form

$$n_1 y_1 \tan a_1 = n_2 y_2 \tan a_2$$

expressing the relation between the linear and the angular magnification at a spherical refracting interface. y_1, y_2 are linear dimensions of object and image, a_1, a_2 the angles made by focal rays and axis at object- and image-points, and the refractive indices of the two media.

Helmholtz'sches Pendel: *Helmholtz pendulum.* A device, due to Helmholtz, whereby it is possible to charge a condenser for a definite short time, varied at will, or to impart varying amounts of magnetization to a specimen of iron.

Helmholtz'sche Spulen: *Helmholtz coils.* Two equal circular coils placed coaxially at a distance apart equal to their radius, and traversed by the same current. The field near the axis between them is practically uniform.

hemihedrisch: *hemihedral.* In re a crystal: having only one-half the number of faces necessary to complete a given type of symmetry.

hemimorph: *hemimorphic.* In re a crystal: terminated at the two ends by dissimilar sets of faces.

Henry: *henry.* The practical c.g.s. electromagnetic unit of inductance (or of mutual inductance), equal to 10^9 abhenrys; viz., the inductance of a circuit in which the variation of current at the rate of 1 amp per second induces an e.m.f. of 1 volt. The millihenry is usually more convenient.

Henry'sches Gesetz: *Henry law.* States that, at constant temperature, the solubility of a gas in a liquid which does not act chemically upon it is proportional to the pressure.

Herpolhode: *herpolhode.* The path traced by the point of contact of the energy ellipsoid of a rigid body with the fixed tangent plane on which it rolls. The term is due to Poinsot (1834).

Herschel Effekt: *Herschel effect.* A decrease in developable density on a photographic plate produced by a second exposure to radiation of longer wave length.

Herschel-Quincke Roehre: *Herschel-Quincke tube.* A branched acoustic tube, resembling a divided or shunted electric conductor; used in studying acoustic interference phenomena.

Hertz: *hertz.* A unit of frequency, equal to 1 cyc per second. (Rare in U. S.)

Hertzoszillator: *Hertz oscillator.* An arrangement of conductors, electric oscillations in which are capable of

emitting electromagnetic (Hertzian) radiations; a forerunner of the radio transmitting antenna circuit.

Hertz'sche Strahlung: *Hertzian radiation, H. waves.* See elektrische Welle.

Hertz'scher Vektor: *Hertzian vector.* A vector Π, pertaining to the electromagnetic field, in terms of which both the electric intensity E and the magnetic intensity H may be specified according to the equations

$$E = \nabla(\nabla \cdot \Pi) - \frac{1}{c^2}\frac{\delta^2 \Pi}{\delta t^2},$$

$$H = \frac{1}{c}\nabla \times \frac{\delta \Pi}{\delta t};$$

physically the equivalent of the vector of an oscillating dipole.

Hertz'sche Wellen: *Hertzian waves, H. radiation.* See Hertz'sche Strahlung.

Heterodyne: *heterodyne.* A coupling of oscillatory circuits of such relative frequency that the beats between them come within the audible range.

heterodyner Wellenmesser: *heterodyne wave meter.* A calibrated electrical oscillator of variable frequency, together with a device, employing the heterodyne principle, for indicating the setting at which the frequency of the oscillator bears a known relation to that of the circuit under test.

heteromorph: *heteromorphic, polymorphic.* Occurring in two or more different crystalline forms.

heteropolar: *heteropolar, polar.* Electrically nonsymmetrical as a molecule which, like HCl, has an effective electric moment.

Heusler'sche Legierungen: *Heusler alloys.* A series of alloys of nonferromagnetic substances, chiefly copper, manganese, and aluminum, which, however, exhibit ferromagnetic properties in a remarkable degree. Developed by F. Heusler and others about 1903.

hexagonal: *hexagonal.* In re crystal structure: having three equal axes at angles of 120 degrees and a fourth at right angles to all three.

Hibbert'scher Flusstandard: *Hibbert flux standard.* A permanent magnet with an annular air gap through which a coil of wire is dropped to produce a known and invariable change in the magnetic flux linked with an electric circuit including the coil. Devised by W. Hibbert, 1892.

Hicks'sche Formel: *Hicks formula.* A modification of the Rydberg (spectral-series) formula, in which allowance is made for the variation of f with the number of the line in the series. It is somewhat similar to the Ritz formula.

High-pass (Kurzwellenfilter fuer HF): *high-pass.* In re a wave filter: having the property of transmitting all frequencies above a certain limit and suppressing those below it.

Hilfskreis: *line of force.* (1) An imaginary line in a field of force which, at each of its points, coincides in direction with the field intensity; a concept due to Faraday. (2) A unit of flux (magnetic, electric), so defined that the number of lines intersecting any cross section, per unit area, is numerically equal to the component of field intensity normal to the section.

Hittorf'scher Dunkelraum: *Hittorf dark space, cathode dark space, Crookes dark space.* That portion of the glow discharge in a Crookes tube lying between the cathode glow and the negative glow; so called because it is nonluminous.

Hittorf'sche Zahlen: *Hittorf numbers, transference numbers, transport n.* A term applied by Hittorf to the fractions of an electrolytic current carried by the anions and by the cations, respectively, the sum of which is unity.

Hitzdrahtamperemeter: *hot-wire ammeter (or voltmeter).* An instrument for measuring current (or voltage) by the heating effect upon a filament.

Hitzdrahtanemometer: *hot-wire anemometer.* An instrument for measuring the velocity of a current of gas by means of its cooling effect on an electrically heated wire.

Hitzdrahtmanometer: *hot-wire gauge.* A pressure gauge which depends upon the cooling effect of the gas upon a hot filament.

Hochfrequenzgenerator: *circuit driver, radio-frequency generator.* A source of h.-f. e.m.f. esp. of the vacuum-tube-controlled type, for experimental use.

Hodograph: *hodograph.* The locus of the terminal point of the evector which, drawn from a fixed origin, continuously represents the velocity of a point moving along any given path.

Hodoskop: *hodoscope.* An apparatus for tracing the paths of cosmic rays by means of an array of small Geiger counters, each of which is connected with a neon lamp which flashes as the counter is set off by the cosmic particle.

Hoehenmesser: *altimeter.* An instrument, resembling an aneroid barometer, which indicates the altitude of an airplane above the ground station at which it was set at zero.

Hof: *halo.* See Halo.

Hof: *corona* (*laymen*). A spectral ring sometimes observed surrounding the sun or the moon; caused by the diffraction of light by suspended matter in the air. Not to be confused with halo.

Hohlraum: *Hohlraum* (*Germ., "empty space"*). A black-body cavity.

Hohlraumbildung: *cavitation.* The formation of a partial vacuum in a liquid, due to the separation of its parts in the process of flow; or the separation of gases from the liquid, with the formation of gas-filled spaces or bubbles.

Hohlraumstrahlung: *cavity radiation, black-body radiation.* The radiation from a black body at a given temperature. Syn. Planckian r., black r.

holohedral: *holohedral.* In re a crystal: having the full number of faces corresponding to the development of the complete maximum symmetry possible to the crystal system in question.

holomorph: *holomorphic.* In re a crystal: having the two ends symmetrical with each other.

holonom: *holonomic, holonomous.* In re a dynamic system: (1) having a number of degrees of freedom equal to the number of independent coordinates; (2) having integrable relations connecting the coordinate velocities.

Holtz'sche Roehre: *Holtz tube.* A vacuum tube across which are funnel-shaped constrictions pointing in one direction, and through which a h.-f. discharge passes much more readily one way than the other.

homogene Formaenderung: *homogeneous strain.* A strain such that all pairs of points in the strained body which were initially at equal distances in parallel directions are still at equal distances in parallel direcitons; though both the distances and the directions may have been altered.

homologes Feld: *homologous field.* A field of force in which the lines of force in a given plane all pass through one point (center of homology), e.g., the electric field between two coaxial charged cylinders.

homologe Temperaturen: *homologous temperatures.* In re two or more substances, esp. metals: absolute temperatures which bear the same ratio to the absolute melting points of the respective substances; especially useful in discussing the properties of plastic solids.

homoeopolar: *homopolar, homoeopolar.* Electrically symmetrical, as a molecule which, like N_2, has no effective electric moment; not polar.

homotrop: *homotropic.* Having similar crystalline structure.

Hooke'sches Gesetz: *Hooke law.* An approximate empirical law of elasticity, which states that the ratio of the stress to the strain, in the case of elongation or rectilinear compression, is constant. First stated by Robert Hooke (1660).

horizontal: *horizontal.* Perpendicular to the direction of gravity.

Horizontalintensitaet: *horizontal intensity.* The intensity of the horizontal component of the earth's magnetic field at any point.

Horopter: *horopter.* The locus of those points in the field of binocular vision which are seen single, i.e., the images of which fall on corresponding retinal points.

Huefner'scher Rhombus: *Huefner rhomb.* A rhombic glass prism used for the comparison of two illuminated surfaces in photometry.

Hull'scher Ring: *Hull ring, powder pattern, Debye-Scherrer ring.* A pattern of parallel lines or bands of ferromagnetic powder deposited on the surface of a magnetized crystal.

Huygen'sches Okular: *Huygens eyepiece.* A telescope eyepiece consisting of a plano-convex field lens and a plano-convex eye lens placed behind the field lens, with a stop halfway between them.

Huygen'sches Penrelgesetz: *Huygens pendulum law.* States that any two conjugate points of a gravity pendulum have the property that the period of oscillation is the same when the pendulum is suspended at either; and that this common period is equal to that of an ideal simple pendulum of length equal to the distance between the two points.

Huygen'sches Prinzip: *Huygens principle.* An important principle of wavc propagation, the essential feature of which is the concept that every point on an advancing wave front acts as a source of disturbance and sends out waves, the resultant effect of which constitutes the propagation of the wave as a whole.

Huygen'sche Wellenoberflaeche: *Huygens wave surface.* The wave front of light traversing a doubly refracting medium.

Huygen'sche Zone: *Huygens zone, half-period element, Fresnel zone.* See Fresnel'sche Zone.

Hydraulik: *hydraulics.* The dynamics of liquids, esp. its technological applications.

hydraulische Durchschnittstiefe: *hydraulic mean depth, hydraulic radius.* The quotient of the cross-sectional area of a stream flowing in a channel or a pipe, divided by the perimeter of the stream.

hydraulischer Gradient: *hydraulic gradient.* The rate of fall of the pressure head along a conduit flowing full of liquid.

hydraulische Gradientlinie: *hydraulic grade line.* An imaginary line so drawn, in reference to a conduit flowing full of liquid under pressure, that each point of the line lies vertically above or below the conduit, and at a distance from it equal to the pressure head at the corresponding point of the conduit.

hydraulische Neigung: *hydraulic slope.* The slope of the hydraulic grade line at any point; numerically equal to the hydraulic gradient.

Hydrodynamik: *hydrodynamics.* The dynamics of liquids.

Hydrokinetik: *hydrokinetics.* That branch of physics which treats of the motion of liquids.

Hydrometer: *hydrometer.* An instrument composed of a light float weighted at one end and bearing a vertical scale, which indicates the specific gravity of the liquid in which it is placed by the depth of its displacement when in equilibrium.

Hydrostatik: *hydrostatics.* That portion of hydrodynamics which does not involve effects of liquid motion.

Hygrograph: *hygrograph.* A recording hygrometer.

Hygrometer, Feuchtigkeitsmesser: *Hygrometer.* Any one of several instruments for measuring the humidity of the atmosphere.

Hyperfeinstruktur: *hyperfine structure.* The structure of a spectrum line which depends upon angular momentum in the atomic nucleus, each ordinary line being thereby rendered a multiplet. It is often superposed upon the isotope structure.

Hyperfeinstrukturquantenzahl: *hyperfine quantum number, fine quantum number.* See Feinstrukturquantenzahl.

Hypsometer: *hypsometer.* An instrument for measuring the boiling points of liquids, esp. for the purpose of estimating elevations above sea level.

Hysteresis: *hysteresis.* One of several effects resembling a kind of internal friction, accompanied by the generation of heat within the substance affected. Magnetic h. occurs when a ferromagnetic substance is subjected to a varying magnetic intensity; electric h., when a dielectric is subjected to a varying electric intensity. Elastic h. is the internal friction in an elastic solid subjected to varying stress.

Hysteresiskonstante: *hysteretic constan, Steinmetz coefficient.* Numerical values of the coefficient are based upon the measurement of the hysteresis loss in ergs per cubic centimeter per cycle and the maximum induction in gausses.

Hysteresiskurve: *hysteresis curve, h. loop.* The graph of the varying magnetic intensity H and the resulting magnetic induction B in a specimen of ferromagnetic material during a complete magnetization cycle.

Hysteresismesser: *hysteresis meter.* An instrument for testing magnetic hysteresis, usually depending upon the torque developed on placing the specimen in a rotating magnetic field or rotating it in a stationary field.

Hysteresisverlust: *hysteresis loss.* A loss of power in the operation of electrical devices, due to magnetic hysteresis.

Hysteresisschreiber: *hysteresigraph.* An instrument which automatically traces hysteresis curves for specimens of magnetic material placed in it.

Hysteresisschleife: *hysteresis loop, h, curve.* See Hysteresiskurve.

I-Wert: *I value.* The value of the quantum number I which determines the internal angular momentum of an atomic nucleus.

ideale Fluessigkeit: *perfect fluid.* An ideal fluid possessing no viscosity; a concept useful in theoretical discussions.

ideales Gas: *perfect gas, ideal gas.* A gas which obeys Boyle's law; not realized in physical fact.

ideale Gaskonstante: *ideal gas constant.* See Gaskonstante.

ideales Gasgesetz: *ideal gas law.* A law connecting the pressure p, molar volume v, and temperature T of an ideal gas; expressed by the equation $pv = RT$; in which R is the ideal gas constant.

idealer Kristall: *perfect crystal, ideal crystal.* A crystal having no mosaic structure and capable of X-ray reflection in accordance with the Darwin-Ewald-Prins law.

idealer Strahler: *perfect radiator, ideal radiator, black body.* A body whose reflectivity is zero for radiation of all frequencies. Only an ideal, it is approximated experimentally by a nearly closed cavity with a small opening or slit.

idiochromatisch: *idiochromatic.* In re a crystal: having photoelectric properties characteristic of the material of the pure crystal itself, and not due to foreign matter.

Impedanz: *impedance.* The ratio of the effective e.m.f. to the effective current in an a.-c. circuit. For a circuit of resistance R, inductance L, and (series) capacitance C, carrying a current of frequency n, its value is

$$\sqrt{R^2 + (2\pi nL - \frac{1}{2\pi nC})^2}.$$

Impuls: *impulse.* The time integral of a force, esp. when applied for a short time; measured by the change in momentum which it would impart to a free mass if acting in a line through the c.m.

Impulsmoment: *momentum, moment of momentum.* (1) (Linear.) The product of the mass of a body by its linear velocity. (2) The angular momentum is the product of the moment of inertia of a rotating body, with respect to the (fixed) axis of rotation, by its angular velocity in radians per unit time; or, the volume integral of the products of the momenta of the elements of mass of the body by their distance from the axis of rotation.

Impulsraum: *momentum space.* A mathematical space in which the radius vector represents momentum and the coordinates x, y, z, represent components of momentum. The momenta of the molecules of a gas, for example, then correspond to points of this space.

Impulsstrahlung: *impulse radiation.* Any radiation that may result from the impacts of rapidly moving particles upon a body of matter, e.g., X-rays, produced by the impacts of electrons.

Impulsverhaeltnis: *impulse ratio.* The ratio of the potential difference required to initiate a spark between terminals, when the voltage is suddenly applied, to that required for the same spark gap with a steady field; a term due to Peek.

Indikatordiagramm: *indicator diagram.* The graphical record made by a steam-engine indicator.

Indikatrix: *indicatrix.* A vectorial ellipsoid, introduced by Fletcher to represent the relative refractive indices of a crystal in different directions.

Induktion: *inductance, induction.* A (not necessarily constant) characteristic of an electric circuit, the measure of which is either the e.m.f. magnetoelectrically induced in the circuit by the variation at unit rate of the current flowing in it, or the magnetic linkage with the circuit produced by unit steady current flowing in it. The practical unit is the henry (for which the linkage per ampere is 10^8 Maxwell-turns).

Induktionsbruecke: *inductance bridge.* An arrangement resembling a Wheatstone bridge, and used for the comparison of inductances by a somewhat similar method.

Induktionsmotor: *induction motor.* An a.-c. motor, in which the torque on the rotating circuit, or rotor, is due to currents induced in it by a varying magnetic field excited by a.c.'s in the stationary circuit, or stator. Such motors are operated by single-phase, two-phase, three-phase, or polyphase currents.

Induktionsmesser: *inductometer.* A variable inductance, esp. one calibrated to indicate the inductance in henrys or millihenrys.

Induktometer: *inductometer.* See Induktionsmesser.

Induktionsspule: *induction coil.* An apparatus consisting of two coupled circuits, interruptions of the current in one of which (the primary) induces an e.m.f., usually large, in another (the secondary). Used for ignition, for operating vacuum tubes, etc.

Induktivitaet: *inductivity, dielectric constant.* See dielektrische Konstante.

induktiver akustischer Widerstand oder akustische Inertanz: *acoustic inertance.* See akustische Inertanz.

Induktor: *inductor.* A coil or electromagnet introduced into a circuit to provide inductance.

induzieren: *induce.* To bring about as the result of exposure to the influence or to the variation of a field of force; e.g., an induced charge, or an induced current, etc.

infrarot: *infrared.* A wide range of invisible radiation frequencies adjoining the visible red and merging into Hertzian radiation.

Infraschall: *infrasonic.* Having a frequency below the audible range.

Inklination: *inclination.* (1) The angle which a line, a surface, or any vector makes with the horizontal. (2) (Geom.) The angle which the direction of a vector or of a curve at any point makes with the axis of abscissas. (3) (Magnetic.) The angle which the magnetic field of the earth makes with the horizontal at any station. Syn. magnetic dip.

Inklinationsmesser: *inclinometer.* (1) Any instrument for measuring inclination, as of the surface of the land or of a rock stratum. (2) (Magnetic.) A magnetic needle poised in a vertical plane, used to indicate the magnetic inclination. Syn. dip needle.

Inklinometer: *inclinometer.* See Inklinationsmesser.

innere Arbeit: *internal work.* Work done by a system against forces operating within it or between its parts, or done upon the system by such forces e.g., when a body expands or when a liquid evaporates, work is done in general against the forces of cohesion between its molecules.

innerer Druck: *intrinsic pressure, internal pressure.* A pressure supposed to exist within a fluid because of its cohesion, and which cooperates with the external pressure to maintain equilibrium against the expansive effect of heat.

innere Energie: *internal energy, intrinsic energy.* That part of the energy of a system any change in which is equal to the algebraic sum of the mechanical work and the heat received by the system; provided that the recognizable forms of bulk energy, such as the kinetic energy of motion of its parts, or its electrical and magnetic potential energy, remain constant throughout such change. The internal energy may be regarded as a scalar, reckoned from a zero taken at some arbitrarily chosen state.

inneres Feld: *intrinsic field, inner field, inner force.* The electric field immediately surrounding any individual molecule in the interior of a polarized dielectric, or the magnetic field surrounding a molecule of a magnetized substance. Its intensity is a linear function of the electric polarization or of the magnetization.

innere Feldkonstante: *inner field constant.* The constant coefficient of the electric polarization or of the magnetization in the linear function representing the intensity of an inner field.

innere Kraft: *inner force.* See inneres Feld.

innere magnetische Induktion: *intrinsic magnetic induction.* That component of the magnetic induction which is proportional to the local magnetization.

innerer photoelektrischer Effekt: *internal photoelectric effect, volume photoelectric effect.* True or primary photoconductivity, apart from the secondary effects usually associated with it.

inneres Potential: *intrinsic potential.* The constant amount by which, according to the theory of Frenkel, the potential in the interior of a body differs from that of its surroundings; closely associated with contact **p.d.**

innere Quantenzahl: *inner quantum number.* A quantum number J, associated with the quantization of the total angular momentum of the atom, exclusive of nuclear spin. It is analogous to the rotational quantum number J of a molecule (inclusive of electron spin); and the term is sometimes thus applied to the molecule.

innere Reflektion (Zurueckstrahlung): *internal reflection.* Reflection of light incident upon the surface of a body from the inside, or at an interface, the medium beyond which has a lower refractive index than that in which the reflection occurs.

innerer Widerstand: *internal resistance.* The resistance of the portion of a circuit occupied by sources of e.m.f. such as batteries or generators.

innere Umkehrung, innere Umwandlung: *internal conversion.* The effect upon an atom produced when a gamma-ray photon emerges from the nucleus and gives up its energy in an encounter with an extranuclear electron.

in regelmaessigen Zeitabschnitten: *isochronous.* In re a vibration: having a period independent of the amplitude.

in Serie gewichelt: *series-wound.* In re a field magnet:

having its winding in series with the external or line circuit.

Instrument zur Messung der Koerzitivkraft: *coercimeter.* An instrument for measuring the coercive force of magnetic materials.

Integrationsinstrument: *integrator.* An instrument that performs definite integrations or summations mechanically.

Integrationsmesser: *integrating meter.* An instrument that sums up or integrates the electric energy used over a period of time, e.g., the ordinary electric light meter.

Integrationsphotometer: *integrating photometer.* A photometer that sums or averages the intensity of a light source in all directions and thus gives the mean spherical candle power by a single observation.

Integrationssphaere: *integrating sphere.* (Photom.) A spherical shell coated inside with a nonselective white paint, used with a photometer for measuring the reflections of material without comparison with a reflection standard.

Integrationswuerfel: *integrating cube, cube photometer.* An integrating photometer similar in principle to the sphere photometer but employing a cubical instead of a spherical cavity.

Intensitaet (zum Beispiel Emission): *intensity (of an emission), flux density.* The flux through unit area of a surface normal to the direction of propagation; or, for a diffuse emission, the flux per unit solid angle per unit area normal to a specified direction. Syn. intensity.

Interferenz: *interference.* A term applied to a variety of phenomena arising from the joint effects of two or more wave trains arriving at the same point simultaneously.

Interferenzphotometer: *interference photometer.* A photometer in which the balance is determined by the disappearance of superposed, complementary interference bands produced by the two sources in a thin film.

Interferometer: *interferometer.* An apparatus used to produce and exhibit interference between two or more coherent wave trains from the same large, luminous area, and often to compare wave lengths with observable displacements of reflectors or other parts.

Interkombinationslinie: *intercombination line.* A combination line between multiplet energy levels having different numbers of components, as between quintet and triplet levels.

intermittency effect: *intermittency effect.* A difference between the photographic density produced by an exposure separated into short flashes and that due to a continuous exposure of the same illumination and total duration.

internationaler Radiumstandard: *international radium standard.* A standard of radioactivity, consisting of 21.99 mg of pure radium chloride, prepared by Mme. Curie and preserved at the Bureau International des Poids et Mesures at Sèvres.

internationale Temperaturskala: *international temperature scale.* A scale of temperature fixed by international agreement. Between — 190 and + 660 degrees C., it is based upon the resistance of a standard platinum resistance thermometer in accordance with the following formulas for resistance at temperature t:

below 0 degree C.,

$$R_t = R_0 [1 + At + Bt^2 + C (t - 100°) t^3],$$

above 0 degree C.,

$$R_t = R_0 (1 + At + Bt^2);$$

where A, B, C are empirical constants. From + 660 degrees C. to the gold point it is based upon the platinum-platin-rhodium thermel, and, beyond this, upon the optical pyrometer.

interpolieren: *interpolate.* To estimate the value of a function for values of the variable lying between those for which the function is known; either graphically, or by a proportion or other interpolation formula.

Interwall: *interval.* The ratio of the higher of two musical frequencies to the lower; e.g., the interval C sharp to C is 1.059.

Interwallfaktor: *interval factor, gamma value.* A quantity relating to the angular momentum levels in the Zeeman effect, introduced by Landé, and denoted by γ.

Interwallregel (Landé): *interval rule (Landé).* See g-Faktor, g-Wert.

Invar: *invar.* An alloy of nickel and iron (about 36 percent Ni) which has the remarkably small linear expansion coefficient 8×10^{-7} per degree C.

invariable Ebene: *invariable plane.* The plane through the c.m. of a body or system of bodies, perpendicular to the vector representing its angular momentum; invariable so long as the system is unaffected by external influences.

Inversion: *inversion.* (1) A reversal of the usual direction of a process; e.g., the change in density of

water at 4 degrees C. (2) The transformation of an optically active substance into one having the opposite rotatory effect, without change of chemical composition.

inverser photoelektrischer Effekt: *inverse photoelectric effect.* The transformation of the kinetic energy of a moving electron into radiant energy, as in the recombination of an electron with an ion, or in the production of X-rays.

inverser piezo-elektrischer Effekt: *inverse piezo-electric effect.* The contraction or expansion of a piezo-electric crystal along an electric axis when subjected to an electric field in that direction.

inverse Spannung: *inverse voltage.* The effective voltage attained in the noncurrent half of the cycle from an a.-c. source used with a valve rectifier, as in operating an X-ray tube with a transformer.

Ion: *ion.* (1) One of two oppositely charged carriers which effect electric conduction in an electrolyte. (2) Any part of a molecule or of an atom, dislodged from the rest by a suitable application of energy. (3) Any electrically charged particle of molecular or atomic order of magnitude.

Ionendosismesser: *iontoquantimeter.* A type of roentgenmeter, devised by Duane, and used for the measurement of X-ray intensities.

Ionengitter: *ion lattice.* The lattice of an ionic crystal.

Ionenkristall: *ionic crystal.* A crystal having chemical ions, rather than neutral atoms or molecules, at its lattice points; e.g., sodium chloride.

Ionenleitfaehigkeit: *ionic conductivity.* The conductivity of a solution due to a given type of ions, corresponding to a given concentration of those ions in the solution.

Ionenzaehler: *ion counter.* A tabular ionization chamber designed by Ebert for measuring the ionization of the air.

Ionenzustand: *ionicness.* A condition defined as being present in a molecule, either heteropolar or homopolar, when, using atomic orbitals, the wave function contains terms corresponding to opposite charges on the two atoms.

Ionisationsdruck: *ionization pressure.* An increase in the pressure within a gas-discharge tube, due to ionization of the gas.

Ionisationsfunktion: *ionization function.* A coefficient proportional to the relative ionization produced in a given gas enclosed in a given ionization chamber by equal amounts of radiant energy of different wave length.

Ionisationskammer: *ionization chamber.* An enclosure containing two oppositely charged electrodes in air or other gas, so arranged that when the gas is ionized, as by X-rays, the ions formed are drawn to the electrodes, thus establishing an ionization current.

Ionisationskoeffizient: *ionization coefficient.* The number of ions formed by the impacts of a rapidly moving corpuscle in a gas, per unit length of path. Relative ionization coefficients are used to compare ionization produced by any ionizing agent in a given substance with that in a standard substance.

Ionisationskondensator: *ionization condenser.* An apparatus consisting of two parallel metal plates, placed within an ionized gas and supplied with a h.-f., a.-c. voltage for the purpose of testing the electrical properties of the ionized gas.

Ionisationsmanometer: *ionization gauge.* A pressure gauge that depends upon the quantitative relation between pressure and ionization current in a vacuum tube.

Ionisationspotential: *ionization potential, ionizing potential.* The p.d., in volts, corresponding to the energy, in electron-volts, required to ionize an atom or a molecule, by the impact of an electron or otherwise.

Ionisationssaeule: *columnar ionization.* (1) A term used in re the properties of ionized gases in tubes or columns as differing from those of gases uniformly ionized throughout. (2) Also frequently applied to the ionization of gases by alpha particles.

Ionisationsstrom: *ionization current.* A current produced by an electric field in an ionized gas.

Ionisationswaerme: *heat of ionization, heat of dissociation.* The quantity of heat evolved in the chemical dissociation of 1 g or 1 mol of an electrolyte.

Ionisationswahrscheinlichkeit: *ionization probability.* One of several arbitrarily chosen expressions involving factors relating to the ionization of a gas by a corpuscular emission, and used as measures of the likelihood or the relative frequency of the ionization of molecules. They are not probabilities in the usually accepted sense.

ionisieren: *ionize.* To separate into ions.

Ionisierungspotential: *ionizing potential.* See Ionisationspotential.

Ionometer: *ionometer.* An ionization chamber used for measuring the intensity of an ionizing emission.

Ionosphaere: *ionosphere.* See Heaviside Schicht.

irrationale Dispersion: *irrational dispersion.* An inequality in the deviation angle for the same wave length, produced by two prisms of the same total dispersion range but of different kinds of glass.

isenthalpisch: *isenthalpic, (enthalpy).* For a fluid system subject to no outside forces except a uniform, normal pressure, it is the thermodynamic potential for constant entropy and pressure. A process in which this quantity is constant is said to be isenthalpic.

isentropisch: *isentropic.* (1) (adj.) Taking place without change of entropy. (2) (n.) The graph representing the variables in a transformation during which the entropy remains constant.

Isobare: *isobar.* An isobaric line.

isobarisch: *isobaric.* (1) Taking place without change of pressure. (2) Connecting points of equal pressure, as an isobaric line. (3) Having the same atomic weight but quite different chemical properties, e.g., the elements uranium X_1 and uranium X_2; such elements are termed isobars.

Isochore: *isochor, isochore.* The graph representing two variables involved in an isometric (constant-volume) thermodynamic change, e.g., pressure-temperature, temperature-entropy, etc.

isochromatisch: *isochromatic.* See gleichfarbig.

isochromatische Kurve: *isochromat.* A curve representing an isochromatic relation.

isochron: *isochronous.* See in regelmaessigen Zeitabschnitten.

isodynamisch: *isodynamic.* A term applied to points on the earth's surface at which the total magnetic intensity of the terrestrial field has the same magnitude. An isodynamic line is a line connecting such points.

isodynamischer Zustand: *isodynamostacy.* A condition of kinetic equilibrium.

isoelektrisch: *isoelectronic.* Having the same number of electrons outside the nucleus. E.g., an atom may be made isoelectronic with the one below it in atomic number by removing one of its outer electrons. An isoelectronic sequence is a series of ions having the same number of extranuclear electrons, but successively increasing nuclear charge.

isoelektrischer Punkt: *isoelectric point.* That critical condition of a colloidal suspension in an electrolytic medium for which the cataphoresis of the suspended particles reduces to zero and reverses in sign as the activity of the electrolyte is increased.

isoenergetisch: *isoenergic.* Taking place under the condition that the internal energy remains constant.

Isogam: *isogam.* A line of equal acceleration of gravity on the earth's surface.

isogon: *isogonic.* (1) Making, or pertaining to, a fixed angle. An isogonic line is a line on the earth's surface, at all points of which the magnetic declination has the same value. (2) In re two crystalline substances: having corresponding dihedral angles of one or more zones equal.

isoklin: *isoclinic, isoclinal.* A term applied to points on the earth's surface at which the magnetic inclination is the same. An isoclinic line is a line connecting such points.

Isolationsstaerke: *insulating strength, dielectric strength.* See dielectrische Kraft.

Isoluxdiagramm: *isolux diagram, isophote.* A curve or surface of equal light intensity.

isomerer Koerper: *isomer.* One of two or more substances composed of molecules having the same kind of atoms and in the same proportions, but which, by reason of some difference in the number or arrangement of those atoms, have entirely different physical and chemical properties.

Isomeres: *isomer.* See isomerer Koerper.

isometrisch: *isometric, cubical.* (1) In re crystal structure: having three equal and mutually perpendicular axes. (2) Having the same volume, or involving the maintenance of a constant volume, e.g., an isometric change in a gas. (3) Represented without perspective convergence, i.e., as of the same size irrespective of distance.

Isomorphie: *isomorphism.* The property, possessed by various groups of compounds, of being identical in crystalline form, and of having the same numbers of atoms, similarly arranged, within the molecule.

isosmotisch: *isosmotic.* In equilibrium as regards os-

motic pressure; applied to solutions on opposite sides of a porous membrane when osmotic action ceases.

Isoplan: *isoplanatic.* In re an optical system: free from coma.

Isophote: *isophote.* See Isoluxdiagramm.

isostatisch: *isostatic.* In static equilibrium; esp. applied to the hydrostatic equilibrium of the earth's crust in accordance with the theory of isostasy.

Isotherm: *isothermal.* (1) (adj.) At the same temperature throughout. An isothermal line is a line on the earth's surface connecting points of equal temperature. (2) (n) A graph representing the variables in a transformation during which the temperature remains constant.

Isotherme: *isotherm.* An isothermal line.

Isotop: *isotope.* One of two or more varieties of the same chemical element which, while they have the same atomic number, have different atomic masses.

Isotopeneffekt: *isotope effect, i. shift.* A systematic difference in the position of lines in the spectra of different isotopes of the same element or of molecules containing them.

Isotopenverhaeltnis: *isotopic ratio.* The ratio between the number of atoms of two isotopes of the same element in the natural mixture, as of O^{16} and O^{18} in ordinary oxygen.

isotrop: *isotropic.* Having the same properties in all directions.

J-Wert, j-Wert: *J value, j value.* The value of the inner quantum number in atoms, or of the rotational quantum number in molecules.

Jellet-Cornu Prisma: *Jellet-Cornu prism.* A type of half-shade analyser in which two parts of a Nicol prism are ground to fit each other so that their transmission planes are not quite parallel.

Jolyscher Leuchtschirm: *Joly screen.* A photometer screen devised by Joly, and apparently also in modified form by Elster, consisting of two slightly separated parallel plates of a translucent substance, e.g. paraffin or opal glass. When the plates are equally illuminated, the interface disappears.

Joule: *joule.* A unit of energy or of work. The absolute joule is equal to 10^7 ergs. The international joule is defined, in electrical terms, as the work required to maintain a current of 1 international amp for 1 sec in a resistance of 1 international ohm.

Joulescher Aequivalent: *Joule Equivalent.* Syn. mechanical equivalent of heat.

Joulescher Effekt: *Joule effect.* (1) (Magnetic.) Extension accompanying change of magnetization. (2) Heating by mechanical means. (3) Generation of Joule heat.

Joulesches Gesetz: *Joule law.* (1) Expresses the quantity of heat (Joule heat) generated by an electric current I (amp) flowing for t (sec) in a conductor of resistance R (ohms) as 0.2388 RI^2t (cal). Since the rate of heat generation is proportional to RI^2, energy lost in this way is sometimes called the RI^2 loss. (2) States that the internal energy of a perfect gas is a function of its temperature only, i.e. does not depend upon its volume or pressure.

Joulesche Waerme: *Joule heat.* Heat generated by an electric current and dependent only upon the resistance and the current, i.e. not including Peltier or Thomson Effect.

Joule-Thomson Effekt: *Joule-Thomson effect.* An effect observed by Joule and Thomson (Kelvin) about 1852 upon the temperature of a gas escaping from a higher pressure into a lower pressure through a porous partition, the change being either a cooling or a heating (the so-called porous-plug experiment). This change indicates the presence of molecular interactions.

Joule-Thomson Experiment: *porous-plug experiment.* See Joule-Thomson Effekt.

K-Serie: *K series.* A series of frequencies in the X-ray spectrum of an element, believed to arise from the transition of electrons from various higher quantum states to the state whose principal quantum number is 1.

kaelteerzeugend: *cryogenic.* Pertaining to low temperatures or to apparatus for producing them.

Kaleidophon: *kaleidophone.* A device for producing the Lissajous curves, consisting of an elastic strip capable of two vibrations at right angles, and having a small mirror mounted across one end. Devised by Wheatstone.

Kaloreszenz: *calorescence.* The transformation of infrared radiant energy into visible light, as by focusing infrared rays upon a thin plate of platinum until it becomes white hot.

Kalorie: *calorie.* (1) A unit, defined as the quantity of heat required to raise the temperature of 1 g of water from 15 to 16 degrees C. (2) One thousand times the above unit.

Kaloriemeter: *calorimeter.* Any one of several types of apparatus used for the purpose of measuring quantities of heat.

kaloriemetrische Koeffizienten: *calorimetric coefficients.* Six quantities which express the rates of absorption of heat by a body of fluid during reversible changes of its volume, pressure, and temperature, viz.,

$$\left[\frac{\delta q}{\delta p}\right]_v, \left[\frac{\delta q}{\delta v}\right]_p, \left[\frac{\delta q}{\delta T}\right]_v, \left[\frac{\delta q}{\delta T}\right]_p, \left[\frac{\delta q}{\delta p}\right]_T, \left[\frac{\delta q}{\delta v}\right]_T.$$

In these T is the temperature; q, quantity of heat; v, volume; p, pressure; and the subscripts denote that the corresponding quantity is to be kept constant.

kalte Elektronenemission: *cold emission.* See Feldemission.

Kalte Emission: *cold emission.* See Feldemission.

Kanalstrahlen: *canal rays.* An emission consisting of positive ions which have passed through openings in the cathode of a gas-discharge tube.

kanonisch: *canonical.* In re the mathematical statement of a physical law: expressed in the simplest completely general form possible.

Kanteneffekt: *edge effect.* An abnormality such as that exhibited by the electric field due to the charge on a conductor near where the latter terminates in a sharp edge.

Kapazitaet: *capacity, capacitance.* The ratio of the quantity of electricity q accumulated in charging a conductor to the accompanying change in its potential V, i.e., the value of dq/dV.

Kapazitaetsmessbruecke: *capacitance bridge.* An arrangement resembling a Wheatstone bridge and used for the comparison of capacitances by a somewhat similar method. See also Farad'sche Bruecke.

Kapazitanz: *capacitance.* See Kapazitaet.

Kapazitanzkoeffizient: *capacitance coefficient.* In re one of a system of neighboring conductors: the capacitance of the given conductor when all the others are kept at zero potential.

Kapillarelektrometer: *capillary electrometer.* An electrometer whose action depends upon the effect of a p.d. on the surface tension at the interface between two liquids in a capillary tube.

Kapillaritaet: *capillarity.* See Haarroehrchenkraft.

Kapillarkonstante: *capillary constant.* In re two liquids of densities p_1, p_2, having the mutual surface tension T: the product $(p_1 - p_2)$ Tg, in which g is gravity.

Kapillarstroemung: *transpiration.* The passage of a gas or a vapor through a capillary, or its exhalation from the pores of an absorbing substance.

Kaskade: *cascade.* An arrangement of condensers, analogous to the series arrangement of battery cells, in which the higher potential plate of each is connected to the lower of the next.

Kaskadenroehre: *cascade (X-ray) tube.* A high-voltage vacuum tube used in the production of hard X-rays or of high-speed ion beams, in which the total voltage is divided by constructing the tube in several sections.

Katakaustik: *catacaustic.* A caustic produced by reflection.

Kataphorese: *cataphoresis.* The movement of solid particles in liquid suspension under the action of an e.m.f.

Katenari'sche Kurve: *catenary.* The curve assumed by a perfectly flexible, uniform chain hanging in equilibrium between two points of support.

Kater'sches Pendel: *Kater pendulum.* One of several types of rigid pendulum designed by Kater for relative

or absolute gravity determinations. The most familiar is reversible, having two adjustable knife edges and depending upon the Huygens pendulum law.

Kathetometer: *cathetometer.* A form of comparator, consisting of a reading telescope or microscope mounted horizontally and movable along a vertical scale.

Kathode: *cathode, kathode.* That electrode from which electrons or negative ions are dispersed, or toward which positive ions are collected, within an electrolytic cell, discharge tube, or similar apparatus.

Kathodendunkelraum: *cathode dark space, Crookes dark space.* That portion of the glow discharge in a Crookes tube lying between the cathode glow and the negative glow; so called because it is nonluminous.

Kathodenfall: *cathode drop.* An abrupt fall of electric potential at the cathode of an electrolytic cell or a vacuum tube.

Kathodenfluessigkeit: *catholyte, katholyte.* The solution surrounding the cathode in an electrolytic cell.

Kathodenleuchten: *cathode glow.* A luminosity which immediately surrounds the cathode in a gas-discharge tube when operating at moderately low pressures, and which increases in extent as the pressure is further reduced.

Kathodenlumineszenz: *cathodoluminescence.* Luminescence excited by cathode rays.

Kathodenphosphoreszenz: *cathodophosphorescence.* Phosphorescence excited by cathode rays.

Kathodenstrahlen: *cathode rays.* An emission from the cathode of a discharge tube, consisting of electrons supplied by the cathode itself and projected at right angles to its surface. The term is usually restricted to the emission from a cold cathode in a gas-filled tube at high potentials and does not include thermions or photoelectrons.

Kathodenzerstaeubung: *cathodic disintegration.* The abrasion of a cathode through the ejection of its atoms in its bombardment by positive ions in a vacuum tube.

Kathodenzerstoerung: *cathodic disintegration.* See Kathodenzerstaeubung.

Kation: *cation, kation.* One of the positive ions moving toward the cathode in an electrolytic cell or a gas-discharge tube.

Kauffman'scher Versuch: *Kauffman experiment.* An experiment upon beta particles moving across magnetic and electric fields, which leads to the conclusion that the mass of an electron is entirely electromagnetic.

Kaustik: *caustic.* A surface which envelops an astigmatic bundle of rays or of normals to the wave surface; as of light reflected from a curved mirror. In a turbid medium it becomes visible as a hollow, luminous cusp.

kegelfoermige Refraktion: *conical refraction.* The transformation of a ray of light into a hollow cone by refraction, at a suitable angle of incidence, in a biaxial crystal.

Keilphotometer: *wedge photometer.* A photometer in which the intensity of the light from one source or both sources to be compared is varied by means of a wedge of absorbing material pushed into the beam until requisite thickness has been interposed.

Kelvin: *Kelvin.* See Thomson.

Kelvin'sches elektrodynamisches Gesetz: *Kelvin electrodynamic law.* States that if a number of electric circuits carrying currents are displaced with reference to each other, the work thus done (whether positive or negative) appears as a change (positive or negative) in the total electromagnetic energy of the circuits.

Kelvin'scher hydrodynamischer Lehrsatz: *Kelvin hydrodynamic theorem.* States that the circulation around any closed fluid filament (stream line) is invariable in time, provided the impressed forces have a single-valued potential and the density is a function of the pressure alone.

Kelvin-Skala: *Kelvin scale.* An ideal, absolute-temperature scale, proposed by Lord Kelvin (1848), the equal intervals on which correspond to equal quantities of work derived from a working substance performing in perfect Carnot cycles between the respective isothermals. It closely approximates the ordinary hydrogen-pressure absolute scale. Syn. thermodynamic scale.

Kelvin'sche thermoelektrische Beziehungen: *Kelvin thermoelectric relations.* Certain formulas derived by Lord Kelvin for the reversible heat development and the thermoelectromotive force in crystals.

Kelvin'sche Waage: *Kelvin balance.* An instrument for measuring an electric current by balancing, against the weight of a known mass, the electrodynamic force on two coils, one at each end of a balance beam; the force on each coil being produced by two fixed coils mounted one above, the other below, the moving coil.

Kennelly-Heaviside Schicht: *Kennelly-Heaviside layer, ionosphere, Heaviside layer.* See Heaviside Schicht.

Kennelly'sches Gesetz der Magnetisierung: *Kennelly law (of magnetization).* States that the reluctivity in magnetizing a specimen of iron is a linear function of the magnetizing force.

Kepler'sche Gesetze: *Kepler laws.* Three laws of satellite motion under a central inverse-square attraction, stated as follows: (1) The orbit is an ellipse with the attracting center at one focus. (2) The radius vector of the revolving satellite describes equal areas in equal times. (3) The squares of the periods of different satellites revolving about the same primary are proportional to the cubes of their mean radii vectors. First stated, empirically, by Kepler with reference to the planets; (1) and (2) in 1609, (3) in 1618.

Kepler'sches Teleskop: *Kepler telescope.* A telescope in which the objective and the ocular are both convergent lenses, the objective forming a real image to be viewed by the ocular in whose first focal plane it lies.

Kern: *core, kernel, nucleus.* (1) Core: *a.* A mass of iron or other ferromagnetic material placed within a coil to enhance the magnetic flux, as in an electromagnet. *b.* The inner metal base or heating element of a thermionic filament, which is covered with a thermionically active coating, usually of barium and strontium oxide. *c.* The inner portion of a nonhomogeneous carbon-arc electrode. *d.* The inner, intensely brilliant portion of the arc itself. (2) Kernel: *a.* A line within a conductor carrying a current, along which the magnetic intensity due to the current is zero. *b.* Syn. Rumpf core. (3) Nucleus: That part of an atom which is supposed to be the seat of its effective mass and to control the motions of its orbital electrons. Current atomic theory assigns to the nucleus a structure which involves an excess positive charge.

Kernbildung: *nucleation.* The action of ions or other particles as centers of condensation.

Kernmagneton: *nuclear magneton.* A unit of magnetic moment, in terms of which those parts of atomic magnetic moments attributed to the atomic nuclei are simple functions of small integers.

Kernmoment: *nuclear moment.* The electric or the magnetic moment, or the moment of momentum, of an atomic nucleus; the last, called the nuclear mechanical moment, being usually expressed in units equal to $h/2\pi$.

Kernverlust: *core loss.* Loss of power through magnetic hysteresis or eddy currents.

Kerr-Effekt: *Kerr effect, electric double refraction.* (1) (Elec.) An electro-optical effect; viz., certain transparent, normally isotropic substances become doubly refracting when subjected to an electric field transverse to the beam of light. (2) (Mag.) The conversion into elliptically polarized light of plane-polarized light when it is reflected, even in or perpendicular to the polarizing plane, from the polished pole-piece of a magnet (polar reflection). The rotation of the elliptic major axis is equal to the magnetization multiplied by the Kerr magneto-optical constant.

Kerr'sches Gesetz: *Kerr law.* In re Kerr effect (1): if n_p and n_s are the refractive indices for light polarized in planes respectively parallel and perpendicular to the electric intensity E, then $n_p - n_s = B\lambda E^2$. Here B is constant for any fixed temperature and any fixed (air) wave length λ, and is called the Kerr electro-optical constant for the given substance, wave length and temperature. Also expressed in the form $\Delta = 2\pi BlE^2$, in which Δ is the phase difference (in radians) introduced by a thickness l of medium.

Kerr-Konstante: *Kerr constants.* The Kerr electro-optical constant and the Kerr magneto-optical constant.

Kerr Zelle: *Kerr cell.* An enclosure containing a small quantity of nitrobenzene or other transparent substance which exhibits electric double refraction, and used to demonstrate or utilize this effect.

Kerzenstaerke: *candle.* The unit of luminous intensity generally used. The international candle was established in 1909 by the national standards laboratories of the United States, Great Britain, and France and adopted in 1921 by the International Commission on Illumination. The U. S. candle, defined in terms of a group of 45 carbon-fiilament lamps at the National Bureau of Standards, agrees with the international candle within the limits of observational error.

Ketteler-Helmholtz Dispersions-formel: *Ketteler-Helmholtz dispersion formula.* An approximate formula for the refractive index n of a substance in terms of the wave length λ:

$$n = 1 + \frac{A\lambda^2}{\lambda^2 - \lambda^2_1} + \frac{B\lambda^2}{\lambda^2 - \lambda^2_2} + \ldots .$$

A, B, ... are constants and λ_1, λ_2, ... are wave lengths of absorption lines, all characteristic of the substance. First stated by Sellmeier and later in modified form by Ketteler and Helmholtz.

Kilogramm: *kilogram.* The practical metric standard of mass and of weight; defined as the mass of a platinum cylinder, known as the kilogramme des archives, at Sèvres.

Kilowattstunde: *kilowatt-hour.* A practical unit of electric energy, equal to 1,000 watt-hours.

Kinematik: *kinematics.* That branch of physics which deals with motion in the abstract, i.e., of points or space figures, and apart from its dynamic aspects.

kinematischer Viskositaetskoeffizient: *kinematic viscosity coefficient.* The ratio of the viscosity coefficient of a fluid to its density.

Kinetik: *kinetics.* That branch of physics which deals with the motion of material bodies in relation to the forces acting upon them.

kinetisches Gleichgewicht: *kinetic equilibrium, isodynamostacy.* Equilibrium in which the system, or parts of it, are in motion; e.g., a particle moving with uniform speed in a straight line is in this condition.

kinetische Energie: *kinetic energy, vis viva* (Lat.). That part of the total energy of a body or system which is obviously associated with its motion or with the relative motions of its parts.

kinetisches Potential: *kinetic potential.* (1) In re a particle of rest mass m_0 moving with speed u: A physical magnitude represented by the expression

$$- m_0 c^2 \sqrt{1 - \frac{u^2}{c^2}}$$

c being the electromagnetic constant. The components of the momentum of the body are, in relativistic mechanics, the derivatives of this quantity with respect to the components of the velocity. (2) Syn. Lagrangian function.

kinetische Reaktion: *kinetic reaction.* The reaction of inertia in an accelerated body. If the mass is m and the acceleration is a, the kinetic reaction is — ma.

kinetische Stabilitaet: *kinetic stability.* The stability of a moving body or system, which has the property that when its motion is slightly altered, it oscillates and, if left to itself, returns to its former state of motion. Illustrated by touching a rapidly spinning top lightly with the finger.

kinetische Theorie: *kinetic theory.* A theory, relating to any group of phenomena, which explains them on the basis of motion, e.g., the kinetic theory of gas dynamics.

Kippschwingungsgeraet: *relaxation oscillator.* An electric oscillator in which a condenser is charged periodically from a d.-c. source through the primary of a transformer and is discharged through a thyratron and a small series inductance when the condenser voltage is at or near its maximum.

Kippschwingungsoszillator: *relaxation oscillator.* See Kippschwingungsgeraet.

Kippschwingungswandler: *relaxation inverter.* An inverter, the circuit of which is based upon that of the relaxation oscillator.

Kirchhoff'sche Bruecke: *Kirchhoff bridge.* A type of resistance bridge described by Heaviside, in which the potential differences through the known and the unknown resistances in series are balanced in a differential galvanometer.

Kirchhoff'sche Gesetze: *Kirchhoff laws.* Several physical laws are attributed to Kirchhoff; the more important: (1) The ratio of the emissive power of a surface to its absorptivity for the same radiation is the same for all surfaces at a given temperature and is equal to the emissive power of a black body at the same temperature. (2) Certain adaptations of Ohm's law to networks of conductors, treated in works on the mathematical theory of electricity.

Kirchhoff'sche Konstante: *Kirchhoff constant.* The constant K in Kirchhoff's formula for the velocity of sound in air confined in a tube, which is

$$v = v_0 \left[1 - \frac{K}{2r\sqrt{\pi n}}\right].$$

v_0 is the velocity in the open air, r the radius of the tube, n the frequency; K is dependent upon the properties of the gas.

Kirchhoff'sches Potential: *Kirchhoff potential.* The retarded potential due to a moving charge or magnet.

Langwellenaufzeichner: *phonautograph.* An early device for recording the wave form of sounds; designed by Koenig and Scott.

klassisch: *classical.* In accordance with long accepted theory; esp., the dynamics of Newton, as opposed to the more recent relativistic, quantum, or wave theories.

klassische Statistik: *classical statistics.* A system of statistical analysis of the distribution of gas molecules or of radiation quanta and their momenta, based upon the number of these respective entities in any given elementary compartment of ordinary space or of momentum space.

Klein-Nishina Formel: *Klein-Nishina formula.* A formula expressing the scattering coefficient μ of a substance for gamma radiation, assumed as due entirely to the Compton effect of the extranuclear electrons.

Thus:

$$\mu = \frac{2\pi Ne^4}{m^2 c^4}\left\{\frac{1+a}{a^2}\left[\frac{2(1+a)}{1+2a} - \frac{1}{a}\log(1+2a)\right] + \frac{1}{2a}\log(1+2a) - \frac{1+3a}{(1+2a)^2}\right\}$$

N is the number of electrons per cm^3, m the electronic mass, e the electronic charge, c the electromagnetic constant, and

$$a = \frac{hv}{mc^2}$$

where hv is the radiation quantum energy (Planck constant × frequency).

Klopfen: *hammer, hammering.* The sharp pounding of a liquid, such as water or mercury, often observed when the tube containing it is devoid of air, which would otherwise act as a cushion.

Knall: *pulse.* A single disturbance propagated as a wave, but not having the cyclic characteristic of a wave train; e.g.; the sound of an electric spark.

Knoten: *node.* (1) A point, line, or surface in a vibrating medium at which the amplitude of the vibration is reduced to zero by the interference of oppositely directed wave trains, forming stationary waves; e.g., one of the stationary points on a vibrating string. (2) In re a wave function: A point at which the real part of the wave variable changes sign.

Knotenpunkte: *nodal points.* In re a symmetrical optical system: two conjugate points on the axis such that any paraxial ray which, before entering the system, intersects the axis at the first nodal point, will emerge from the system in a parallel direction and intersect the axis at the second nodal point. If the system is surrounded by the same medium on both sides, the nodal points are identical with the principal points, q.v.

Knudsensche Gleichung: *Knudsen equation.* A somewhat complicated equation for the flow of a rarefied gas through a cylindrical tube at very low pressures.

Knudsen Manometer: *Knudsen gauge, Knudsen absolute manometer.* A gauge for measuring extremely low gas pressures. It operates on the principle of unequal bombardment of a surface by molecules of different energies which gives a measurable resultant force proportional to the pressure of the gas.

Knudsen-Molekularstreugesetz: *Knudsen molecular scattering law.* A law of the diffuse emission or reflection of molecules from a solid surface, analogous to the cosine emission law for radiation. It states that the fraction dn/n of all the n molecules emitted or reflected from the surface within solid angle $d\omega$ making an angle ϕ with the normal is equal to

$$\frac{1}{\pi}\cos\phi\, d\omega$$

Knudsen-Weber'sches Gesetz: *Knudsen-Weber law.* An experimentally established law for the resistance to the motion of spheres in a viscous medium. It is an extension of the Stokes law and reduces to it under appropriate limits.

Koaggregation: *coaggregation.* The union of fog particles into drops of appreciable size, as in the formation of rain in a cloud.

Koch'scher Widerstand: *Koch resistance.* A high resistance, consisting essentially of an illuminated photoelectric cell used at voltages low enough to insure that the resistance is independent of the voltage.

Kochen: *ebullition.* The familiar phenomenon of boiling, exhibited by a liquid at a temperature sufficiently high for the rapid formation and escape of bubbles of vapor.

Koerpermittelpunkt: *center of figure, c. of volume.* In re any three-dimensional space figure: that point which coincides with the center of mass of a body formed by constructing the figure out of homogeneous material.

Koerzitivkraft: *coercive force, coercivity, retentivity.* (1) The magnetic intensity required to reduce the magnetic induction in a previously magnetized material to zero. If the material has been magnetized to saturation this quantity is called the coercivity. (2) *a.* The value of the remanence for the case of a symmetrical magnetic hysteresis cycle extending to practical saturation. *b.* The ratio of the remanence to the magnetic induction at saturation under these same circumstances. Syn. retentivity coefficient.

Kohaerer: *coherer.* A cell containing a granular conductor between two electrodes, which becomes highly conducting only when subjected to an electric field; formerly used as a detector.

Kohaerenz: *coherence.* A relation between two wave trains, such that when brought into coincidence they are capable of producing interference phenomena. The maximum path difference for which interference persists is the coherence length.

Kohaesion: *cohesion.* That property of a substance which enables it to cling together in opposition to forces tending to separate it into parts.

Kohlrausches Gesetz: *Kohlrausch law.* States that the two kinds of ions of an electrolyte in solution conduct the current independently of each other and in proportion to their transference numbers.

Koinzidenzmethode: *coincidence method.* A method of timing a periodic phenomenon by observing coincidences between the occurrences of the phenomenon in question and those of one whose period is known, e.g., the vibration of a pendulum.

Kollektor: *collector.* (1) An exploring electrode or probe, esp. in a vacuum tube. (2) Syn. Faraday cylinder. (3) An apparatus for measuring the vertical potential gradient of the atmosphere.

Kollimator: *collimator.* An optical apparatus, the purpose of which is to furnish a beam of parallel rays of light. A common form consists of a lens, having a small opening or slit at its principal focus.

Kolliniationszentrum: *center of collineation.* That point through which pass all straight lines joining conjugate points of a spherical refracting surface or of a thin lens. For the former it is the center of curvature and for the latter, the optical center.

Kolloid: *colloid.* A substance in the colloidal state. Typical colloids are smoke, gelatine solution, starch solution, albumen, and very finely divided gold in suspension.

kolloidale Loesung: *colloidal solution.* A mixture which contains ingredients in the colloidal state; in contradistinction to a true or "molecular" solution.

kolloidaler Zustand: *colloidal state.* The finely divided state of matter dispersed in solids, liquids, or gases, the particles of which have diameters ranging approximately between 10^{-7} cm and 10^{-5} cm. In liquids or gases the particles remain suspended indefinitely but do not pass through very fine filters.

Kolorimetrie: *colorimetry.* The measurement of color. Such a measurement may be made directly in terms of the three attributes of color, viz., hue, saturation, and brilliance; or directly in terms of the physical characteristics of the stimulus, such as spectral energy distribution, intensity, modal wave length, spectral purity, etc.

Koma: *coma.* One of the types of spherical aberration, due to the asymmetry of a bundle of rays of finite aperture.

Kombinationslinie: *combination line.* An atomic spectral line produced by a transition between two multiplet energy levels.

Kombinationsprinzip: *combination principle.* An expression of the fact that the existence of spectral lines can be predicted by calculating the quantum energy, and hence the frequency, resulting from the transition of an electron from one stable state to another. First stated in an empirical form by Ritz.

Kombinationsserie: *combination series.* A series of spectral lines formed in accordance with the combination principle of Ritz.

Kombinationston: *combination tone.* A subjective tone produced by the simultaneous sounding of two or more physical tones.

Kombinationsverbot: *combination defect.* A discrepancy arising from the application of the combination principle to certain molecular spectra, and explained on the assumption that the initial or the final rotational energy levels are close doubles.

Kommutator: *commutator.* Any device for reversing the direction of an electric current or for interchanging the connections to a circuit.

Komparator: *comparator.* An instrument for the accurate measurement of moderate distances, usually consisting of a telescope or a microscope arranged to move laterally along a scale.

Kompensator: *compensator.* An apparatus, the original form of which was designed by Babinet, for the measurement of the phase difference between the two components of elliptically polarized light.

Kompensationstheorie: *compensation theorem.* See Ausgleichslehrsatz.

Komplementaerfarben: *complementary colors.* Two colors which, when mixed additively in proper proportions, produce the sensation of white.

Komplex-Ion: *complex ion.* The result of the combination of a positive ion with an uncharged molecule.

Komplex-Spektrum: *complex spectrum.* A spectrum containing multiplet lines.

Kompressibilitaet: *compressibility.* The reciprocal of the bulk modulus. Also called compressibility coefficient.

Kompressionswaerme: *heat of compression.* The heat generated per unit mass per unit change of pressure

or of volume, in the compression of a substance, such as a gas. Its value depends upon the circumstances of the compression.

Kondensationskoeffizient: *condensation coefficient.* The ratio of the total volume of the molecules of a gas to the volume of the gas; a term due to Loschmidt.

Kondensationspumpe: *condensation pump.* Any air pump acting on the principle which uses the impact of a stream of vapor to compress a gas to such a pressure that a force pump can take hold, the vapor being removed from the compression space by condensation.

Kondensationswaerme: *heat of condensation.* See Verdampfungswaerme.

Kondensator (elektr.): *condenser.* A device consisting of two electrical conductors, usually in the form of metal plates, separated by a small thickness of dielectric, which has the effect of largely increasing the capacitance of each conductor.

Konsensor (opt.): *condenser.* A system of strongly converging lenses used to concentrate the light on the object or slide in a projector.

Konduktanz: *conductance.* (1) The reciprocal of electric resistance. (2) Knudsen uses the term in an analogous manner as applying to the case of flow of rarefied gases in tubes.

konjugierte Punkte: *conjugate points.* (1) (Opt.) Two points of an optical system such that each is the image of the other. (2) (Dyn.) Two points of a rigid body, on opposite sides of the c.m. and in line with it, such that if the body, when free, is given an impulse in a transverse line through either point, it begins to rotate about an axis through the other.

konjugierte Zweige: *conjugate branches.* Two branches of an electric network, so related that an e.m.f. in one produces no current in the other.

Konkavgitter: *concave grating.* An optical grating ruled on a concave, spherical, reflecting surface, which not only acts as a grating, but serves also to focus the image of the slit without the use of lenses. Such gratings were first constructed by Rowland.

konkav-konvek: *concavo-convex.* Having two curved surfaces, of which one, the concave, has greater curvature than the other, which is convex; applied esp. to lenses. Syn. concave-meniscus.

konservatives Feld: *conservative field.* A field of force such that, if a particle moves from one point to another within the field, the work done depends only upon its initial and its final position, and not upon the path which it follows.

konservatives System: *conservative system.* A system of bodies acted upon only by forces within the system, so that the total dynamical energy of the system remains constant.

Konstantan: *constantan.* An alloy of 60 percent Cu and 40 percent Ni, used for resistance coils because of its very low temperature coefficient of resistance.

Kontaktpotentialdifferenz: *contact potential difference.* A difference of electric potential which devleops between two dissimilar conductors when they are placed in contact; first observed by Volta. Syn. Volta effect.

Kontaktwinkel: *angle of contact.* The angle which a liquid surface makes with the submerged part of the solid surface with which it is in contact, as in a capillary tube.

kontinuierliches Spektrum: *continuous spectrum.* A spectrum which exhibits no structure and appears to represent a continuous variation of wave length from one end to the other, e.g., the spectrum of an incandescent solid.

Kontinuitaetsgleichung: *equation of continuity.* (1) An equation which, in physical analysis, expresses the fact that the rate at which the quantity of any conserved entity, e.g. matter, electricity, or energy, changes within any region is equal to the difference between the rates at which this entity enters and leaves that region. (2) An equation relating to the flow of a gaseous substance, which expresses the fact that the product of the cross section, the speed of flow, and the density remains constant.

Kontraktionskoeffizient: *contraction coefficient.* The ratio of its area of smallest cross section to the area of the orifice is the contraction coefficient.

Kontur oder Gestalt: *contour.* (1) The geometrical form of a surface, esp. as indicated by its plane sections. (2) The wave-length-intensity curve for a particular line or band of the spectrum.

Konvektion: *convection.* Circulation in a fluid of nonuniform temperature, due to differences of density.

Konvergenz: *convergence.* (1) A negative divergence; e.g. for the gravitational field within a material substance of density ρ it is $-4\pi\rho$. (2) The increasing density of spacing of the lines in a spectral series as the series limit is approached with decreasing wave length. (3) (Math.) The property of converging, as an algebraic series.

Konvergenzfaktor: *convergence factor.* The coefficient B in the square term of the quadratic function:

$$v = v_0 + AN + BN^2,$$

representing the frequency of the spectral line of ordinal number N in a rotation-vibration spectral band. v_0 is the frequency corresponding to the zero line.

konvex-konkav: *convexo-concave.* Having two curved surfaces, of which one, the convex, has greater curvature than the other, which is concave; applied esp. to lenses. Syn. convex-meniscus.

Konzentrationszelle: *concentration cell.* An electrolytic cell whose e.m.f. is due to a difference in concentration between different parts of the electrolyte.

Koordinate: *coordinate.* (1) One of the quantities specified in defining the position of a point or the value of a point function. (2) In general, one of a set of variables used to express the condition or the behavior of a physical system, as pressure, volume, temperature, entropy, time, etc. In this broader sense they are often termed generalized coordinates.

Koordinationsgitter: *coordination lattice.* A crystal lattice in which each ion bears the same relation to the adjacent ions in all three coordinate directions, so that the identity of the molecule becomes ambiguous.

Koordinationsregel: *coordination rule.* Describes the process whereby the magnetic sublevels of a multiplet (spectral line) in weak fields are co-ordinated with the magnetic levels of the component vectors in strong fields. As the field changes, the co-ordinate levels merge. Similar rules exist also for other types of coupling.

Kopf: *head.* (1) A quantity used in relation to fluid motion, and having the dimension of length, which is in proportion to the energy of the particles of fluid. Three component heads are distinguished, viz., those corresponding to elevation, to pressure, and to speed of flow, respectively. (2) The edge of a spectral band or series.

Kopplung: *coupling.* (1) A juxtaposition of two electric circuits, such that their mutual relationship permits variations of current in one circuit to affect the e.m.f. in the other. (2) An interaction between one of the electrons of an atom and other parts of the atomic electron system. (3) In general, any interaction between two or more systems.

Kopplungskoeffizient: *coupling coefficient.* (1) An abstract fraction relating to the closeness of coupling of two circuits A, B. If f_1 is the fraction of the inductance of A that is shared with B, and f_2 the fraction of the inductance of B that is shared with A, the inductive coupling coefficient is the mean proportional of f_1 and f_2. The capacitative coupling coefficient is defined in an analogous way. (2) In general, an abstract constant entering into the equations of motion of two coupled systems and dependent upon the mutual effect of one upon the other.

Korona (elektr.): *corona (electr.).* The result of a partial electric breakdown in a gas, such as a brush discharge or a glow discharge.

Korona (astronom.): *corona (astron.).* An extended, luminous, gaseous envelope which constitutes the outermost portion of the sun.

Koronavoltmeter: *corona voltmeter.* An apparatus for the measurement of high peak voltages by the formation of a corona.

Korrektionsfaktor: *correction factor.* See Berichtigungsfaktor.

Korrelation: *correlation.* See Beziehung.

Korrespondenzprinzip: *correspondence principle.* A relation assumed, in Bohr's radiation theory, to exist between the observed intensities and frequencies of a molecular or atomic spectrum and the radiations which would be emitted by an oscillator in accordance with classical theory.

korrespondierende Zustaende: *corresponding states.* See Gesetz der korrespondierenden Zustaende.

Kosinus Emissionsgesetz: *cosine emission law.* States that the rate of emission or diffuse reflection of radiant energy in a given direction from any element of area of a perfectly diffusing surface is proportional to the cosine of the angle of emission, measured between the emitted ray and the normal to the surface. For emission it holds rigorously for black surfaces only. Syn. Lambert law.

Kosinus Photometer: *cosine photometer.* A photometer in which the illumination of one surface to be compared is varied, in accordance with the cosine emission law, by varying its orientation.

kosmische Strahlung: *cosmic radiation, c. rays.* A type of very penetrating radiation of unknown origin, apparently traversing interplanetary space in all directions, and detected by the ionization which it produces in electroscopes, ion counters, etc.

Kossel-Sommerfeld'sche Gesetze: *Kossel-Sommerfeld laws.* (1) States that the arc spectra of elements of even

atomic number show odd multiplicity, and vice versa. Syn. alternation law. (2) States that the spectrum of a singly ionized element (first spark spectrum) resembles that of the next preceding element in the atomic-number table; the spectrum of a doubly ionized element (second spark spectrum), that of the next but one; etc. Syn. displacement law (2).

Konstante der Bindungskraft: *bond force constant.* The Hooke-law force constant for infinitesimal extension or compression of a chemical bond in a molecule; a concept used in the treatment of the normal vibrations of a molecule.

Kovolumen: *covolume.* A term sometimes used to denote the volume of the space throughout which a gas is distributed, minus the volume of the molecules themselves. The factor v — b in the van der Waals equation may be considered as representing this quantity.

Kraefte: *forces.* The cause of the change of movement of material bodies, determined by point of application, direction, and magnitude; the magnitude of the force is the product of mass and acceleration, the scientific unit of the force is the dyne, the technical unit the kilogram.

Kraeftepolygon: *force polygon.* See Vektorpolygon.

Kraeftevieleck: *force polygon.* See Kraeftepolygon.

Kraftlinie: *line of force.* (1) An imaginary line in a field of force which, at each of its points, coincides in direction with the field intensity; a concept due to Faraday. (2) A unit of flux (magnetic, electric), so defined that the number of lines intersecting any cross section, per unit area, is numerically equal to the component of field intensity normal to the section.

Kraftmesser: *dynamometer.* See Dynamometer.

Kraftroehre: *tube of force.* See Faraday'sche Roehre.

Kreis: *circuit.* (1) (Electr.) A conductor, or group of conductors, so arranged and connected or coupled as to be capable of conducting an electric current or system of currents when supplied with suitable e.m.f.'s. (2) (Magnetic.) A closed tube or multiple connected region, the surface of which is everywhere tangential to the magnetic induction; or a series of bodies approximately filling such a region. The field magnet and armature core of a motor form a typical magnetic circuit.

Kreisbahn: *central orbit.* An orbit traversed by a body under the influence of a force directed toward a fixed center.

Kreis der geringsten Aberration: *least circle of aberration.* The smallest cross section of a bundle of reflected or refracted rays forming a symmetrical caustic surface.

Kreis der geringsten Unschaerfe: *circle of least confusion.* The small, round spot which, on account of aberration effects, constitutes the smallest image of a point source which can be formed by an uncorrected lens.

Kreisel: *gyro.* The rotating part of any such device as a gyrostat, gyrocompass, etc., or in general, any rotating rigid body. See also Gyroskop and Gyrostat.

Kreiseldynamik: *gyrodynamics.* The dynamics of rotating bodies, esp. those affected by precession.

Kreiselkompass: *gyrostatic compass, gyrocompass.* One of several devices utilizing the tendency of a rapidly spinning gyro to maintain its axis of rotation as a nonmagnetic compass on shipboard. The arrangements for neutralizing various sources of error make the mechanism somewhat complicated.

kreiselmagnetisch: *gyromagnetic.* See gyromagnetisch.

Kreiselradius: *radius of gyration.* Of a rigid body with respect to a given axis: a distance such that, if all the particles of the body were at that distance from the given axis, its moment of inertia with respect to that axis would be unchanged. Syn. swing radius.

Kristallanalyse: *crystal analysis.* The study of the arrangement of atoms, ions, or molecules in crystals, chiefly by X-ray methods, aided by the theory of space groups.

Kristalldetektor: *crystal detector.* A rectifier consisting of a conducting crystal, e.g., of galena or silicon, against which presses a sharp steel point. The device has marked nonsymmetrical resistance.

Kristalldiamagnetismus: *crystal diamagnetism.* Abnormal and anisotrop diamagnetism observed in crystals of a few substances; e.g.; bismuth.

Kristallgitter: *crystal grating.* A crystal suitably mounted to serve as a diffraction grating, e.g., for X-rays.

Kristallkunde: *crystallography.* That branch of physical science which deals with the geometrical form of crystals.

Kristallographie: *crystallography.* See Kristallkunde.

Kristallumineszenz: *crystalloluminiscence.* The emission of light upon the precipitation of crystals from a solution.

kristalloidaler Zustand: *crystalloid state.* A condition of a substance in liquid form, in which its largest particles, either single molecules or polymers, are too small to be caught on the finest filters. Substances in this state are known as crystalloids.

Kristallspektograph: *crystal spectograph.* An instrument for photographing the spectrum formed by using a crystal, e.g., calcite, as the diffracting system.

Kristallsystem: *crystal system.* A group which includes all crystals containing the same number and kind of planes of symmetry. There are six crystal systems: isometric or cubical, tetragonal, orthorhombic, monoclinic, triclinic, hexagonal; q.v.

Kristallwachstumflaeche: *gliding plane.* See Gleitflaeche.

Kristallwasser: *water of crystallization.* Water molecules incorporated in the structure of a crystal.

kritischer Bereich: *critical range.* The range of temperature between two transitions in a metal, as iron or steel, e.g., between the recalescence points.

kritische Daempfung: *critical damping.* The degree of damping which must be applied to a body, displaced against a potential or an elastic force, in order just to prevent its oscillating upon returning to its neutral condition. For a condenser circuit, the critical damping corresponds to the relation $R^2 = 4\ L/C$, in which R, L, C are resistance, inductance, and capacitance, respectively.

kritische Frequenz: *critical frequency.* (1) Syn. threshold frequency. (2) The frequency of an intermittent illumination which is just sufficient to prevent a sensation of flicker.

kritische Geschwindigkeit: *critical speed, parabolic velocity.* The speed with which a particle at any point in the field of a gravitational attracting center must be endowed in order that its orbit shall be a parabola. If the point is at the surface of the gravitating mass (as a planet), this speed is the same as the velocity of escape.

kritischer Koeffizient: *critical coefficient.* The ratio of the critical temperature of a substance to its critical pressure.

kritische Konstanten: *critical constants.* These are the critical temperature, critical pressure, and critical density of any one substance.

kritische Konzentration: *critical concentration.* The relative proportion in the mutual solution of two partially immiscible liquids in the vicinity of their interface when the critical solution temperature is reached, but before they become mutually diffused.

kritische Loesungstemperatur: *critical solution temperature.* The temperature below which each of two liquids is only partially soluble in the other (conjugate solution), but above which they are consolute. Syn. Consolate temperature.

kritisches Potential: *critical potential.* The p.d. in volts, corresponding to the energy in electron-volts, required either to excite or to ionize an atom or a molecule; i.e., either the radiation potential or the ionizing potential of the atom or molecule.

kritische Stroemungsgeschwindigkeit: *critical velocity of flow.* The speed at which a smooth, streamline flow of a liquid or a gaseous substance breaks into a turbulent flow or eddy.

kritische Temperatur: *critical temperature.* The temperature at which a fluid is in the critical state. Above this temperature, the fluid cannot exist as a liquid or as a vapor. Hence, a fluid at a temperature higher than its critical temperature cannot be liquefied by pressure alone. The critical temperature in degrees centrigrade is for water 365 degrees.

kritische Wellenlaenge: *critical wave length.* The wave length corresponding to the critical or threshold frequency in a quantum process brought about by radiation.

kritischer Winkel: *critical angle.* See totale Reflektion.

kritischer Zustand: *critical state.* A condition of a substance such that the liquid and the vapor state are identical. For a pure substance, this occurs only at a particular temperature (the critical temperature) and pressure (the critical pressure). A substance above its critical temperature will not separate into two fluid phases, however great the pressure applied. For water the critical temperature is 374 degrees C., the critical pressure 217 atm., while the critical density is 0.329 g/cm^3. These are its critical constants.

kryoskopisch: *cryoscopic.* Pertaining to the freezing points of liquids or to their determination.

Kryostat: *cryostat.* A thermostat for use at very low temperatures.

kubisch: *cubical.* (1) (Cryst.) Syn. isometric (1). (2) Having reference to volume, esp. in cubical expansion.

kubischer Photometer: *cube photometer.* An integrating photometer similar in principle to the sphere photometer but employing a cubical instead of a spherical cavity.

Kuehler: *condenser.* An apparatus for changing a vapor into the liquid state.

kuenstliche Radioaktivitaet: *induced radioactivity.* (1) Radioactivity produced artificially, by corpuscular bombardment or otherwise. (2) Originally used by the Curies to denote radioactive deposit.

Kugelabstand: *sphere gap.* A spark gap between two spherical knobs of equal diameter. From the width of the gap and the diameter of the knobs, it is possible to calculate the approximate spark potential; hence the gap may be used as a simple voltmeter for high potentials.

Kuhn-Reich'sche Summenregel: *Kuhn-Reiche sum rule.* In re the quantum theory of dispersion: states that the factors by which the classical terms corresponding to the several absorption frequencies in the dispersion formula of the atom are multiplied, and which are characteristic of the respective absorption lines, have unity as their sum.

Kundt'sche Konstante: *Kundt constant.* The Verdet "constant" divided by the magnetic susceptibility. In the case of ferromagnetic substances, having variable susceptibility, the Verdet factor is not constant but is proportional to the susceptibility; so that it must be divided by the latter to give a constant value.

Kundt'sches Rohr: *Kundt tube.* A long glass tube, like a horizontal organ pipe, inside which is sprinkled a quantity of fine powder, or which is provided with some other device to exhibit the acoustic nodes and antinodes when the tube is sounded.

Kupplung: *turn-flux, linkage, fluxturns.* A measure of the interlocking of a magnetic flux with an electric circuit, viz., the product of the flux by the number of turns of the circuit surrounding it, expressed in maxwell-turns.

kurze Nebelspuren: *fish tracks.* Short cloud tracks terminating in a collection of droplets, attributed by Wilson to the scattering of X-ray quanta.

L-Diagramm: *Laue pattern.* The photographic record of the diffracted beams produced when heterogeneous X-rays from a pinhole or slit impinge upon a single crystal.

L-Entkopplung: *L-uncoupling.* A change that may take place in the quantization of a rotating molecule as the angular speed increases; the change being from a quantization of the electronic angular momentum L to that of the angular momentum of the revolving nuclei.

L-Serie: *L series.* A series of frequencies in the X-ray spectrum of an element, believed to arise from the transition of electrons from various higher quantum states to the state whose principal quantum number is 2.

Ladung: *Load.* (1) The power delivered by a generator to the line. (2) A resistance, inductance, or capacitance intentionally placed in a circuit, usually to increase or control the reactance. (3) The force sustained by any structural member, as a beam or a column.

Laengendichte: *line density.* The mass per unit length, as of a wire or a slender rod.

Lag: *lag.* (1) A delay in the phase of current maxima behind the corresponding e.m.f. maxima in an inductive a.c. circuit. (2) In general, a delay in the action of any device, e.g. of a thermometer behind changes of temperature.

Lagrange'sche Funktion: *Lagrangian function.* An expression for the kinetic minus the potential energy in a conservative system. Syn. Kinetic potential.

Lagrange'sche Gleichungen: *Lagrange equations.* A set of differential equations relating to a system of particles, one equation for each of the n degrees of freedom, corresponding to the generalized coordinates $q_1, q_2 \ldots\ldots, q_n$. If E_k denotes the kinetic energy of the system, the form of each equation is

$$\frac{d}{dt}\left(\frac{\delta E_k}{\delta \dot{q}_r}\right) - \frac{\delta E_k}{\delta q_r} = Q_r$$

$$(r = 1, 2, \ldots\ldots, n);$$

in which $\dot{q}_r$ denotes dq_r/dt.

$$\sum_1^n Q_r \, \delta q_r$$

is the work done by the external forces in the arbitrary displacement $\delta q_1, \delta q_2, \ldots\ldots \delta q_n$.

Laguerre'sches polynom: *Laguerre polynomial.* A polynomial in x and e^x which occurs in the radial factor of the quantum-mechanical solution of the hydrogen atom.

Lambda/2-Blaettchen: *half-wave plate.* A plate of mica or other doubly refracting crystal, of such thickness as to introduce a phase difference of ½ cyc between the ordinary and the extraordinary components of the light traversing it.

Lambda/4-Blaettchen: *quarter-wave plate.* A plate of mica or other doubly refracting crystal of such thickness as to introduce a phase difference of one-fourth cycle between the ordinary and the extraordinary components of the light traversing it.

Lambdaplatte: *wave plate.* See Lambda/2-Blaettchen and Lambda/4-Blaettchen.

Lambda/4-Verschiebung: *quadrature.* A phase difference of one-quarter cycle.

Lambdawert: *lambda value.* The value of the orbital angular momentum of a molecule about its axis of figure, expressed as a multiple of the quantum number $h/2\pi$.

Lambert: *lambert.* A unit of brightness, equal to that of a perfectly diffusing surface emitting or reflecting light at the rate of 1 lumen per cm^2. Equivalent to $1/\pi$ candle/cm^2.

Lambert'sches Gesetz: *Lambert law.* See Kosinus Emissionsgesetz.

lamellar: *lamellar.* (1) Syn. laminar. (2) In re a vector point function: having a circuitation equal to zero. Syn. irrotational, noncircuital.

laminar: *laminar.* In the form of a thin layer or lamina. Syn. lamellar (1).

Lanchester'sche Regel: *Lanchester rule.* In re the precessional effect on a gyroscope: view the whirling gyro from a point in the plane of its rotation and apply a torque to the axis of rotation, the axis of the applied torque being coincident with the line of sight; the immediate result is a precessional tipping of the rotation axis toward or from the observer, such that the gyro now appears to rotate in the same direction as the applied torque.

Landé-Faktor: *Landé factor.* See g-Faktor.

Landolt'sches Band: *Landolt band.* A dark band sometimes appearing in the field of crossed Nicols with an intense source, as the sun; due to the light being not strictly parallel, so that it is not all extinguished at once.

Langevin'sche Funktion: *Langevin function.* A function of the form

$$L(x) = \cot x - \frac{1}{x};$$

used in the kinetic theory of gases.

Langevin'sches Gesetz: *Langevin law.* Expresses the average magnetic moment of the molecules of a gas as $\mu^2H/3kT$, in which μ is the magnetic permeability, H the magnetizing field, k the Boltzmann constant, and T the absolute temperature.

Langevin'sches Ion: *Langevin ion.* An electrified particle in a gas, resulting from the accumulation of gaseous ions upon dust particles or other nuclei.

Langmuir'scher Dunkelraum: *Langmuir dark space.* A nonluminous region surrounding a negatively charged probe inserted into the positive column of a glow or arc discharge.

langwellige Grenze: *long-wave limit.* The quantum energy just sufficient to release photoelectrons from a given surface. The corresponding frequency is the threshold frequency. Syn. photoelectric threshold.

Laplace'sches Gesetz: *Laplace law.* See Ampere'sches Gesetz.

Laplace'sche Gleichung: *Laplace equation.* A linear differential equation of the second order which occurs very frequently in mathematical physics. E.g., for any point in an electric field at which there is no free electricity, the potential V satisfies this equation, which in rectangular co-ordinates has the form

$$\frac{\delta^2V}{\delta x^2} + \frac{\delta^2V}{\delta y^2} + \frac{\delta^2V}{\delta z^2} = 0$$

Laplace'scher Operator: *Laplace Operator.* The differential operator which occurs in the Laplace and the Poisson equations. In rectangular coordinates it is

$$\left[\frac{\delta^2}{\delta x^2} + \frac{\delta^2}{\delta y^2} + \frac{\delta^2}{\delta z^2}\right],$$

and is often represented by the symbol ∇^2. Thus the Laplace equation may be written $\nabla^2V = 0$. Syn. Laplacian.

La Porte'sche Regel: *La Porte rule.* States that in dipole radiation, even spectral terms combine only with odd, and vice versa.

Larmor-Praezession: *Larmor precession.* See Larmor-'sches Prinzip.

Larmor'sches Prinzip: *Larmor principle.* Sets forth the first-order effect of a magnetic field upon the electronic orbits in an atom, as a precessional motion of the orbit about an axis lying in the direction of the field, sometimes referred to as the Larmor precession.

Laue'sche Gleichungen: *Laue equations.* A set of three simultaneous equations which must be satisfied for any intensity maximum of radiation diffracted by a crystal.

Laufterm: *running term.* One of a series of progressively different terms appearing in the energy differences which determine a series of spectral lines. Each line of the series is determined by the difference between one fixed term and one of the successive values of the running term.

Lautlehre: *phonetics.* That branch of acoustics which deals with the study of the production and the constitution of vocal sounds.

Lautstaerke: *intensity level.* A term used in acoustics to denote the relation of one sound intensity to another, as expressed in bels or decibels; it is the common logarithm of their ratio.

Le Chatelier'sches Prinzip: *Le Chatelier principle.* A form of the least-energy principle, stating that when a dynamic system is in stable equilibrium any change in its state brings about conditions opposed to further change in the same direction; equivalent to a definition of stable equilibrium.

Lecher Oszillator: *Lecher oscillator.* A device for producing a system of standing waves in two parallel wires, called Lecher wires.

Legendre'sche Gleichung: *Legendre equation.* A differential equation of the form

$$\frac{d}{dx}\left\{(1 - x^2)\frac{dy}{dx}\right\} + ay = 0.$$

The solutions of this equation are Legendre functions or Legendre polynominals.

Legendre'sches Polynom: *Legendre polynomial.* A cosine polynomial which occurs in the angular factor of the quantum-mechanical solution of the hydrogen atom.

Lehrsatz: *theorem.* (1) That which is considered and established as a principle or law; hence, sometimes, a rule. (2) A general statement that has been proved or whose truth has been conjectured.

Lehrsatz der reziproken Energie: *reciprocal-energy theorem.* A theorem due to Rayleigh; as follows: Let

an e.m.f., E_1, inserted in any branch, designated as No. 1, of a transducer produce a current I_2, in any other branch No. 2; correspondingly, let an e.m.f., E_2, inserted in branch No. 2, produce a current I_1, in branch No. 1; then, if Ohm's law holds,

$$I_1E_1 = I_2E_2.$$

Closely related to the reciprocity theorem.

Leistung: *Power.* The time rate of the doing of work; or energy transferred per unit time.

Leistungsfaktor: *power factor.* The ratio of the mean power to the apparent power in an a.-c. circuit. If the e.m.f. and current are sinusoidal, the power factor is equal to the cosine of the phase angle.

Leitelektron: *conduction electron.* One of the electrons, supposedly from the outer levels of the atoms, which are concerned with the electrical conduction in a metal. The energy levels in which these electrons are found are called conduction levels.

Leitfaehigkeit: *conductivity.* (1) (Thermal.) The facility with which heat flows through a conductor, as measured by the quantity of heat transmitted per unit time, per unit temperature gradient along the direction of flow, per unit cross-sectional area. (2) (Electric.) The facility with which a substance conducts electricity, as measured by the current density per unit potential gradient in the direction of flow. It is the reciprocal of the resistivity. Syn. specific conductance.

Leitfaehigkeitsdispersion: *conductance dispersion.* A variation of the equivalent conductance of an electrolyte for an a.c. of varying frequency.

Leitfaehigkeitsmesser: *conductimeter.* An apparatus for measuring the electrical conductivities of substances, esp. of liquids.

Lenard-Roehre: *Lenard tube.* A vacuum tube specially designed to exhibit Lenard rays; recently improved as the Coolidge cathode-ray tube.

Lenard-Strahlen: *Lenard rays.* Cathode rays that have escaped from the vacuum tube through a "window" or thin metallic foil. Produced and studied by Lenard in 1894.

Lenz'sches Gesetz: *Lenz law.* States that whenever an e.m.f. is induced in a conductor by the variation of a magnetic field or by the relative motion of the conductor and the field, the direction of that e.m.f. is such as to tend to produce a current whose reaction with the field opposes the variation or the motion.

Leuchtintensitaet: *luminous intensity.* In re a point source of light: the luminous flux emitted per unit solid angle (spheradian) in a specified direction.

Leuchtstaerkenverteilungskurve: *luminosity curve.* A distribution curve showing luminous flux per element of wave length as a function of wave length.

Leuchttemperatur: *brightness temperature.* The temperature that is obtained for nonblack bodies with an optical pyrometer calibrated to give the correct temperature of a black body. It is always less than the true temperature.

Leuchtwirksamkeit: *luminous efficiency.* The ratio of the luminous flux to the radiant flux for the complete range of an emission of radiant energy.

Levogyr: *levogyrate, laevogyrate, levorotatory.* The opposite of dextrogyrate, i.e., producing a left-handed rotation in polarized light.

Lewis-Adams'sches Verhaeltnis: *Lewis-Adams relation.* A hypothetical relationship involving the elementary charge e, the electromagnetic constant c, and the Planck constant h; viz.,

$$\frac{8\pi^3e^2}{ch} = \left(\frac{15}{\pi^2}\right)^{1/3}.$$

Lewis-Langmuir'sches Atom: *Lewis-Langmuir atom.* A concept of the nuclear atom in which the extranuclear electrons are assumed to occupy fixed relative positions; in contrast to the orbital electronic atom of Rutherford and Bohr. Syn. static atom.

Lewis-Rayleigh'sches Leuchten: *Lewis-Rayleigh glow.* A yellow afterglow, most readily produced by condensed or electrodeless discharges in nitrogen. At ordinary temperatures, its spectrum consists of certain bands of the N_2 system.

Leydener Flasche: *Leyden jar.* The original form of electric condenser, in which the dielectric is a glass jar; credited to Muschenbroeck.

Leydener Temperaturskala: *Leyden temperature scale.* A low temperature range of the centigrade scale, based upon the boiling point of hydrogen as — 252.74 degrees C. and and that of oxygen as — 182.95 degrees C.; from the work of Onnes at the Leyden laboratory.

Lichtdruck: *light pressure.* A pressure proportional to the radiant energy in a unit of space, exerted by radiation on bodies upon which it impinges, and due to momentum.

lichtelektrische Zelle: *photocell, photoelectric cell.* A compact arrangement of metallic electrodes to obtain a photoelectric current.

Lichtenberg'sche Figur: *Lichtenberg figure.* A pattern traced on a dielectric surface, which has been nonuniformly electrified, by sifting over it fine powders, such as a mixture of sulphur and red lead.

Lichtfluss: *luminous flux, light flux.* Rate of emission of visible radiation, esp. as judged by its visual effect.

Lichtintensitaetsmesser spezieller Art: *flashometer.* An apparatus for studying the time-intensity distribution of flashes of light.

Lichtjahr: *light-year.* A unit of interstellar distance, equal to the distance which light travels, in a vacuum, in 1 year; approximately equal to 9.45988×10^{17} cm or 5.87837×10^{12} mi.

Lichtmenge: *light, quantity of.* A measure of the time integral of luminous flux; commonly expressed in lumenhours.

Lichtmesser: *photometer.* An apparatus for measuring the intensity of a light source.

Lichtmuehle: *radiometer.* An instrument for measuring the intensity of thermal radiation.

lichtnegativ: *light-negative.* Having negative photoconductivity, i.e., decreasing in conductivity under the action of light. Selenium sometimes exhibits this property. Syn. photo-negative.

lichtpositiv: *light-positive.* Having positive photoconductivity, i.e., increasing in conductivity under the action of light. Selenium ordinarily has this property.

Lichtquantitaet: *quantity of light.* See Lichtmenge.

Lichtquellenausbeute: *light-source efficiency.* The ratio of the luminous flux from a source of light to the power required to maintain it; usually expressed in lumens per watt.

Lichtquellenstaerke: *light-source efficiency.* See Lichtquellenausbeute.

Lichtraster: *light valve.* A device, either mechanical or electro-optical, for controlling the intensity of a beam of light, or for intermittently cutting it off, as a shutter.

Lichtvektor: *light vector.* The electric vector concerned in the propagation of electro-magnetic radiation.

Lichtverteilungskurve: *light distribution curve.* A graph showing the variations of luminous intensity with the direction of emission. If it is in polar coordinates, the curve is sometimes called a polar candle-power diagram.

Linearoszillator: *linear oscillator.* A system composed of two parts so connected that they are capable of oscillating with respect to each other along the line joining them, e.g., two balls at the ends of a rubber cord, the two ions of a polar molecule, or the positive and negative electricity in a Hertz oscillator.

Linie gleicher Ultrastrahlintensitaet: *isocosm.* A line of equal cosmic-ray intensity on the earth's surface.

Linienabstand: *line interval.* The difference in frequency between two adjacent lines in a spectral series.

Linieninterwall: *line interval.* See Linienabstand.

Linienspektrum: *line spectrum.* An atomic spectrum, characterized by distinct lines, rather than by bands as in molecular spectra.

linksdrehend: *levorotatory.* See Levogyr.

Linsenmesser: *lensometer.* An instrument designed for the measurement of the optical characteristics of spectacle lenses.

Liouville'scher Lehrsatz: *Liouville theorem.* States that for a conservative system of particles, the number of particles per unit volume in any representative group of the particles remains unaltered as the particles move.

Lippich'sches Prisma: *Lippich prisma.* A type of half-shade analyzer consisting of a small Nicol prism covering half the field of the polarimeter.

Lippmann'scher Effekt: *Lippmann effect.* The effect of a p.d. upon the mutual surface tension of two conducting, inmiscible liquids, as mercury and an electrolytic solution. The surface tension is greatest when the p.d. is zero.

Lippmann'sche Streifen: *Lippmann fringes.* Interference maxima which may be detected photographically, in parallel planes, in the space in front of a mercury surface from which light is normally reflected; due to the interference of the incident with the reflected light, forming stationary waves.

Lissajous'sche Kurven: *Lissajous curves.* A family of plane curves described by a point having two simple harmonic motions at right angles; varying with the relations of amplitude, frequency, and phase.

Liter: *liter, litre.* Originally defined as 1,000 cm^3 but for practical purposes now defined as the volume of 1 kg of pure water at its maximum density (4 degrees C.), and therefore equal to 1000.027 cm^3.

Lloyd'scher Spiegel: *Lloyd mirror.* A mirror used with very high incidence angle to produce by reflection two coherent light sources resulting in interference bands.

Lochbild: *pinhole image.* The inverted picture formed by light passing from the source directly through a small opening and falling on a screen.

loeschen: *quench.* See ausloeschen.

Loeslichkeit: *solubility.* The equilibrium concentration of a solute in satured solution.

loeslich in allen Verhaeltnissen: *consolute.* Miscible or mutually soluble in all proportions.

Loesung: *solution.* A mixture of substances whose intimacy is of molecular order and the proportion of whose ingredients (concentration) is subject to continuous variation over a certain range.

Loesungsdruck: *solution pressure.* (1) The osmotic pressure of a solution of a substance in equilibrium with its solid phase. (2) (Electrolytic.) The electrolytic influence which, according to Nernst's hypothesis, urges positive metallic ions to break away from the metal and enter the solution with which it is in contact.

Loesungswaerme: *heat of solution.* The quantity of heat absorbed or evolved per gram or per mol of a solute when it is dissolved in so large a volume of solvent that further dilution causes no further absorption or evolution of heat.

logarithmisches Dekrement: *logarithmic decrement.* The Napierian logarithm of a damping factor or oscillation decrement.

logarithmisches Potential: *logarithmic potential.* A potential associated with a field of force subject to the inverse-first-power law instead of to the Newtonian or inverse-square law; so called because its value involves the logarithm of the distance.

logarithmische Skala: *logarithmic scale.* A linear scale on which the actual distances of the points from the zero of the scale are proportional to the logarithms of the numbers with which these points are labeled.

Lokalelement: *local action.* A chemical reaction which takes place in an electrolyte on the surface of an electrode at points where particles of foreign matter serve to complete microscope voltaic circuits, and which results in corrosion of the electrode even when the main circuit of the cell is open.

Lokalvereanderung: *local change.* Any dynamic process in which the attention is fixed upon a point of space, through which particles of a system pass in succession, differences in their motions being noted; in contradistinction to individual change, q.v.

longitudinale Masse: *longitudinal mass.* The ratio of force to acceleration, as given by the special theory of relativity, in the case of a particle that is accelerated in the direction of its existing velocity; not a fundamental concept, since there is no law of conservation for this kind of mass.

Lorentz'sche Doppelbrechung: *Lorentz double refraction.* A group of optical phenomena in crystals, consisting of double refraction effects of the second order, not ordinarily observed and not included in the usual theories of crystal optics. E.g., Lorentz showed that even certain cubic crystals are not optically isotropic.

Lorentz'sche Einheit: *Lorentz unit.* The difference in quantum energy corresponding to the Lorentz displacement in the normal Zeemann effect; expressed by the formula heH 4π m_0c, in which h is the Planck constant, e the elementary charge (in e.m.u.), c the electromagnetic constant, m_0 the rest mass of the electron, and H the magnetic intensity responsible for the effect.

Lorentz'sche elektromotorische Kraft: *Lorentz electromotive force.* A force acting upon an electric particle by reason of its motion relative to a magnetic field.

Lorentz'sches Elektron: *Lorentz electron.* A moving electron which, according to the theory of Lorentz, has had its dimension parallel to the direction of motion shortened in the ratio

$$\sqrt{1 - \frac{u^2}{c^2}} : 1 \ ;$$

in which u is the speed of the electron and c, the speed of light.

Lorentz'scher Faktor: *Lorentz factor.* (1) The ratio of the intensity of an X-ray crystal-diffraction beam of a given order to that of the zero order, or undeflected, beam. (2) A factor expressing the dependence of the intensity upon the glancing angle, as the crystal is rotated.

Lorentz-Fitzgerald'sche Kontraktion: *Lorentz-Fitzgerald contraction.* See Fitzgerald-Lorentz'sche Kontraktion.

Lorentz Invarianz: *Lorentz invariance.* An attribute of any fundamental equation of physics which exhibits its agreement with the requirements of the special theory of relativity by being invariant under the Lorentz transformation.

Lorenz-Lorentz'sche Beziehung: *Lorenz-Lorentz relation.* A relation connecting the refractive index n of a dielectric with its density ρ:

$$\frac{n^2 - 1}{(n^2 + 2)\rho} = C;$$

in which C is a constant for the given dielectric, known as the specific refractive power.

Lorentz Transformation: *Lorentz transformation, Lorentz-Einstein t.* The process of transforming the mathematical expression corresponding to a given physical concept from the independent variables x, y, z, t, used by a given observer, to a new set x', y', z', t', used by a second observer in uniform motion relative to the first; making use of the Lorentz equations for the transformation of space and time variables.

Lorentz Triplet: *Lorentz triplet.* A spectral triplet observed with light at right angles to the magnetic field, in the normal Zeeman effect. The center line is polarized with the electric vector parallel to the field, the others perpendicular to the field.

Lorentz'sche Verschiebung: *Lorentz displacement.* The difference in frequency between the undisplaced line and either of the two outer components of a Lorentz triplet in the normal Zeeman effect.

Lorenz'sche Zahl: *Lorenz number.* A constant which, according to Lorenz, represents the product of the mobility coefficient of an ion by its radius. Its value is about 9.37×10^{-7} cm/ohm.

Loschmidt'sche Zahl: *Loschmidt number.* The number of molecules per cm^3 of an ideal gas at N.T.P. equal to about 2.705×10^{19}.

Ludwig-Soret Effekt: *Ludwig-Soret effect.* The effect of temperature upon the concentration of one of the components of a mixed crystal.

Lueckensatz: *vacancy principle.* States that a configuration of q of the p electrons of given principal and azimuthal quantum numbers, required to complete a closed group, gives rise to spectral terms having the same J values as those which arise from a configuration of p — q of the same electrons.

Lumen (Einheit der Beleuchtung): *lumen.* A unit of luminous flux equal to the flux through unit solid angle (spheradian) from a uniform point source of 1 candle. The total emission in all directions from such a source is 4π lumens.

Lumenmesser: *lumen meter.* A device for measuring luminous flux; specifically, a photometer designed by Blondel for measuring mean spherical candle power.

Lumenophor: *Lumenophor.* A molecule or group of molecules which according to the Kowalski theory of luminescence, is capable of emitting light when excited by absorbing the energy of an incident electron.

Lumenstunde: *Lumen-hour.* A unit quantity of luminous energy, equal to the emission of 1 lumen for 1 hour.

Lummer-Brodhun Photometer: *Lummer-Brodhun photometer.* A photometer in which the comparison of the illuminations on opposite sides of a white screen is made by a method depending upon the principle of total reflection.

Lummer-Gehrke Platte: *Lummer-Gehrcke plate.* A type of interferometer, based upon the interference effect of multiple reflections inside a glass plate with strictly plane and parallel faces, and capable of high resolving power.

Lumineszenz: *luminescence.* (1) An emission of radiation, esp. visible light, by a substance as a result of the absorption of energy from some other emission, either radiant or corpuscular. (2) In general, an emission of light by a substance from other causes than high temperature.

Lux: *lux.* A practical metric unit of illumination, equal to 1 lumen per m^2; or, the illumination of a surface at a uniform distance of 1m from a symmetrical point source of 1 candle. Syn. metercandle.

Luxmesser: *luxmeter.* A type of illuminometer that measures illumination in luxes.

Luxometer: *luxometer.* A portable form of cosine illumination photometer, depending upon the comparison of the illuminated test area with an area illuminated by a lamp at an adjustable angle of incidence.

Lyman Banden: *Lyman bands.* A group of spectral bands in the Schumann region of the hydrogen spectrum between 1450 Å and 1650 Å. The frequencies are multiples of

$$\left(\frac{1}{1^2} - \frac{1}{n^2}\right)$$

in which $n = 2, 3, 4, \ldots\ldots$

Lyman Kontinuum: *Lyman continuum.* A continuous spectrum in the ultraviolet, extending from the visible down to 300 Å or lower; produced by a heavy condenser discharge through a capillary.

M-Serie: *M series.* A series of frequencies in the X-ray spectrum of an element, believed to arise from the transition of electrons from various higher quantum states to the state whose principal quantum number is 3. Discovered by Siegbahn.

M-Wert: *M value, magnetic quantum number.* A quantum number related to the behavior of an atom or a molecule in a magnetic field, and equal to the component of the angular momentum of the system about the field direction as axis, expressed as a multiple of $h/2\pi$ (h is the Planck constant). Used in connection with magneto-optical phenomena, such as the Zeeman effect. Syn. equatorial quantum number, axial quantum number.

Mach'sche Zahl: *critical velocity ratio.* The ratio of the velocity of a fluid to that of sound in that medium.

Madelung'sche Konstante: *Madelung constant.* (1) A factor which occurs in the expression for the wave length of the residual radiation (Reststrahlen) selectively reflected by a given heteropolar crystal. (2) The constant k in the expression kE^2/r for the potential energy of separation of the two unlike ions in a heteropolar crystal, which have charges $\pm$ E and are a distance r apart.

Magnalium: *magnalium.* One of several alloys of aluminum and magnesium. That developed by Mach (69 percent Al and 31 percent Mg) has high reflectivity in the visible and the ultraviolet regions.

magnetische Achse: *magnetic axis.* In re a magnet or an equivalent electric circuit: the vector direction of the magnetic moment. For a bipolar magnet with concentrated poles, it is approximately the direction of the line drawn from the south to the north pole.

magnetischer Aequator: *magnetic equator.* A line around the earth, approximately a great circle midway between the magnetic poles, and coinciding with the line of zero magnetic inclination.

magnetische Analyse: *magnetic analysis.* (1) The separation of a stream of electrified particles by a magnetic field in accordance with their mass, their charge, or their speed. (2) The study of the properties of iron or other magnetic bodies by magnetic methods.

magnetische Breite: *magnetic latitude.* See geomagnetische Breite.

magnetische Daempfung: *magnetic damping.* The damping of a mechanical motion by means of the reaction between a magnetic field and currents generated by the motion in accordance with the Lenz law.

magnetische Doppelbrechung: *magnetic double refraction.* See Cotton-Mouton'scher Effekt.

magnetisches Element: *magnetic element.* (1) Syn. Ampèrian current. (2) Any group of Ampèrian currents, e.g., a spinning electron, which conserves its magnetic moment throughout the process considered. (3) Any one of the quantities customarily chosen to specify the earth's magnetic field at a given point; viz., declination, inclination, total intensity, horizontal intensity, or vertical intensity.

magnetisches Feld: *magnetic field.* A region in which there is a magnetic intensity, as indicated by the torque experienced by a bipolar magnet placed in it, due to the influence of magnets or electric currents.

magnetischer Fluss: *magnetic flux.* The surface integral, over any specified area, of the normal component of the magnetic induction commonly expressed in maxwells or gauss-cm^2.

Magnetische Flussdichte: *magnetic flux density, magnetic induction.* A vector quantity, usually associated with the condition of a substance when placed in a magnetic field, having the same direction as the magnetizing force (provided the substance is isotropic), and having a magnitude dependent upon the magnetizing force and upon the nature of the substance. Its measure is the e.m.f. produced in an electric circuit linked with the induction at a definite time rate, in accordance with the Faraday law. The induction is normal if the substance is not already magnetized when placed in the magnetic field.

magnetische Hauptsuszeptibilitaet: *principal magnetic susceptibility.* The magnetic susceptibility of a nonferromagnetic crystal for one of the three or more directions along which the magnetization is parallel to the magnetic intensity.

magnetische Induktion: *magnetic induction, magnetic flux density.* See magnetische Flussdichte.

magnetische Induktionsroehre: *tube of magnetic induction.* A magnetic circuit so bounded as to have the same magnetic flux, (esp. unit flux) through every cross section.

magnetische Inklination: *magnetic inclination.* The angle which the magnetic field of the earth makes with the horizontal at any station. Syn. magnetic dip.

magnetische Intensitaet: *magnetic intensity.* A vector quantity pertaining to the magnetic field, the measure of which, at any point in a vacuum, is the force per unit pole experienced by a free magnetic pole placed

at that point. It is closely related to magnetic induction; in a vacuum proportional to it, and if in the same measure, even identifiable with it.

magnetischer Kompass: *magneto compass.* A device used as a compass on airplanes, utilizing the inductive effect of the earth's magnetic field to excite the field magnet of a small magneto or dynamo. When the instrument is properly oriented, the current generated reduces to zero.

magnetischer Kreis: *magnetic circuit.* A closed tube or multiply connected region, the surface of which is everywhere tangential to the magnetic induction; or a series of bodies approximately filling such a region. The field magnet and armature core of a motor form a typical magnetic circuit.

magnetischer Kreislauf: *magnetic cycle.* A cycle of changes in the magnetic induction or the magnetization of a ferromagnetic substance due to an alternating magnetic intensity. A symmetrical cycle may be represented by a hysteresis curve with its center at the origin.

magnetische Linse: *magnetic lens.* An apparatus used to focus beams of rapidly moving electrons or ions by means of the effect of a nonuniform magnetic field.

magnetischer Meridian: *magnetic meridian.* The horizontal line, through any point on the earth's surface, which coincides with the direction of the horizontal component of the earth's magnetic field at that point.

magnetisches Moment: *magnetic moment.* That vector, associated with a magnet or an equivalent electric circuit, whose vector product by the magnetic intensity of the field, in which the magnet or the circuit is placed, gives the resulting torque upon the same; the magnetic intensity considered being exclusive of any component contributed by the magnetic body itself. For a bipolar magnet with concentrated poles, the magnetic moment is approximately the product of the pole strength by the distance between the poles, and its direction, that of the line drawn from the south to the north pole.

magnetische Nachwirkung: *magnetic lag, magnetic aftereffect.* A delay not due to eddy currents, in the establishment of the magnetic induction which finally corresponds to a given magnetic intensity in a given sequence of magnetic states.

magnetisches Pendel: *magnetic pendulum.* A bar magnet suspended so as to oscillate as a pendulum in a magnetic field.

magnetisches Potential: *magnetic potential.* A scalar point function analogous to electric potential. Its value at any point is the line integral of the magnetic intensity taken from that point to infinity.

magnetisches Potentiometer: *magnetic potentiometer.* A slender solenoid, used to measure magneto-motive forces between points in a magnetic field. Its core may be of flexible, nonferromagnetic material, or of a highly permeable alloy.

magnetische Quantenzahl: *magnetic quantum number.* See M-Wert.

magnetischer Resonanzbeschleuniger: *magnetic resonance accelerator.* See Zyklotron.

magnetische Rotationsinvariante: *invariant of magnetic rotation.* The value of the expression

$$\frac{\Lambda n \rho}{(n^2 - 1)^2},$$

in which Λ is the Verdet constant, n the refractive index, and ρ the density, of a transparent substance; approximately the same for different substances.

magnetische Rotation: *magnetic rotation.* See Faraday-'scher Effekt.

magnetisches Rotationsspektrum: *magnetic rotation spectrum.* The absorption spectrum of a substance under the influence of a magnetic field in the direction of the transmitted light, which is thus subjected to the Faraday effect.

magnetischer Spektrograph: *magnetic spectrograph.* A magnetic mass or velocity spectrograph.

magnetisches Spektrum: *magnetic spectrum.* The record of a magnetic spectrograph.

magnetische Strahlen: *magnetic rays.* A term applied by Righi to certain phenomena in a discharge tube under the influence of a strong magnetic field.

magnetischer Vektor: *magnetic vector.* That component of the electromagnetic field, associated with electromagnetic radiation, which is of the nature of a magnetic field; supposed to coexist with, but to act at right angles to, the electric vector.

magnetische Verzoegerung: *magnetic lag.* See magnetische Nachwirkung.

magnetische Viskositaet: *magnetic viscosity.* A property sometimes ascribed to ferromagnetic substances to account for magnetic lag.

Magnetisierung: *magnetization.* (1) A vector quantity associated with a substance under magnetic influence, viz., the magnetic moment per unit volume. Divided by the density, it gives the specific magnetization, or magnetic moment per unit mass. Syn. intensity of magnetization. (2) The process of increasing the magnetic moment of a body.

Magnetisierungskraft: *magnetizing force.* The magnetic intensity brought to bear upon a substance and effective in producing its magnetization. It is in general less than the magnetic intensity of the field external to the substance.

Magnetisierungskurve: *magnetization curve.* A graph on the magnetization-intensity (I-H) or the induction-intensity (B-H) diagram, representing successive states of a ferromagnetic substance. A normal magnetization curve is a portion of a symmetrical hysteresis loop. The initial or virgin magnetization curve is such a curve representing the first excursion from the origin, and is distinct from the subsequent cycles.

Magnetisierungsstaerke: *intensity of magnetization.* See magnetische Intensitaet.

Magnetismus: *magnetics.* That branch of physics which deals with the phenomena of magnetism.

magnetoelastisch: *magnetoelastic.* Pertaining to magnetostriction effects associated with elastic vibration.

magnetoelektrische Induktion: *magnetoelectric induction.* See elektromagnetische Induktion.

Magnetogenerator: *magnetogenerator.* An a.-c. generator in which the field is maintained by a permanent magnet. Often abbreviated "magneto."

magnetokalorischer Effekt: *magnetocaloric effect.* The reversible cooling of a ferromagnetic body, magnetized to saturation in a strong magnetic field, when the field is removed. Discovered by P. Weiss and R. Forrer in 1924.

Magnetometer: *magnetometer.* An instrument for the measurement of magnetic intensity, magnetic induction, or magnetic moment.

magnetomotorische Kraft: *magnetomotive force.* In re any closed path constituting a magnetic circuit: the line integral of the magnetizing force, or the change in magnetic potential, due to the magnetizing agency (as a coil) which acts upon the magnetic circuit. If it is due to the current in a coil, it is proportional to the number of ampere-turns.

Magneton: *magneton.* (1) A unit of magnetic moment in terms of which molar magnetic moments are small integers (Weiss, 1911), or simple functions of small integers (Bohr, 1913). The empirical Weiss magneton is 1125.0 e.m.u., the theoretical Bohr magneton is 555.7 e.m.u. (2) A unit of magnetic moment in terms of which the magnetic moments of magnetic elements (Ampèrian currents) are functions of small integers. The theoretical Bohr magneton in this sense is 9.158×10^{-21} c.g.s.e.m.u.

Magnetonzahl: *magneton number.* An integral number by which, according to Sommerfeld, the Bohr magneton must be multiplied to give the magnetic moment of a given atom.

magnetooptische Analyse: *magneto-optical analysis.* A method of chemical analysis based upon differences in the lag of the Faraday effect behind the magnetic intensity for different substances.

magnetooptische Dispersion: *magneto-optical dispersion.* Expresses the Faraday effect as the derivative, with respect to the wave length, of the product of the Verdet constant by the refractive index.

magnetooptischer Parameter: *magneto-optical parameter.* A complex constant involved in the electron theory of the Faraday and the Kerr effect, and having a distinctive value for each metal.

magnetooptische Rotation: *magneto-optical rotation.* See Faraday'scher Effekt.

Magnetophotophorese: *magnetophotophoresis.* See Photophorese.

magnetostatischer Oszillator: *magnetostatic oscillator, magnetostriction oscillator.* An electric oscillating system containing as one of its elements a magnetostriction resonator, by which the frequency is controlled.

Magnetostriktion: *magnetostriction.* A class of phenomena involving strains (magnetostrains) in a ferromagnetic body when placed in a magnetic field.

Magnetostriktionsoszillator: *magnetostriction oscillator, magnetostrictive o.* See magnetostatischer Oszillator.

Magnetostriktionsresonator: *magnetostriction resonator.* A magnetostrictive body, usually in the form of a rod, which may be excited magnetically into resonant vibration at one or more frequencies.

Magnetostriktionsuebertrager: *magnetostriction transceiver.* A magnetostriction resonator applied to sending and receiving subaqueous signals of definite frequency, usually 17,000 cyc per sec or higher.

Magnetowiderstand: *magnetoresistance.* An increase in electrical resistance of a conductor, associated with the application of a constant magnetic field; dependent upon the orientation of the conductor in the field.

Magnetpol: *magnetic pole.* One of those regions of the surface of a magnet, just outside which the magnetic intensity arising therefrom is greatest. Unless this intensity is everywhere zero (as may happen), a magnet must have at least one pole of each sign.

Magnetpolstaerke: *magnetic pole strength* (*unit pole, c.g.s. magnetic*). An ideal magnetic point pole, two of which, at a distance of 1 cm apart in a vacuum, would exert a mutual repulsion (or attraction) of 1 dyne. Such a pole gives rise to 4π maxwells of free magnetism. Actual magnetic poles are often treated quantitatively as if made up of a number of unit poles equal to the "pole strength."

Magnetron: *magnetron.* (1) A type of thermionic vacuum tube in which the motion of the ions is controlled by the influence of a magnetic field perpendicular to the electric field propelling them. (2) A device for generating radio waves of very short wave length (from 75 to 150 cm).

Magnus Effekt: *Magnus effect.* A lateral thrust exerted by wind upon a rotating cylinder (Magnus rotor) whose axis is perpendicular to the wind direction. The effect has been utilized in ship propulsion and in other devices.

Majorana'sche Kraefte: *Majorana forces, M. interactions.* Attractive forces between neutrons or between protons and neutrons within an atomic nucleus; supposed to offset the mutual repulsion of the nuclear protons and to produce saturation of bonds between nuclear particles. Of especial significance is the energy associated with these forces, which is supposed to owe its origin to the exchange of position of the two interacting particles.

Malus'sches Gesetz: *Malus law.* (1) States that the intensity of a beam of light, after two reflections from nonmetallic surfaces at the polarizing angle, is proportional to the square of the cosine of the angle between the two planes of reflection. Discovered by Malus in 1808. A similar law applies to light passing through two Nicol prisms. (2) States that an orthotomic system of rays remains orthotomic after any number of reflections and refractions.

Manganin: *manganin.* An alloy of copper (84 percent), manganese (12 percent), and nickel (4 percent), used for resistance coils because of its very low temperature coefficient of resistance.

mannigfaltig: *multiple,* [*parallel* (*in the electrical sense*)]. Electrically connected between the same terminals, as two or more conductors or condensers.

Mannigfaltigkeit (opt.): *multiplicity.* The largest number of components possessed by any multiple term in a given spectral system. Multiplicities as high as 9 are known, but not all the terms of a system have the maximum number of components.

Manokriometer: *manocryometer.* An instrument used for determining the variation of freezing point with pressure. Devised by de Visser.

Manometer: *manometer.* A pressure gauge.

manometrische Waage: *manometric balance.* An apparatus for the comparison of the magnetic susceptibilities of liquids.

Mariotte'sche Flasche: *Mariotte bottle.* A pneumatic device by which the rate of discharge of a liquid from an orifice may be maintained constant for some time, irrespective of the level of its surface.

Martens'scher Keil: *Martens wedge.* A type of quartz wedge rotator for polarized light, used in some polarimeters to compensate and thus measure the optical rotation whose value is sought.

Marx'scher Effekt: *Marx effect.* The reduction in the energy of a photoelectric emission by the simultaneous incidence of radiation of lower frequency than that producing the emission. Observed by E. Marx in 1930, and called by him the regressive effect.

Masse: *mass.* A basic physical magnitude pertaining primarily to matter (though having an interpretation also, in modern physics, with reference to electricity and to energy); the measure of which is found in its relation to inertia. In accordance with Newton's second law, the masses of bodies are inversely proportional to the accelerations given them by the same force, as when two free bodies are drawn together by an elastic cord connecting them.

Massenabsorptionskoeffizient: *mass absorption coefficient.* See Absorptionskoeffizient.

Massendefekt: *mass defect.* The amount by which the mass of an atom falls short of the sum of the masses of the particles of which it appears to be composed, as the latter are separately measured.

Massenspektrograph: *mass spectrograph, m. spectrometer.* An apparatus for separating an emission of electrically charged particles into distinct streams in accordance with their masses, by means of magnetic or

electric deflection, and for ascertaining their masses in this way. The streams of particles are often made to strike a photographic plate and thus render their positions observable as "lines," like those of a spectrum.

Massensuszeptibilitaet: *mass susceptibility.* The ratio of the magnetization in a substance to the magnetizing force responsible for it. Divided by the density, it gives the mass susceptibility or specific susceptibility of the substance.

Massenzahl: *mass number.* A type of atomic number which designates the number of protons in the nucleus of the atom, instead of the older, Moseley number.

Massenzentrum: *center of mass.* In re any body or system of bodies: a point such that if any plane be passed through it, the mass moments, with respect to it, of the portions on opposite sides of the plane are equal. Syn. center of inertia, centroid.

Masson'sche Gleichung: *Masson equation.* An empirical formula for the apparent molar specific volume of a substance in solution, viz.,

$$\Psi = a C^{1/2} + b,$$

in which C is the molar concentration and a and b are empirical constants.

Materiewelle: *matter wave.* See de Broglie Welle.

mathematisches Pendel: *ideal simple pendulum.* A particle of finite mass but infinitesimal size, suspended as a gravity pendulum by a weightless thread; a convenient theoretical concept.

Matrizenmechanik: *matrix mechanics.* The quantum mechanics of Heisenberg, expressed in the mathematical notation of matrices.

Matteucci'scher Effekt: *Matteucci effect.* An e.m.f. developed between the ends of a twisted ferromagnetic wire upon change of its magnetization. Discovered by C. Matteucci, 1857.

Maxwell: *maxwell.* The practical, c.g.s. electromagnetic unit of magnetic flux, equal to 1 gauss-cm^2. Each maxwell may be represented by a "line" of (magnetic) force.

Maxwell-Ampère'sches Gesetz: *Maxwell-Ampère law.* A modification of the Ampère law, made by Maxwell to allow for the displacement current in the dielectric as well as the current in the conductor.

Maxwell-Boltzmann'sches Gesetz: *Maxwell-Boltzmann law.* The principle of equipartition of energy.

Maxwell'sche Bruecke: *Maxwell bridge.* (1) An arrangement resembling a Wheatstone bridge, but used for comparing an inductance with a capacitance. (2) An arrangement similarly used for comparing an inductance with a mutual inductance.

Maxwell'scher Daemon: *Maxwell demon.* An imaginary intelligent being of molecular proportions, introduced by Maxwell into his arguments on the thermodynamics of gases.

Maxwell'sches Diagramm: *Maxwell diagram.* A diagram made up of the vector polygons of forces corresponding to the different members of a framed structure or truss, one polygon for each joint of the structure.

Maxwell'sches Dreieck: *Maxwell triangle.* A graphical device for representing the trichromatic coefficients of the components of a three-color mixture.

Maxwell'sche elektromagnetische Gleichungen: *Maxwell electromagnetic equations.* Four relations which, according to Maxwell's electromagnetic theory, describe the conditions at any point under the influence of varying electric and magnetic fields, in a region in which, in general, there are conductors, dielectrics, and paramagnetic or ferromagnetic bodies. They are most concisely expressed in vector notation, and appear in various forms, of which the following are typical:

$$\nabla \times H = \frac{1}{c}\frac{\delta D}{\delta t} + \frac{4\pi u}{c},$$

$$\nabla \cdot B = 0,$$

$$\nabla \times E = -\frac{1}{c}\frac{\delta B}{\delta t}$$

$$\nabla \cdot D = 4\pi\rho.$$

In these, H = magnetic intensity, B = magnetic induction, E = electric intensity, D = electric displacement, ρ = electric density, u = (conduction) current density, c is the electromagnetic constant.

Maxwell'sches Gesichtsfeld: *Maxwellian view.* An optical arrangement in which a real image of a surface is formed by a lens at the pupil of the observer's eye, resulting in a field of uniform brightness more intense than that of the surface as viewed without the lens.

Maxwell'sche Reihenformel: *Maxwell series formula.* A formula, derived by Maxwell, which expresses the mutual inductance of two coaxial circular coils as the difference of two complicated infinite series in terms of the radii of the two coils and their distance apart.

Maxwell'sche Spitze: *Maxwell top.* A gyroscope in

the form of an adjustable top, whose point of support may be set below, at, or above the c.m.

Maxwell'sche thermodynamische Beziehungen: *Maxwell thermodynamic relations.* Four differential equations of thermodynamic change, which connect the temperature Θ, the volume v, the pressure p, and the entropy Φ, as follows:

$$\left(\frac{\delta\Phi}{\delta p}\right)_v = -\left(\frac{\delta v}{\delta\Theta}\right)_\Phi, \quad \left(\frac{\delta\Phi}{\delta v}\right)_\Theta = \left(\frac{\delta p}{\delta\Theta}\right)_v,$$

$$\left(\frac{\delta\Phi}{\delta p}\right)_\Theta = -\left(\frac{\delta v}{\delta\Theta}\right)_p, \quad \left(\frac{\delta\Phi}{\delta v}\right)_p = \left(\frac{\delta p}{\delta\Theta}\right)_\Phi.$$

The subscripts denote that the corresponding quantity is to be kept constant. The equations may take other forms, those here given being in terms of independent variables subject to experimental control.

Maxwell'sches Verteilungsgesetz: *Maxwell distribution law.* An expression for the statistical distribution of speeds or energies among the molecules of a pure gas free from convection currents and at a uniform temperature. It takes various forms, of which the following is typical:

$$dN = Au^2e^{-B^2u^2}du;$$

expressing the number of molecules having speeds in the range $u - \frac{1}{2}\,du$ to $u + \frac{1}{2}\,du$. A and B are constants involving the temperature and pressure.

Maxwell-Wagner'sche Polarisation: *Maxwell-Wagner polarization.* A type of electric polarization exhibited by heterogeneous dielectrics, e.g., colloidal suspensions, and ascribed to the accumulation of charges at the dielectric interfaces; in contrast to the dipole polarization of homoegeneous polar dielectrics.

Maxwell'sche Windung: *maxwell-turn.* A unit of magnetic linkage, corresponding to one line of force surrounded by 1 turn of the circuit. Syn. line-turn.

Maupertuis'sches Prinzip: *Maupertuis principle, least-action principle.* States that if a dynamic system passes spontaneously and without change in total energy from one configuration to another, the action involved in the process is a minimum; or (an equivalent statement) that the line integral of the momentum of each particle is a minimum. Enunciated by Maupertuis.

McCoy Zahl: *McCoy number.* The ratio of the total alpha radiation from a radioactive substance to the alpha radiation per cm^2, in a direction perpendicular to the surface, of a layer of uranium oxide (U_3O_8) of indefinite thickness.

McLeod'scher Manometer: *McLeod gauge.* A device for measuring the pressure of highly rarefied gases by first compressing a portion of the gas and observing the pressure thus "magnified"; from this the original pressure may be calculated.

Mechanik: *mechanics.* Syn. dynamics; but often with special reference to machines or building construction.

mechanisches Aequivalent: *mechanical equivalent.* See dynamisches Aequivalent.

mechanischer Nutzeffekt: *mechanical advantage.* The (ideal) ratio of the force exerted by a machine to the force exerted on it by the operator. A more practical measure is the ratio of the linear displacement effected by the operator to the displacement produced by the machine, since this is independent of the influence of friction.

Megohmempfindlichkeit: *megohm sensitivity.* The sensitivity of a galvanometer expressed as the resistance in megohms (millionths of an ohm) necessary to reduce the deflection to 1 scale division, when an e.m.f. of 1 volt is applied to the circuit.

mehrfach: *multiple,* [*parallel* (*in the electrical sense*)]. See mannigfaltig.

Mehrfachionisation: *multiple ionization.* The extraction of more than one electron from an atom, e.g., by the impact of an electron of sufficient speed.

Mehrfachterm: *multiple* (*spectral*) *term.* A group of nearly equal spectral terms corresponding to a set of closely adjacent quantum states or energy levels.

mehrphasisch: *multiphase, polyphase.* Having or utilizing several phases; e.g., a polyphase current or motor.

Meissner'scher Effekt: *Meissner effect.* The acquisition of nearly complete diamagnetism ($\mu = 0$) by certain metals when cooled below the superconductivity transition point.

Melde'scher Versuch: *Melde experiment.* An experiment with a vibrating string, in which the nodes and antinodes are distinctly visible.

Meniskus: *meniscus.* The concave or convex free surface of a liquid in a tube, due to capillary action.

Meniskuskorrektor: *meniscus correction.* A correction often necessary in taking readings on liquid columns, as in a barometer, because the end of the column is not a plane surface.

Meniskuslinse: *meniscus lens.* A lens whose two surfaces have curvatures of the same sign, i.e., which is

either convexo-concave or concavo-convex. The former is called convex-meniscus, the latter concave-meniscus.

Meridian: *meridian.* A line perpendicular to the axis of an optical system, e.g., any diameter of a circular lens.

Meridianstrahl: *meridian ray.* Any one of a narrow bundle of rays in a symmetrical optical instrument which lies in the meridian section of the bundle, made by the plane containing the chief ray and the optic axis of the instrument.

Mersenne'sches Gesetz: *Mersenne law.* States that the frequency of a vibrating string varies inversely as the length, inversely as the square root of the line density, and directly as the square root of the tension.

Mesoform: *meso form, m. phase.* A form of a substance which fails to exhibit optical activity because of a structure in which the dextrogyrate and levogyrate effects are balanced against each other.

mesomorph: *mesomorphic.* In or pertaining to the liquid crystal state. Syn. smectic.

Messerkantenversuch: *knife-edge test.* A method of testing large mirror objectives.

metakristallner Zustand: *metacrystalline state.* An arrangement of molecules, due to strain or other influence, which, while it does not involve a true crystal structure, is capable of giving rise to X-ray diffraction patterns analogous to those produced by crystals.

metamagnetisch: *metamagnetic.* Having the property of being either paramagnetic or diamagnetic according to conditions such as the intensity or the direction of the applied field.

metastabiler Zustand: *metastable state.* (1) A kind of equilibrium which is not attainable indifferently from different directions, e.g., that of super-cooled water, which may be reached by cooling liquid water but not by warming solid ice. (2) In re an atom: an excited state in which, however, the atom will not emit radiation unless further stimulated by some external influence or disturbance, such as a collision.

metazentrische Hoehe: *metacentric height.* Height of the metacenter above the c.m.

Metazentrum: *metacenter.* That point, always above the c.m., of a rigid body floating in equilibrium, through which the buoyant force may be considered to act when the body is slightly tipped. In general its position depends upon the plane of tipping; a boat has a transverse metacenter (as it rolls) and a longitudinal metacenter (as it pitches).

Meteorograph: *meteorograph.* An apparatus which records conditions of atmospheric pressure, temperature, and humidity.

Meteorologie: *meteorology.* That branch of physical science which treats primarily of atmospheric phenomena.

Meter: *meter.* The basic unit of the metric system, originally defined as 0.0000001 of the earth's meridian quadrant at sea level. The actual metal standard meter bar at Sèvres is constructed to fulfill this ideal specification as accurately as possible. The ratio of the meter to the English yard is about 1.093611.

Meterkerze: *meter-candle, lux.* A practical metric unit of illumination, equal to 1 lumen per m^2; or, the illumination of a surface at a uniform distance of 1 m from a symmetrical point source of 1 candle.

Meterkerzensekunde: *meter-candle-second.* A unit of photographic exposure, corresponding to an illumination of 1 lux for 1 sec.

Methode der kleinsten Quadrate: *method of least squares.* A systematic procedure for the adjustment of observations in accordance with the principle of least squares.

metrische Pferdestaerke: *metric horse power, force de cheval.* A metric gravitational unit of power, equal to 75 m-kg of work per second, and equivalent to about 736 watts or 0.9863 hp.

Metrologie: *metrology.* That branch of science which deals with systems of units and methods of measurement.

Mho: *mho.* A unit of electrical conductance, the reciprocal of the ohm. Thus a conductor having a resistance of 4 ohms has a conductance of 0.25 mho. Syn. reciprocal ohm.

Michelson'scher Interferometer: *Michelson interferometer.* An interferometer, designed by A. A. Michelson, which is arranged to produce interference maxima and minima between two wave trains, as of light, separated from the same original train and reunited after reflection from two mirrors. The phase of the interference is varied by moving one of the mirrors forward or backward, and the wave length thereby compared with the mirror displacement.

Michelson-Morley'scher Versuch: *Michelson-Morley ex-*

periment. A classic and crucial experiment, involving the transmission and reflection of light through the mirror system of an interferometer, which was intended to reveal the existence of an ether drift due to the earth's motion, and the negative result of which was the starting point of the theory of relativity. First performed by Michelson and Morley in 1881.

Mikrochronograph: *microchronograph.* A chronographic device for very small intervals of time, e.g., the period of a sound vibration or the duration of an electric **spark.**

Mikrodensitometer: *microdensitometer.* A microphotometer for the measurement of the density of photographic images.

Mikrodichtemesser: *microdensitometer.* See Mikrodensitometer.

Mikrokinematograph: *microcinematograph.* A moving-picture camera for microscopic objects, such as particles exhibiting the Brownian movement, growing microcrystals, etc.

Mikrokristall: *microcrystal.* One of the small crystals in a finely crystallized mass, e.g., in cast iron.

Mikromanipulator: *micromanipulator.* A device, controlled by compressed air or otherwise, for manipulating microscopic objects in any desired manner while under observation.

Mikromanometer: *micromanometer.* An instrument for observing and measuring very small pressure differences or fluctuations.

Mikromechanik: *micromechanics.* The dynamics of very minute bodies, such as the component parts of an atom or of a molecule.

Mikrometer: *micrometer.* One of a class of measuring instruments in which linear displacements to be measured are made to correspond with the travel of a screw, of accurately adjusted pitch and provided with a large head graduated to indicate small subdivisions of the pitch.

Mikron: *micron.* A unit of length, equal to one-millionth of a meter, or 0.001 mm. Commonly designated by the symbol μ. The millimicron, or 0.001 micron, 0.000001 mm, is designated by $\mu\mu$ or $m\mu$.

Mikrophotometer: *microphotometer.* An instrument for the measurement or comparison of small luminous intensities.

Mikropyrometer: *micropyrometer.* An apparatus, devised by Burgess, for measuring the melting points of small specimens of refractory substances.

Mikroradiometer: *microradiometer.* An instrument for the measurement of very feeble radiation.

mikroskopisches Reversibilitaetsprinzip: *microscopic reversibility principle.* A principle of statistical equilibrium, formulated in various ways; by Richardson as follows: "Every isolatable process is exactly compensated in a state of statistical equilibrium by precisely the same process working backward." The process of detailed balancing in ionized gases is an example.

mikroskopisches Umkehrungsprinzip: *microscopic reversibility principle.* See mikroskopisches Reversibilitaetsprinzip.

Mikrovoltempfindlichkeit: *microvolt sensitivity.* The sensitivity of a galvanometer as expressed in scale divisions per impressed microvolt.

Mikrowaage: *microbalance.* (1) Any balance for weighing very small masses. (2) A very small differential buoyancy balance for measuring densities of gases.

Mikrowellen: *microwaves, ultrashort waves.* The shortest electromagnetic waves employed in radio communication; specifically, those below 10 m in wave length or above 30,000 kc per second in frequency.

Miller'sche Bruecke: *Miller bridge.* A type of bridge circuit devised by J. H. Miller for measuring the amplification factors of vacuum tubes.

Miller'scher Index: *Miller index.* One of the three numbers (h, k, l) used to designate any set of parallel planes of atoms in a crystal, viz., the simplest integers proportional to the reciprocals of the intercepts of the planes on the crystal axes.

Milliamperemeter: *Milliammeter.* Any type of galvanometer which measures small electric currents directly in milliamperes, or thousandths of an ampere.

Millivoltmeter: *millivoltmeter.* A voltmeter reading in millivolts, or thousandths of a volt.

Minkowski Welt: *Minkowski world.* The totality of the four-dimensional continuum known as space-time and measured off in space-time co-ordinates.

Mischkristall: *mix-crystal, mixed c.* A crystal composed of two or more different chemical substances, both of whose molecules or ions occupy positions in the same crystalline structure irrespective of the substance to which they belong.

Mischungsmethode: *mixture method.* A method of physical measurement in which two bodies are placed in communication until an equilibrium is obtained between them. Used esp. in calorimetry, in which case the quantity measured is heat and the equilibrium is one of temperature.

Mischungswaerme: *heat of mixture.* Heat evolved or absorbed upon the mixture of two liquids, not due to chemical reaction between them.

Mittelpunkt: *mean center.* In re a number of points in space: the point which corresponds to the centroid of a system of equal particles placed at the given points.

Mittelpunktprojektion: *gnomonic projection.* See gnomonische Projektion.

mittlere freie Wegelaenge: *mean free path.* The average distance which the particles composing an ensemble, e.g., molecules composing a gas, travel between successive encounters with other similar particles in the process of thermal agitation.

mittlere Geschwindigkeit: *drift speed.* The mean speed with which electrons or ions progress through a medium where they are continually experiencing collisions.

mittlere horizontale Kerzenstaerke: *mean horizontal candle power.* The average candle power of a light source, as viewed from all directions in the horizontal plane containing it.

mittlere Lebensdauer: *average life, decay modulus.* In re any variable which diminishes or "decays" exponentially, e.g., radioactivity: the time required for the variable to diminish to 1/e or 36.97 percent of its original value. It is equal to 1.443 times the half-value period, and is the reciprocal of the decay coefficient.

mittlere sphaerische Kerzenstaerke: *mean spherical candlepower.* The average candlepower of a light source, as viewed from all directions. It equals the total luminous flux, in lumens, divided by 4π.

Mizelle: *micelle.* An aggregate of colloidal particles, associated with water molecules.

modifizierte Linie: *modified line.* See Compton Effekt.

Modul: *Modulus.* (1) A real positive quantity, numerical or physical, that expresses the measure of some function, property or effect, as of elasticity strength, efficiency, etc., esp. under unit conditions. (2) A standard or norm. (3) (math.) a. Absolute value, b. Theorem of numbers.

Modul der Periodizitaet: *periodicity, modulus of.* The change which takes place in the action during one complete cycle of a periodic process.

modulieren: *modulate.* To vary, esp. the amplitude or the frequency of an oscillation or a wave train, in some characteristic manner, as in sending radio signals or in broadcasting.

Mol: *mol, mole, gram molecule.* That mass of a pure substance which, in grams, is numerically equal to the molecular mass of the substance. The gram molecule of every pure substance thus contains the same number of molecules, viz. about 6.06×10^{23} (Avogadro number).

molar: *molar.* (1) Pertaining to a mol, or measured in mols. Syn. grammolecular. (2) Pertaining to masses of appreciable size; massive; bodily.

molares Brechungsvermoegen: *molar refractivity.* The product of the specific refractivity by the molecular weight.

molares freies Volumen: *molar free volume.* The molar volume of a substance at any temperature in the liquid state, minus its molar volume at the freezing point.

molare Leitfaehigkeit: *molar conductivity.* The electrical conductivity of an electrolyte in solution (conductivity of solution minus that of the solvent) per unit concentration in mols per cm^2; usually as compared with some standard liquid, as mercury.

molare Polarisation: *molar polarization.* A quantity P_m pertaining to the molecules of a pure dielectric, and connected with the polarizability a and the dielectric constant κ by the relation

$$P_m = \frac{4}{3}\pi N a = \frac{\kappa - 1M}{\kappa + 2\rho};$$

in which N is the Avogadro number, M the molecular weight, and ρ the density. It is also equal to the limiting value of the molar refraction, as the wave length increases.

molare Refraktion: *molar refraction.* The product of the molecular weight of a substance by its specific refractive power.

molare Rotation: *molar rotatory power, m. rotation.* Molar rotatory power is the specific rotatory power multiplied by the molecular (or atomic) weight.

molare Suszeptibilitaet: *molar susceptibility.* The mass susceptibility of a pure substance multiplied by its mole-

cular weight; or the mass expressed in terms of mols instead of grams.

Molarvolumen: *molar volume.* The specific volume of a substance in cm^3 per mol; esp. in the liquid state at the boiling point (Nernst). Equal to the molecular mass divided by the density.

molare Waerme: *molar heat.* The product of the molecular mass of a substance by its specific heat, or the thermal capacity of 1 mol of the substance.

Molekuelfeld: *molecular field.* The electric field within a material body due to the presence of polar molecules.

Molekuelgitter: *molecular lattice.* A crystal lattice which may be regarded as built out of molecules as the units of structure.

Molekuelkristall: *molecular crystal.* See Molekuelgitter.

Molekuelmoment: *molecular moment.* The electric moment of a polar molecule.

Molekuelspektrum: *molecular spectrum.* A band spectrum composed of radiation frequencies due to energy changes within molecules. There are three types: vibration frequencies caused by changes in the vibration energy of the atoms; rotation frequencies, corresponding to changes in the rotation energy of the molecule; and electron frequencies, due to electronic transitions. Bands may also arise from combinations of these types.

Molekuelstrahl: *molecular ray, m. beam.* A stream of molecules moving in nearly parallel directions, after emergence into a vacuum from a low-pressure reservoir through a succession of narrow apertures.

Molekularmanometer: *molecular gauge.* A pressure gauge for the measurement of very low gas pressures by means of the viscous friction exerted on a moving body, as a rotating disk.

Molekularpumpe: *molecular pump.* An air pump in which the molecules of the gas to be exhausted are carried away by the friction of a rapidly revolving disk or cylinder.

Molekularstrahl: *molecular ray, m. beam.* See Molekuelstrahl.

Moment: *moment.* (1) Moment of a force with respect to any axis: the product of the perpendicular distance r from the axis to the line of action of the force by that component of the force which is perpendicular to the axis and to the radius r. Syn. torque. (2) Moment of a mass or a volume with respect to any plane (or axis): the volume integral of the products of the elements of mass or of volume by their distances from the plane (or axis). (3) Moment of an area with respect to an axis (or a point) in its plane: the surface integral of the products of the elements of area by their distances from the axis (or point).

Momentanachse: *instantaneous axis, axis of instantaneous rotation.* See augenblickliche Achse.

Monochord: *monochord, sonometer.* An acoustic instrument consisting of one or more strings stretched on a resonating box; used for making measurements of musical pitch and for other acoustic experiments. Syn. monochord, esp. if only one string.

monochromatisch: *monochromatic.* In re any radiation, esp. light: composed of wave trains of a limited range of frequency.

Monochromator: *monochromatic illuminator, monochromator.* An instrument for producing and isolating a beam of monochromatic radiation.

monodispers: *monodisperse.* A term used to characterize disperse systems whose particles are of sensibly uniform size.

monoklin: *monoclinic.* In re crystal structure: having two of the three axes perpendicular to the third, but oblique to each other.

monomolekulare Schicht: *monomolecular layer, monolayer.* An adsorbed film or layer having a thickness of one molecule of the substance composing it.

Morera Lehrsatz: *morera theorem.* Stated thus: "Any two systems, S_1, S_2, S_3 of forces acting on a system of particles with bonds independent of the time determine, starting from rest, displacements generable in the same infinitesimal interval of time, these displacements being such that the work computed as done by the forces S_1 through the displacements corresponding to the forces S_2 is equal to the work computed as done by the forces S_2 through the displacements corresponding to the forces S_1."

Morse-Allis-Lamar'sche Verteilungsfunktion: *Morse-Allis-Lamar distribution function.* A function representing the statistical distribution of the speeds of electrons in a gas.

Mosaikstruktur: *mosaic structure.* The subdivision of a crystal into polyhedral blocks of microscopic dimensions, with discontinuities in the lattice structure between them; apparently associated with the secondary structure.

Moseley-Gesetz: *Moseley law.* States that all the heavier chemical elements may be arranged in a series, such that the square root of the frequency of a given line in the X-ray spectrum increases by a constant amount in passing from one element of the next. This sequence of elements is now recognized as that of their atomic (Moseley) numbers.

Moseley'sche Kurve: *Moseley curve, M. diagram.* A curve which graphically exhibits the relationship between the atomic numbers of a sequence of elements and the wave lengths of their corresponding spectral lines.

Moseley Zahl: *Moseley number.* See Atomzahl.

Motorgenerator: *motor generator.* A generator operated by a motor esp. a d.-c. generator on the same shaft with an a.-c. motor, and used for obtaining d.-c. service from a.-c. mains. Syn. motor transformer, rotary converter.

Mott'scher effekt: *Mott effect.* The partial polariaztion of a beam of electrons, i.e., orientation of their spin axes in one direction, due to scattering by the atoms of a target.

Mue: *mu.* A vernacular term used to designate: (1) The micron. (2) The amplification factor of a triode, esp. in such phrases as "high-mu tube", etc.; so called because of the common use of the symbol μ to represent this factor.

Mueller'sche Bruecke: *Mueller bridge.* A five- or six-decade Wheatstone bridge for precise resistance thermometry, characterized by ratio arms of relatively high resistance, adjustable to equality, and a third arm variable in steps of 0.0001 ohm, with dial switches for the five lower decades.

Mutarotation: *mutarotation.* A change of optical rotatory power or a reversal of its direction, e.g., in a solution passing from levogyrate to dextrogyrate activity as it is diluted.

multipel: *multiple.* See mannigfaltig.

Multiplett: *multiplet.* A group of lines in an atomic spectrum, arising from transitions between the different components of two multiple spectral terms and hence exhibiting the characteristic frequency differences of these terms. The number may vary from 1 to 15 or 20.

Multivibrator: *multivibrator.* An electric oscillating system so designed that the energy is chiefly distributed among the harmonic partial frequencies rather than in the fundamental frequency. Devised by Abraham and Bloch.

Muttersubstanz: *parent.* (1) The first or primordial element of a radioactive series. (2) In re any radioactive product: that element from whose disintegration it is immediately derived. E.g., the parent of radon is radium, while that of the whole series is uranium. (3) A spectrum line which represents a normal quantum process, unaffected by such influences as are responsible for satellite lines, as in the Zeeman effect.

N Serie: *N series.* A series of frequencies in the X-ray spectrum of an element, considered as arising from the transition of electrons from various higher quantum states to the state whose principal quantum number is 4. First observed by Dolejsek.

Nachfliessen: *afterflow.* The persistence of plastic flow in a solid after the external forces primarily responsible for it have ceased to act.

Nachhall: *reverberation.* A succession of echoes, esp. of sound in a large room; the result of repeated reflections.

Nachhallzeit: *reverberation time.* The time required for the average acoustic energy density in a reverberating enclosure to fall off to one-millionth of its initial, steady-state value, after the source has been silenced. It depends upon the geometrical form and equivalent absorption of the enclosure and upon the frequency of the sound.

Nachleuchten: *afterglow.* (1) A luminosity which persists in a rarefied gas after the passage of an electrodeless discharge through it. (2) Syn. phosphorescence.

Nachlieferungskoeffizient: *production coefficient.* The rate at which primary radiation produces secondary radiations with respect to the thickness of medium traversed. If dI_2 is the intensity of secondaries produced in thickness dx by primary radiation of intensity I_1, the coefficient is

$$\beta = \frac{dI_2/dx}{I_1}.$$

nacktes Atom: *stripped atom.* See elektronenberaubtes Atom.

Nagaoka'sche Formel: *Nagaoka formula.* A formula for the inductance in microhenrys of any single layer of a cylindrical coil or solenoid:

$$L = K\frac{0.03948\, r^2N^2}{l};$$

in which r is the radius and l the length of the coil, in cm, N is the number of turns, and K a constant depending upon the ratio of r to l, tables of which have been published.

Nahpunkt: *near point.* That point on the axis of the eye which is at such distance as to be seen distinctly with the utmost possible degree of accommodation, i.e., when the focal power of the crystalline lens is greatest.

Nebelkammer: *cloud chamber.* See Expansionskammer.

Nebelspur: *cloud track.* A row or streak of droplets formed in a cloud chamber by the passage through it of an ionizing particle, whose path is thus revealed.

Nebenbogen: *secondary bow.* A faint rainbow which sometimes appears outside the brighter primary bow and has its colors in the reverse order.

Nebenschluss: *shunt.* A branch of an electric circuit in parallel with other parts of the same.

nebenschlussgewickelt: *shunt-wound.* In re a field magnet: having its winding in parallel with the external or line circuit.

Nebenschlusskondensator: *by-pass condenser.* A condenser used to provide an a.-c path of comparatively low impedance around a circuit element.

Nebensonne: *parhelion.* One of the bright, spectrally colored spots, commonly called "sun dogs," which appear at times in cold weather on either side of and above and below the sun, at a distance of about 22 degrees from it. They are due to the refraction of the sunlight by minute crystals of ice suspended in the air.

negatives Energieniveau: *negative energy level.* One of the negative values for the energy levels of an electron yielded by the Dirac equation, which has both positive and negative solutions. The positive values corresponding to observation, but the physical significance of the negative values is not evident.

negatives Energiespektrum: *negative energy spectrum.* A set of transitions involving negative energy levels.

negative Energiestufe: *negative energy level.* See negatives Energieniveau.

negatives Glimmlicht: *negative glow.* A luminous region in a Crookes tube at moderate pressure, lying between the Crookes dark space and the Faraday dark space.

negative Impedanz: *negative impedance.* A property possessed by certain electrical devices, such that when introduced into a circuit the current and the e.m.f. are in opposite directions. If there is no resultant inductance or capacitance effect, the property is termed negative resistance.

negativer Kristall: *negative crystal.* A uniaxial, birefringent crystal in which the extraordinary wave has the greater velocity, e.g., Iceland spar.

negativer Widerstand: *negative resistance.* See negative Impedanz.

Neigung: *inclination.* See inklination.

Neigungsnadel (magnetisch): *dip needle, dipping n, inclinometer.* A magnetic needle poised in a vertical plane, used to indicate the magnetic inclination.

nematischer Zustand: *nematic state.* A stage preliminary to the mesomorphic state, in which the molecules may be regarded as having a common orientation, but not otherwise arranged.

Neper: *neper.* A unit used, like the bel, to express the relationship between two amounts of power (acoustic, electric, etc.) as an interval on a logarithmic scale. The number of nepers in such an interval is the Napierian logarithm of the square root of the ratio of the two powers compared; therefore 1 neper is the value of that interval for which the ratio is $e^2 = 7.389$. The neper is equal to 0.8686 bel or 8.686 decibels.

Nephelometer: *nephelometer.* A type of photometer used for the measurement of light transmitted or of light scattered by translucent substances, or of the turbidity of liquids, and for determining therefrom the quantity of suspended matter present.

Nernst'sche Bruecke: *Nernst bridge.* A four-arm bridge containing condensers instead of resistances, and used for the measurement of capacitances at high frequencies.

Nernst'scher Effekt: *Nernst effect.* A p.d. which develops between the two edges of a strip of metal, in which heat is flowing longitudinally, when the plane of the strip is placed perpendicularly across a magnetic field. Discovered by Ettingshausen and Nernst in 1886.

Nernst Lampe: *Nernst lamp.* An electric lamp whose luminosity proceeds from a short, slender rod of zirconium oxide (Nernst glower) heated to brilliant white incandescence by the current.

Nernst'scher Waermelehrsatz: *Nernst heat theorem.* States that in the neighborhood of absolute zero, all physical and chemical processes are isentropic.

Neumann'sches Dreieck: *Neumann triangle.* The triangle which graphically represents the equilibrium of the three surface tensions at a point where two immiscible liquids come in contact in the air, as when a drop of one liquid rests on the surface of the other.

neutrale Achse: *neutral axis.* The line of intersection of any cross section of a rod or beam with the neutral layer.

neutrale Kurve: *neutral curve.* A graph between pressure and temperature, at all points of which the specific volumes of the solid and the liquid phases are equal. For points on one side of the curve the solid specific volume exceeds that of the liquid, while the reverse is true for points on the other side.

neutrale Schicht: *neutral layer.* That longitudinal layer of material in a rod or beam, perpendicular to the plane of flexure, which is neither lengthened nor shortened when the rod is bent.

Neutrino: *neutrino.* A type of neutron having electronic mass or smaller. The existence of such a particle was suggested by Bragg. The name neutret was proposed by Langer.

Neutrodyn: *neutrodyne.* An amplifier circuit containing a capacitance for neutralizing the tendency to regenerate due to the internal capacitance between plate and grid of the amplifier tube.

Neutron: *neutron.* An apparently stable particle, having a mass at least approximately equal to that of the proton, but electrically neutral. Its existence was first demonstrated by Chadwick in 1932.

Newton'sches Abkuehlungsgesetz: *Newton law of cooling.* States that the rate of cooling of a heated body by radiation and convection varies directly as the excess of its temperature above that of its surroundings. It is approximately applicable only to small ranges of temperature.

Newton'sche Gesetze der Dynamik: *Newton laws of dynamics.* Three dynamic principles which underlie the structure of the Newtonian mechanics. They may be stated as follows: (1) Every body remains in its state of rest or of uniform motion in a straight line, except as it may be caused to alter that state by the application of external forces. (2) Any change of momentum takes place in the direction of the force producing it, and at a rate proportional to the magnitude of the force. (3) To every force there is opposed an equal, reactive force in the same straight line.

Newton'sche Kraft: *Newtonian force.* One of several types of mutual interaction which obey the inverse-square law, e.g., gravitation, electric force, magnetic force, etc.

Newton'sche Mechanik: *Newtonian mechanics.* The classical mechanics based upon the Newton laws of dynamics, as distinct from quantum mechanics, wave mechanics, or relativity.

Newton'sche Potentialfunktion: *Newtonian potential*

function. An expression common to all potentials associated with inversesquare forces, viz.,

$$V = \int \frac{dm}{r},$$

in which m is mass (or electric charge, or magnetic pole strength) and r is distance from the element dm. The gravitational, the electric, and the magnetic potentials each contain a factor of this form.

Newton'sches Potential: *Newtonian potential.* See Gravitationspotential.

Newton'sche Ringe: *Newton rings.* The circular interference bands formed by light reflected from the glass-air interfaces between a convex glass surface and a plane glass surface in contact with it. The center of the ring system is the point of contact.

Newton'sche Theorien von der Kreisbewegung: *Newton theorem of orbital motion.* States that the velocity of a body moving in a central orbit is inversely proportional to the normal from the center of attraction to the tangent to the orbit at the point occupied by the body.

Nichols'sches Prisma: *Nicol prism, Nicol, nicol.* A well known device for producing planepolarized from unpolarized light, by means of two prismatic segments of Iceland spar cemented by a thin layer of Canada balsam interposed at such an angle that the ordinary component of the original light is entirely eliminated by total reflection at the cementing layer, while the extraordinary component passes through.

Nichols'scher Radiometer: *Nichols radiometer.* An instrument devised by Nichols to demonstrate the pressure of light, and used to measure the intensity of radiation in the visible and infrared.

Nichols'scher Strahlenmesser: *Nichols radiometer.* See Nichols'scher Radiometer.

Nichtvariant: *nonvariant.* Having no degrees of freedom, i.e., zero variance.

Niederschlag: *strike.* An initial electrochemical deposit; or sometimes the electrolyte from which such deposit is made.

Niederschlagspotential: *striking potential, deposition potential, sedimentation potential.* The minimum p.d. between an electrode and the surrounding electrolyte required to deposit ions of a given kind. See also Dorn-Effekt.

Normalelektrode: *normal electrode.* A metal electrode immersed in a normal solution of an electrolyte having that metal as one of its ions.

normaler Dampf: *normal vapor.* A vapor whose molecules are all of one kind, and not polymerized.

normale Fluessigkeit: *normal liquid.* A liquid whose molecules are all of one kind, and not polymerized.

normales Gas: *normal gas.* A gas whose molecules are all of one kind, and not polymerized.

Normalgleichung: *normal equation.* One of a set of simultaneous equations involving a set of experimental unknowns, which occurs in the course of the least-square adjustment of a larger number of observation equations.

normale magnetische Induktion: *normal (magnetic) induction.* See magnetische Flussdichte.

normaler Kathodenfall: *normal cathode potential drop.* The constant value of the p.d. between the cathode and the negative glow in a discharge tube in which the cathode is not entirely covered by the cathode glow.

normale Stromdichte: *normal current density.* The constant value of the current density over that part of the cathode in a discharge tube which is covered with the cathode glow, when this does not entirely cover the cathode.

Normalisierung: *normalization.* The operation of multiplying a given characteristic wave function (eigenfunction) Ψ_m by a constant, called a normalization constant, in order that when so modified, the wave function will fulfil the condition that the volume integral

$$\int |\Psi_m|^2 \, dv = 1$$

Normalloesung: *normal solution.* A solution in which the solute has a concentration of 1 equivalent weight per liter of solution.

Normaltemperatur und Normaldruck: *normal temperature and pressure (N.T.P.).* The temperature 0 degrees C and pressure 1 atm. Syn. standard conditions.

Normalterm: *normal term.* A spectral term in which the fine-structure level having the smallest inner quantum number lies farthest down on the energy-level diagram.

Nuance: *tint.* A chromatic color of relatively low saturation and relatively high brilliance.

Nullinie: *zero line.* A wave length in an absorption band in certain types of molecular spectrum, which cor-

responds to a gap in the sequence of absorption lines, and which marks an origin or axis for the band as a whole. Syn. missing line.

Nullmethode: *null method, balance method, zero method.* A method of measurement in which the quantity to be measured is by adjustment so related to the known quantity with which it is compared that the scale reading of the indicating instrument becomes zero; as in the use of a balance or of a Wheatstone bridge.

Nullpunktenergie: *zero-point energy.* The energy possessed by a thermodynamic system in any prescribed condition taken as a zero of reference; in particular, at the absolute zero of temperature.

Nullzweig: *zero branch.* A series of lines in an absorption band of a molceular spectrum, in the production of any one of which there is no change in the rotational quantum number.

numerische Apertur: *numerical aperture.* In re an objective, esp. of a microscope: (1) The product of the refractive index of the medium in front of the objective by the sine of half the angle of the cone of rays which enters the objective and which thus defines the field of view. (2) The ratio of the diameter of the aperture of the objective to the focal length.

numerische Dichte: *numerical density.* The number of particles or points per unit of space (area or volume) in any region.

O Serie: *O series.* A series of frequencies believed to exist in the X-ray spectrum of an element and to arise from the transition of electrons from various higher quantum states to the state whose principal quantum number is 5.

oberer Zustand: *upper state.* That one of the two energy states or levels, before and after a quantum transition, in which the atom or the molecule has greater electronic energy.

Oberflaechenaufladungswaerme: *surface heat of charging.* Heat theoretically developed when an electric charge is imparted to a metallic surface.

Oberflaechenauftrieb: *surface of buoyancy.* The surface described by the center of displacement as a floating body is tipped through various angles and in various directions without altering the volume of displacement. Any vertical section of this surface through the metacenter is a curve of buoyancy.

Oberflaechendichte: *surface density.* The quantity per unit area of anything distributed over a surface, e.g. of an electric charge.

Oberflaechenenergie: *surface energy.* Energy which depends upon the surface area and configuration of a body, e.g., a bubble or a drop of liquid, and which varies when either is varied isothermally.

Oberflaechengitter: *surface lattice.* A structural pattern manifested at a natural cleavage surface of a crystal, and recognized by effects analogous to those of a plane grating.

Oberflaechenintegral des normalen Feldes: *surface integral of normal field.* The surface integral of the normal component of the field intensity over any given surface, i.e., the sum of the products obtained by multiplying each element of the surface by the component of intensity perpendicular to the surface at the point occupied by the element.

Oberflaechenphotoelektrischer Effekt: *surface photoelectric effect, photoelectric emission.* Pertaining to the electric effects of light or other radiation; esp. to the phenomenon (photoelectric emission), manifested by certain metals, of giving off electrons (photoelectrons) when subjected to suitable radiation. The movement of these electrons in an electric field imposed for the purpose is a photoelectric current.

Oberflaechenspannung: *surface tension.* The peculiar effect of cohesion manifested at the free surface of a liquid, or at the interface of two immiscible liquids, and giving the impression of a tense, elastic skin or membrane. It is measured in units of force per unit length, e.g., dynes per centimeter, across any line on the surface.

Oberflaechenwiderstand: *surface resistivity.* The electric resistance of the surface of an insulator, measured between the opposite edges of a centimeter square of the surface.

Objektiv: *objective.* That lens, lens combination, or mirror which, in an optical instrument, first receives the light coming from the object and gives the rays their first change of focus, as in the formation of a real image by the objective of a telescope. Syn. object glass.

Objektivprisma: *objective prism.* A large prism placed before the objective of a telescope in order to produce spectral images of stars on a photographic plate in its focal plane.

Objektpunkt: *object point.* See Gegenstandspunkt.

Oeffnungswinkel: *aperture angle.* See Aperturwinkel.

Oelrefraktometer: *oleorefractometer.* An instrument for comparing the refractive indices of liquids, such as oils, with that of a standard liquid. Devised by Amagat and Jean.

Oersted: *oersted.* (1) Substituted by international agreement in 1932 for the term gauss to designate the practical, c.g.s., electromagnetic unit of magnetic intensity. A unit magnetic pole, placed in a vacuum in which the magnetic intensity is 1 oersted, is acted upon by a force of 1 dyne in the direction of the intensity vector. (2) Prior to 1932, the practical c.g.s. electromagnetic unit of magnetic reluctance.

Oersted'scher Versuch: *Oersted experiment.* A classic experiment with a wire and a compass needle, which revealed the presence of a magnetic field surrounding an electric current.

Ohm: *ohm.* The practical unit of electrical resistance. The absolute ohm is that resistance in which an e.m.f. of 1 absolute volt will maintain a constant current of 1 absolute ampere. The international ohm is the resistance of a column of mercury of uniform cross section, having a mass of 14.4521 g and 106.3 cm in length, at 0 degrees C. (The cross section is 1 mm^2.) The ratio of the international to the absolute ohm is about 1.00046.

Ohm'sches akustisches Gesetz: *Ohm acoustic law.* States that all musical tones are either simple harmonic or capable of analysis into simple harmonics; and that

the ear is able to distinguish the several components as distinct, pure tones.

Ohm'sches Gesetz: *Ohm law (of electric currents).* A law which connects the e.m.f., the resistance (or conductance), and the current in a conductor or a circuit, and which takes different forms according to the circumstances in which it is applied. The usual, elementary statement is: the steady current in a circuit is equal to the e.m.f. divided by the resistance of the circuit. It does not apply to all circuits.

Ohmmeter: *ohmmeter.* An instrument for measuring resistance directly in ohms.

Ohm'scher Widerstand: *Ohmic resistance.* The term is used to distinguish the true resistance from the types of impedance which do not contribute to the heating of the circuit. Syn. resistance.

Ohmzentimeter: *ohm-centimeter.* A unit of electric resistivity, viz., the resistivity of a substance of which a uniform rod of 1 cm^2 cross section has a resistance of 1 ohm per cm length.

okkludieren: *occlude.* To absorb, as some metals take up certain gases and apparently incorporate them into the metallic structure.

Oktave: *octave.* (1) A musical interval of numerical value 2; i.e., a range of pitches, the highest of which has double the frequency of the lowest. (2) Hence, a ratio of 2:1 between frequencies of any type of vibration or wave emission.

Oktett: *octet.* A group of eight electrons collectively related in a special manner to the outer structure of an atom.

Oktupol: *octupole.* A system consisting of two equal quadrupoles in parallel planes, but with their corresponding charges reversed.

Okular: *ocular, eyepiece.* That part of an optical instrument, as a telescope or a microscope, to which the eye is applied.

Okularmikrometer: *eyepiece micrometer, ocular micrometer.* (1) A micrometer mounted in an eyepiece or ocular. (2) A microscopic scale mounted in the focal plane of a microscope or telescope ocular. (3) A finely divided scale ruled or photographed on a slip of transparent glass and placed in the focal plane of the eyepiece of a microscope, for the purpose of measuring the dimensions of objects viewed with the instrument.

Omegawert: *omega value.* The value of the quantum number which refers to the combined spin and orbital angular momentum of a molecule, expressed as a multiple of $h/2\pi$.

Opazimeter: *opacimeter, turbidimeter.* An instrument for measuring the turbidity of a liquid, as in water-purification plants.

Opposition: *opposition.* A phase difference of one-half cycle.

Optik: *optics.* That branch of physical science which treats of the phenomena of light and of vision. Physical optics deals with the theories of the mechanism of light and its propagation. Geometrical optics regards light simply as an emission traveling in straight lines and traces its course in "rays" through reflecting and refracting systems. Physiological optics deals with the eye and vision.

optische Achse: *optic axis.* A direction through a doubly refracting crystal in which light traversing the crystal suffers no double refraction. Syn. axial direction.

optische Analyse: *optical analysis.* The investigation of problems concerning stresses in materials by photoelastic methods.

optische Bahn: *optical path.* The path followed by luminous energy through an optical system. Optical paths are equivalent if they require the same time when traversed by light of the same frequency.

optische Bank: *optical bench.* A horizontal track with a graduated scale upon which lenses or other optical pieces may be mounted for experiments in image formation, interference, etc.

optische Ebene: *optically plane, o. flat.* Departing from a true plane only by distances small compared with the wave lengths of light.

optische Konstanten: *optical constants.* A set of quantities used to specify the optical properties of a substance; such as the refractive index, the reflectivity, and the absorption coefficient.

optische Laenge: *optical length.* The vacuum equivalent of an optical path. For any one medium, it is equal to the geometrical length of the path multiplied by the refractive index of the medium.

optischer Mittelpunkt: *optical center.* A point so located on the axis of a lens that any ray, which in its passage through the lens traverses a line passing through this point, has its incident and emergent parts parallel.

optischer Pyrometer: *optical pyrometer.* A pyrometer in which the temperature of a body is indicated by the total brightness of its incandescence, or by the ratio of the brightness at two different wave lengths.

optische Rotation: *optical rotation.* The effect which some transparent media, such as sugar solutions and quartz (parallel to its axis), exhibit in rotating the polarization cycle, whether linear or elliptical, of light traversing them, by a definite amount for each unit of thickness. Syn. rotatory polarization.

optischer Zeiger: *optical lever.* A laboratory device for measuring angles of deflection by means of a long beam of light reflected from a small mirror. Syn. mirror and scale.

Optometrie: *optometry.* A branch of optics dealing with the optical performance of the individual eye and with measurements upon it.

ordentlich: *ordinary.* Pertaining to that plane-polarized component of a ray of light which, in traversing a unaxial crystal, has its electric vector at right angles to the principal plane. It obeys the Snell law of refraction.

Ordnung: *order.* The integral number of wave lengths or cycles in the phase difference between two mutually amplifying wave trains, as in the production of interference bands or diffraction spectra. Successive bands or grating spectra are of the first, second, ..., nth **order.**

Ordnungszahl: *ordinal number.* (1) The number of a line in a rotation-vibration spectral band, counting either way from the zero line. In the R branch the numbers are +, in the P branch they are—. (2) An integer denoting the position of a term in a spectral series, the value for the lowest term being fixed by arbitrary convention. Syn. atomic number.

Orientierung: *orientation.* The assignment or imposition of a definite direction in space.

orthobar: *orthobaric.* A term used to characterize the densities or specific volumes of the phases which are in thermodynamic equilibrium in any closed system; most commonly applied to the coexistent liquid and vapor phases of a one-component system.

orthochromatisch: *orthochromatic.* A term which, in reference to photographic materials, implies equal sensitivity to all colors; a condition which is by no means fulfilled in fact. The term really indicates that the material is sensitive to green as well as to shorter wave lengths. See also isochromatisch.

orthorhombisch: *orthorhombic.* In re crystal structure: having three mutually rectangular axes, no two of which are equal.

orthoskopisch: *orthoscopic.* Free from optical distortion.

orthotom: *orthotomic.* In re a system of light rays: so disposed that they may all be cut at right angles by a suitably chosen surface.

Osborne-Reynolds'sche Stroemung: *Osborne-Reynolds streaming.* The movement of a gas from cold to hot along a surface having a temperature gradient of suitable magnitude. It is prominent in thermal transpiration, and also appears to be responsible for at least a part of the radiometric forces in gases at intermediate pressure.

Osmometer: *osmometer.* An apparatus for measuring the rate of osmosis.

Osmose: *osmosis.* The undirectional diffusion of fluids through membranes or porous partitions, which results in osmotic pressure. The phenomenon is termed endosmosis when the diffusion is inward, toward the interior of the osmotic cell; exosmosis, when it is outward.

osmotischer Druck: *osmotic pressure.* See Osmose.

Oszillograph: *oscillograph.* An instrument which renders visible, or automatically traces, a curve representing the time variations of electric phenomena. The recorded trace is an oscillogram. Developed largely by Duddell and Braun.

Oszilloskop: *oscilloscope.* An instrument similar to an oscillograph, and with which oscillatory phenomena are observed visually.

Otto'scher Kreislauf or Otto Zyklus: *Otto cycle, Beau de Rochas cycle.* The thermodynamic cycle of the ordinary, four-stroke, internal combustion engine; commonly called the Otto cycle.

Ovalzirkel: *trammel.* See Ellipsenzirkel.

p-Elektron: *p-electron.* An orbital electron whose azimuthal quantum number is 1.

P Serie: *P series.* A series of frequencies believed to exist in the X-ray spectrum of an element and to arise from the transition of electrons from various higher quantum states to the state whose principal quantum number is 6. Not to be confused with p-series, sometimes used as an abbreviation for principal series.

P-Zustand: *P-state, P-level.* The state of an atom in which the azimuthal quantum number is unity.

P Zweig: *P branch.* A set of molecular spectrum lines corresponding to unit increases in rotational quantum number.

Paar: *couple.* (1) (Dyn.) A system composed of, or equivalent to, two equal, antiparallel forces. (2) (Elec.) A pair of metals placed in contact, as a voltaic couple or a thermocouple.

Pachimeter: *pachimeter.* An instrument for measuring the elastic shear limit of a solid material.

Packungsanteil: *packing fraction.* The ratio of the amount, by which the atomic weight of an isotope differs from the nearest integral value, to that atomic weight; expressed in ten-thousandths of a unit. E.g., for berylium, of atomic weight 9.02, the packing fraction is

$$0.02/9.02 = 22.17 \times 10^{-4}.$$

Packungseffekt: *packing effect.* The existence of a mass defect in the nucleus of an atom, attributed by some to an emission of energy upon the building together of the component parts of the nucleus.

panchromatisch: *panchromatic.* A term applied to photographic materials which are sensitive to all wave lengths within the visible spectrum (though not uniformly so; different panchromatic materials vary considerably in the wave-length distribution of their sensitivity).

parabolische Geschwindigkeit: *parabolic velocity, p. speed.* The speed with which a particle at any point in the field of a gravitational attracting center must be endowed in order that its orbit shall be a parabola. If the point is at the surface of the gravitating mass (as a planet), this speed is the same as the velocity of escape. Syn. critical speed.

Parachor: *parachor.* A term due to Sugden, pertaining to a liquid and its saturated vapor, and denoting the (constant) value of the expression

$$\frac{m\tau^{1/4}}{\rho - \delta}$$

m is the molecular weight, τ the surface tension, and ρ and δ the densities of liquid and vapor, respectively.

parakristalliner Zustand: *paracrystalline state.* An incipient crystallization, i.e., the arrangement or arraying of the molecules of a substance as it approaches the crystallization point.

Parallaxe: *parallax.* The change in the apparent position of an object, or in its direction from the observer, due to a movement of the observer.

parallel: *parallel.* See mannigfaltig.

paramagnetisch: *paramagnetic.* Having a magnetic permeability greater than unity, and susceptibility therefore positive; yet not ferromagnetic.

Parameter: *parameter.* (1) One of the constants entering into a functional equation and corresponding to some characteristic property, dimension, or degree of freedom. (2) The ratio of the displacement of an atom from its normal position within a crystal to the lattice constant in the direction of displacement. (3) The distance from the origin of the axes of a crystal to the intersection of any axis with a face, or a face produced, in terms of the arbitrary unit selected for measurement along that axis.

parametrische Ebene: *parametral plane.* A crystal plane whose parameters are all unity and whose Miller indices are therefore (111).

Parasit: *parasite.* A current in a circuit, due to some unintentional cause, such as inequalities of temperature or of composition; particularly troublesome in electrical measurements.

paraxial: *paraxial.* In re light rays traversing an optical system: close to and making only small angles with the axis.

Pascal'sches Gesetz: *Pascal law.* States that such part of the pressure in a fluid as is due to externally applied forces (not to gravity, inertia, electrical potential, etc.) has the same value throughout the body of fluid when the latter is in equilibrium.

Paschen-Back'scher Effekt: *Paschen-Back effect.* A magnetooptical phenomenon, related to the Zeeman effect, but produced only in the most intense magnetic fields. Discovered by Paschen and Back in 1921.

Paschen'sches Gesetz: *Paschen law.* States that the sparking potential between two given terminals in a given gas is a function of the product of the pressure by the spark length. It follows that for a given p.d., the spark length is inversely proportional to the pressure.

Paschen Serien: *Paschen series.* A series of infrared spectral lines of the hydrogen spectrum, whose frequencies are multiples of

$$\frac{1}{3^2} - \frac{1}{n^2}$$

in which n = 4, 5, 6, ...

passive Widerstand: *passive resistance.* A condition within a system in unstable equilibrium which keeps it from releasing energy and becoming stable until slightly disturbed, e.g., a cocked gun or a supercooled liquid.

Pauli'sches Prinzip: *Pauli principle.* States that no two electrons in the same atomic or molecular system can have all their quantum numbers identical; discovered by **Pauli.**

Peltier'scher Effetk: *Peltier effect.* The heating or cooling effect produced at the junction between two metals by a current sent across the junction (exclusive of the Joule heat due to resistance); depending upon the direction of flow. Discovered by Peltier in 1834. Heat so evolved or absorbed is called the Peltier heat.

Peltier'sche elektromotorische Kraft: *Peltier electromotive force.* That component of the e.m.f. of a thermocouple which corresponds to the local Peltier heats at the junctions between the different metals, and is added to the Thomson e.m.f. to make up the total (Seebeck) thermoelectromotive force.

Peltier'scher Koeffizient: *Peltier coefficient.* The quantity of heat (Peltier heat) developed or absorbed per second per ampere of current at a given thermojunction in the Peltier effect.

Peltier'sche Waerme: *Peltier heat.* See Peltier effect.

Pentankerzenstaerke: *pentane candle.* A unit of intensity of a light source, equal to one-tenth of the intensity of the standard pentane lamp. Its value is approximately equal to the international standard candle.

Penthode: *pentode.* A type of vacuum tube having five elements, viz., the filament, the plate, and three grids.

Periode: *period.* The time interval during which a vibrating body completes one vibration. In this time the body in the reference circle makes one revolution.

periodisches Gesetz: *periodic law.* The principle that certain properties of the elements recur in regular cycles when the elements are arranged in the order of their atomic weights (as discovered by Mendelejeff), or, more accurately, when arranged in the order of their atomic numbers (as pointed out by Moseley). An arrangement of the elements to exhibit this principle is called the periodic table or the periodic system.

Periodizitaetsmodul: *modulus of periodicity.* The change which takes place in the action during one complete cycle of a periodic process.

Periodogramm: *periodogram.* A curve or graph representing a periodic variation, such as the wave form of a complex musical sound.

Periodometer: *periodometer.* See harmonischer Analysator.

peripheres Elektron: *peripheral electron.* One of the outer electrons of an atom, to whose activity the spectral lines of visible light and thermal radiation are attributed, and which are supposed to be responsible for chemical combination. Syn. valence electron.

Permalloy: *permalloy.* One of a series of alloys of nickel, iron, and sometimes small quantities of other metals, as chromium or molybdenum, having abnormally high magnetic permeability. A typical permalloy is composed of 78.5 percent Ni and 21.5 percent Fe.

permanente Achse: *permanent axis.* An axis about which a free rigid body, when once set rotating, will continue to rotate in stable equilibrium. It is in general the principle axis of greatest moment of inertia through the c.m.

permanentes Gas: *permanent gas.* A gas, such as hydrogen or nitrogen, whose critical temperature is far below normal atmospheric temperatures, and which therefore retains its gaseous state at all pressures.

permanente Veraenderung: *permanent set.* A deformation which persists after release from stress.

Permanenzprinzip: *permanence principle.* Either of two "sum rules" relating, respectively, to the sums of the Landé factors and interval factors of the components in the Zeemann effect; which state that the sum of the values of the factor in question for all the J values, other quantum numbers remaining constant, is independent of the magnetic intensity. Syn. sum rule.

Permeabilitaet: *permeability.* (1) (Magnetic.) The ratio of the magnetic induction to the magnetic intensity in the same region. In paramagnetic matter the permeability is nearly independent of the magnetic intensity; in a vacuum it is strictly so. But in ferromagnetic matter the relationship is definite only under fully specified conditions. (2) (Porous.) The volume of a

fluid of unit viscosity which, in unit time, passes through unit cross section of a porous medium under unit pressure gradient.

Permeabilitaetsmesser: *permeameter.* An instrument for measuring the average magnetic permeability of a ferromagnetic sample.

Permeameter: *permeameter.* See Permeabilitaetsmesser.

Permeanz: *permeance.* The reciprocal of the magnetic reluctance.

Perminvar: *perminvar.* One of a series of alloys of iron, nickel, and cobalt, whose magnetic permeability is constant at different magnetic intensities, i.e., for which the induction is proportional to the magnetizing field.

Permitivitaet: *permittivity.* See elektrische Konstante.

Petzval'sche Bedingung: *Petzval condition.* A criterion stated by Petzval for the flatness of an image formed by a refracting optical system of S surfaces. If the radius of curvature of the sth refracting surface through which the light passes is r_s and its refractive index is n_s, the condition is expressed by the summation

$$\sum_{s=1}^{s=S} \frac{1}{r_s} \left[\frac{1}{n_s} - \frac{1}{n_{s-1}} \right] = 0.$$

Pferdestaerke: *force de cheval (Fr.), metric horsepower.* (1) A metric gravitational unit of power, equal to 75 m-kg of work per second, and equivalent to about 736 watts or 0.9863 hp. (2) An English gravitational unit of power based originally upon Watt's experiments with horses, and now standardized ft-lb per second. Equivalent to about 746 watts.

Pfund Serie: *Pfund series.* A series believed to exist in the far infrared spectrum of hydrogen, in which the frequencies are characterized by the factor

$$\frac{1}{5^2} - \frac{1}{n^2}, \quad n = 6, 7, 8, \ldots$$

Phase: *phase.* (1) A quantity which denotes the stage of progress of any cyclic operation, as a vibration; often expressed as an angle, by analogy with rotation. Thus if the cycle is one-third completed, the phase is $2\pi/3$ or 120 degrees, etc. (2) One of two or more dissimilar components of a body of matter, segregated from each other by interfaces dependent on their dissimilarity; e.g., two immiscible liquids in contact, or the solid, liquid, and vapor phases of one substance in three-phase equilibrium.

Phasendiagramm: *phase diagram, equilibrium curve.* A graph representing the relation between values of two variables of state, as temperature and pressure, for which there is equilibrium between two states or phases. E.g., the fusion curve follows the equilibrium between solid and liquid states; the vaporization or saturation c., that between liquid and satured vapor states; and the sublimation c., that between solid and vapor states.

Phasendichte: *density-in-phase.* The number of points, each of which corresponds to one of the particles of a system, per unit volume of the phase space used to represent the state of the system.

Phasengeschwindigkeit: *phase velocity.* A vector whose direction is normal to the wave front and whose magnitude is the speed of propagation of a plane-wave disturbance. Syn. wave velocity.

Phasengleichgewicht: *phase equilibrium.* An equilibrium between two or more interconvertible phases of a substance, as between ice, water, and water vapor, or between a solute and its satured solution.

Phasenkonstante: *phase constant.* In re a harmonic, cyclic process: the constant term in that linear function of the time which appears as the argument of the sine or cosine factor in the expression for the cyclic variable. E.g., for an a.c.

$$I = I_0 \cos (2\pi nt + \Delta)$$

Δ is the phase constant.

Phasenmesser: *phase meter.* An apparatus for measuring phase differences between a.c.'s or electric oscillations.

Phasenraum: *phase space.* An ideal, multidimensional space in which the coordinates represent the variables required to specify the state of a substance or of a system. Syn. extension-in-phase.

Phasenregel: *phase rule.* A law of equilibrium between phases of a chemically homogeneous mixture (as a solution) or of a pure substance; stated as follows: the number of degrees of freedom, or the variance, of the system is equal to the number of components in the mixture, minus the number of phases involved, plus 2. E.g., if the substance is pure and we include all three possible phases, there is no degree of freedom, three-phase equilibrium existing only at the triple point; but if we consider only the liquid and the vapor states, a pure substance has one degree of freedom, i.e., along the vaporization curve. First stated in general form by J. W. Gibbs.

Phasenumkehrung: *phase reversal.* A change of phase

equal to one-half cycle, such as may be experienced by light waves upon reflection under certain conditions.

Phasenwelle: *phase wave-de Broglie wave.* A wave or wave group assumed in wave mechanics to be associated with an elementary particle (electron, proton).

Phasenwinkel: *phase angle.* The phase difference between the impressed e.m.f. and the current in an a.-c. circuit, expressed as an angle.

Phonautograph: *phonautograph.* An early device for recording the wave form of sounds; designed by Koenig and Scott.

Phonetik: *phonetics.* See Lautlehre.

phonetisches Rad: *phonic wheel.* A type of synchonous motor geared to a revolution counter, which can be used to measure the frequency of the alternating or interrupted current driving it. The modern synchronous electric clock operates on a similar principle. Devised by La Cour.

Phonometer: *phonometer.* An instrument for the measurement of the intensity of sounds.

Phosphor: *phosphor.* Any substance which is phosphorescent; esp. a synthetic material.

Phosphoreszenz: *phosphorescence.* A form of luminescence in which the emission of light continues for a time after the exciting stimulus has ceased.

Phosphorogen: *phosphorogen.* A substance which promotes phosphorescence in another, as manganese does in zinc sulphide.

Phosphoroskop: *phosphoroscope.* An apparatus for observing and measuring the decay of phosphorescence.

Phot: *phot.* A unit of illumination, equal to 1 lumen per cm^2, or 10,000 luxes.

Photoaktivitaet: *photoactivity, photoconductivity.* Electrical conductivity due to photo-ionization, e.g., in gases or in many nonmetallic crystals. Syn. photoactivity, photosensitivity.

Photoanisotropie: *photo-anisotropy.* The property of having different optical constants in different directions, possessed by many crystals, and by other substances under special anisotropic conditions.

photochemisch: *photochemical.* Pertaining to the chemical activity of molecules, ions, and atoms brought about by the absorption of radiant energy.

photochemisches Aequivalent: *photochemical equivalence.* The principle, enunciated by Einstein, that in photochemical action each effective light quantum is transformed entire into chemical energy.

Photodichtemesser: *photodensitometer, Syn. densitometer.* A form of photometer used especially for measuring the density of silver deposits on photographic plates or films.

Photodissoziation: *photodissociation.* The dissociation of a chemical compound by the action of radiant energy. Syn. Photodisintegration.

Photoeffekt: *photoeffect, Syn. photoelectriceffect.* See oberflaechenphotoelectrischer Effekt.

photoelastisch: *photoelastic.* Pertaining to the study of elastic phenomena in transparent solids by means of their effects on transmitted polarized light; esp. that of forced double refraction.

photoelektrisch: *photoelectric.* See oberflaechenphotoelektrischer effekt.

photoelektrische Absorption: *photoelectric absorption.* The conversion of radiant energy into the energy of photoelectric emission.

photoelektrisch Arbeitsfunktion: *photoelectric work function.* The work function for the emergence of photoelectrons from a given metal.

photoelektrische Ausbeute: *photoelectric emissivity, Syn. photoelectric yield, p. sensitivity, spectral sensitivity.* The rate of photoelectric emission from a metal per unit radiant flux of any given frequency.

photoelektrischer Effekt: *photoelectric effect.* See Photoeffekt.

photoelektrische Emission: *photoelectric emission.* See oberflaechenphotoelektrischer Effekt.

photoelektrisches Emissionsvermoegen: *photoelectric emissivity.* See photoelektrische Ausbeute.

photoelektrische Empfindlichkeit: *photoelectric sensitivity, Syn. photoelectric yield.* See photoelektrische Ausbeute.

photoelektrisches Grenzpotential: *photoelectric limiting potential.* The stopping potential for the fastest electrons in a given photoelectric emission.

photoelektrischer Grenzwert: *photoelectric threshold.* See Langwellige Grenze.

photoelektrische Konstante: *photoelectric constant.* A quantity which, multiplied by the frequency of any radiation exciting photoemission, gives in c.g.s. units the p.d. corresponding to the quantum energy absorbed by the escaping photoelectron. Equal to h/e, where h is the Planck constant and e the electronic charge.

photoelektrischer Schwellenwert: *photoelectric threshold.* See langwellige Grenze.

photoelektrischer Strom: *photoelectric current.* See oberflaechenphotoelektrischer Effekt.

photoelektromotorische Kraft: *photoelectromotive force.* An e.m.f. due to photovoltaic action.

Photoelektron: *photoelectron.* See oberflaechenphotoelektrischer Effekt.

Photoemission: *photoemission, Syn. photoelectric emission.* See oberflaechenphotoelektrischer Effekt.

Photoempfindlichkeit: *photosensitivity.* The property of exhibiting any kind of photoelectric effect when irradiated, e.g., photoelectric emission, photoconductivity, or photovoltaic action.

Photogen: *photogen.* A substance which emits light by luminescence.

Photogoniometer: *photogoniometer.* An apparatus for studying various aspects of crystal X-ray diffraction and X-ray spectra. May be used as an X-ray spectrograph or as a goniometer.

Photoionisation: *photo-ionization.* Ionization in a gas which results from the action of radiation quanta, esp. those of visible light or ultraviolet.

Photokathode: *photocathode.* The illuminated electrode, at a negative potential, in a photoelectric cell.

Photokernspaltung: *photodisintegration.* The disintegation of an atomic nucleus by the action of radiant energy.

Photoleitfaehigkeit: *photoconductivity.* Electrical conductivity due to photo-ionization, e.g., in gases or in many nonmetallic crystals. Syn. photoactivity, photosensitivity.

Photolumineszenz: *photoluminescence.* Luminescence of which the stimulating cause is visible light or ultraviolet.

photomagnetischer Effekt: *photomagnetic effect.* The direct effect of light upon the magnetic susceptibility of certain substances.

Photometer: *photometer.* See Lichtmesser.

Photometerkopf: *photometer head.* That part of a photometer which comprises the screen, the means of viewing it, and the accessories used in judging the equality of illumination.

photometrischer Mittelpunkt: *photometric center, p. centroid.* That point of a luminous or of an illuminated surface which bears the same relation to the distribution of brightness or of illumination that the centroid of a thin plate bears to the distribution of its mass per unit area. Syn. luminous center of gravity.

Photon: *photon.* An energy quantum of visible light; or in general, of any electromagnetic radiation.

Photonenstoss: *photo impact.* The impact of a photon or light quantum, as in such processes as photo-ionization or photoelectric emission.

Photoneutron: *photoneutron.* A neutron emitted as the result of photodisintegration.

Photophorese: *photophoresis.* A propulsive effect of an intense beam of light upon very small particles (of the order of 1 micron in diameter) in suspension in the air; the particles moving either toward or away from the light source. The effect becomes less as the pressure increases. In electrophotophoresis (photophoresis in an electric field) and in magnetophotophoresis (photophoresis in a magnetic field), the particles have a component of motion in the direction of the field.

Photostrom: *photocurrent.* A photoelectric or a photovoltaic current.

Photostromkoeffizient: *photocurrent coefficient.* The change in the photocurrent generated by a photoelectric or a photovoltaic cell, per unit change in radiant flux producing it.

photovoltaisch: *photovoltaic.* Capable of acting as a source of e.m.f. under the influence of light.

Photozelle: *photocell, photoelectric cell, photronic cell.* (1) See lichtelektrische Zelle. (2) A type of photovoltaic cell using selenium.

photometrisches Zentrum: *photometric center, p. centroid.* See photometrischer Mittelpunkt.

physikalische Gleichung: *physical equation.* An equation, each term of which represents a concrete physical

quantity, or which contains symbols representing such quantities.

Pi Ebenen: *Pi-planes.* Atomic planes bounding crevices in the mosaic structure of a crystal. Sometimes called Zwicky pi-planes.

Piezo-dielektrisch: *piezo-dielectric.* Pertaining to changes in dielectric constants resulting from mechanical stress.

Piezo-elektrisch: *piezo-electric.* Characterized by the property, exhibited by certain crystals, of becoming electrically polarized and of developing charges of "piezo-electricity" when subjected to strain.

Piezo-elektrische Achse: *piezo-electric axis.* See elektrische Achse.

Piezo-elektrischer Generator: *piezo-electric oscillator, p.-e. generator.* An electric oscillating system containing as one of its elements a piezo-electric resonator by which the frequency is controlled. Syn. piezo-oscillator.

Piezo-elektrische Konstanten: *piezo-electric constants.* The constants in the linear equations expressing the electric polarization developed in a deformed crystal in terms of the components of strain and the components of stress.

Piezo-elektrischer Oszillator: *piezo-electric oscillator, p.-e. generator.* See Piezo-elektrischer Generator.

Piezo-elektrischer Resonator: *piezo-electric resonator.* A plate or rod of piezo-electric crystal which may be excited electrically into resonant vibration at one or more frequencies. The term is commonly applied to the combination of the piezo-electric body with electrodes in a suitable mounting. Developed by W. G. Cady.

Piezolumineszenz: *piezoluminescence, Syn. triboluminescence.* Luminiscence caused by grinding, in such substances as glass and certain crystals. Tribothermoluminescence refers to the same phenomenon, when heat is required subsequent to the grinding.

Piezometer: *piezometer.* See Fluessigkeitsmanometer.

Pilotballon: *pilot balloon.* A small balloon released for the purpose of studying the movements of the air.

Pirani-Manometer: *Pirani gauge.* A type of hot-wire gauge which, as improved by Hale, has a filament resembling that in an incandescent lamp. The filament temperature is deduced from its resistance.

Pitot-Manometer: *pitometer.* An instrument, utilizing the principal of the Pitot tube, which makes a continuous record of the variations in velocity of a liquid stream. Devised by Code.

Pitometer: *pitometer.* See Pitot-Manometer.

Pitot'sche Roehre: *Pitot tube.* A narrow tube inserted in a fluid stream with its open end facing the current, and communicating at the other end with a manometer; used for measuring the speed of flow.

Planck-Einstein Gleichung: *Planck-Einstein equation.* The equation

$$h\nu_{max} = Ve,$$

which is the mathematical expression corresponding to the Duane-Hunt law for the conversion of electron energy into X-ray quanta. ν_{max} is the maximum X-ray frequency evoked by an electron e which has acquired its energy from a potential increment V; h is the Planck constant. An equivalent form of the relation is $\lambda V = 1.234 \times 10^{-4}$ cm-volt, in which λ is the X-ray wave length.

Planck'sche Farbe: *Planckian color.* The color or the wave-length-intensity distribution of the light emitted by a black body at a given temperature.

Planck'sches Gesetz: *Planck law.* The statement that the value of the quanta of radiation of any frequency is proportional to the frequency, as expressed by the equation

$$q = h\nu$$

in which ν is the frequency and h the Planck constant. First enunciated by M. Planck in 1900.

Planck'sche Gleichung: *Planck equation.* A formula expressing the spectral energy distribution of black-body radiation at a given absolute temperature T in terms of wave length λ. The emissive power of the black body within the wave-length range $d\lambda$ is given as

$$dE\lambda = 2\pi c^2 h\lambda^{-5} \left[\frac{ch}{e^{K\lambda T} - 1}\right]^{-1} d\lambda$$

in which c is the electromagnetic constant, h the Planck constant, and k the Boltzmann constant. An alternative form gives the radiant energy density within the black-body cavity as

$$8\pi c^2 h\lambda^{-5} \left[\frac{ch}{e^{K\lambda T} - 1}\right]^{-1} d\lambda.$$

Planck'sche Konstante: *Planck constant.* A constant h having the dimensions of action (energy $\times$ time) and appearing in many physical formulas; approximate value, 6.547×10^{-27} erg-sec. In particular it

represents the ratio of the energy of any radiation quantum to its frequency. First recognized by Planck in 1900. Syn. elementary quantum of action.

Planck'scher Strahler: *Planckian radiator.* An ideal black body.

Planck'sche Verteilung: *Planckian distribution.* See Planck'sche Gleichung.

Planimeter: *planimeter.* An instrument used to measure the area of any closed, plane figure traced on paper. A well known type which makes use of polar co-ordinates about a fixed pivotal point is called a polar planimeter.

plankonkav: *plano-concave.* Having two surfaces, one of which is plane and the other concave; applied esp. to lenses.

plankonvex: *plano-convex.* Having two surfaces, one of which is plane and the other convex; applied esp. to lenses.

Plasma: *plasma.* That part of an electric discharge in a rarefied gas which contains electrons and positive ions in such relative numbers that their charges nearly neutralize one another.

Plasmoid: *plasmoid.* One of a class of luminous bodies of various shapes which appear in highly exhausted tubes under excitation of very high frequency, and which are not as yet well understood.

Plastimeter: *plastometer, Syn. mobilometer.* An apparatus for measuring the plasticity of a substance.

Plastizitaet: *plasticity.* A property of some solids, by virtue of which they begin to exhibit continuous shear, or to flow, when subjected to shearing stress of sufficient magnitude.

Plastometer: *plastometer.* An apparatus for measuring the plasticity of a substance.

Plattenelektrode: *plate.* Any flat electrode, as of a storage cell or a condenser.

Plattenlnterferenzspektrum: *channeled spectrum.* A spectrum containing interference bands, produced by light which has been reflected from two parallel surfaces, such as those of a thin glass plate.

Platinit: *platinite.* An alloy of nickel and iron (about 46 percent Ni), whose expansion coefficient is nearly equal to that of platinum, and which may therefore be used to replace that metal for lead wires in vacuum tubes.

Platinrhodium: *platinrhodium.* An alloy of platinum and rhodium, commonly used in thermocouples.

Platinstandard: *platinum standard.* A unit of luminous intensity proposed by J. Violle, viz., that of 1 cm^2 of the surface of molten platinum at its melting point. Syn. Violle standard.

Pleochroismus: *pleochroism.* The property, possessed by certain crystals, of exhibiting different absorption colors as viewed in the direction of the different crystal axes; e.g., iolite, which appears dark blue, light blue, and yellow with light transmitted along the respective axes. Syn. polychroism.

ploetzliche Gasaufzehrung: *leanup.* The gradual disappearance of gases from a discharge tube during its operation.

Pneumatik: *pneumatics.* That branch of physics which deals with the dynamic properties of gases.

Poinsot'sche Bewegung: *Poinsot motion.* The motion of a rigid body having one point fixed, the resultant of all forces acting upon which is zero.

Poinsot'scher Lehrsatz: *Poinsot theorem.* States that when a rigid body moves about its fixed c.m. under no forces, the energy ellipsoid, fixed in the body, rolls without slipping on a plane fixed in space (the invariable plane); and the vector from the fixed point to the point of contact represents the instantaneous angular velocity of the body in direction and magnitude.

Poinsot Prezession: *Poinsot precession.* The precessional rotation of a nonsymmetrical body, i.e., one which has three principal axes with different moments of inertia; as distinguished from regular precession.

Poise: *poise.* A unit of viscosity, for which the viscosity coefficient is equal to 1 dyne-sec/cm^2. Named from Poiseuille. The practical unit for solutions, etc. is the centipoise, or 0.01 poise.

Poiseuille'sches Gesetz: *Poiseuille law.* Expresses the (volume) rate of flow through a capillary as follows:

$$\frac{dV}{dt} = \frac{\pi r^4 \Delta p}{8\eta l}$$

Δp = pressure difference, r = radius, l = length of capillary, η = viscisity coefficient of fluid.

Poisson'sche Gleichung: *Poisson' equation.* A differ-

ential equation relating the potential function to the density at any point. For the gravitational potential function V it is

$$\nabla^2 V = -4\pi\rho$$

where ρ is the (mass) density.

Poisson'sche Klammer, P. Klammerausdruck: *Poisson bracket.* An abbreviated notation used in mechanics. The Poisson bracket of F_r and F_s with respect to the variables $p_1, p_2, \ldots, p_n, q_1, q_2 \ldots, q_n$ is defined as

$$\left[F_r F_s\right]^E = \sum_{k=1}^{k=n} \left(\frac{\delta F_r}{\delta q_k} \frac{\delta F_s}{\delta p_k} - \frac{\delta F_s}{\delta q_k} \frac{\delta F_r}{\delta p_k} \right)$$

Poisson'sches Verhaeltnis, Poisson'sche Verhaeltniszahl: *Poisson ratio.* The ratio of the fractional transverse contraction to the fractional longitudinal extension of a body under tensile stress. Syn. rho ratio.

Poisson'sche Verteilung: *Poisson distribution.* A statistical distribution defined by the equation.

$$p = \frac{a^x e^{-a}}{x!},$$

It is approximated by the Gaussian distribution when a is large.

polar: *polar.* (1) Electrically nonsymmetrical, as a molceule which, like HCl, has an effective electric moment. Syn. heteropolar. (2) In re a crystal structure: having an asymmetry in the location of certain sets of atoms. (3) Pertaining to or measured from a pole.

polares Kerzenstaerkediagramm: *polar candle-power diagram.* See Lichtverteilungskurve.

polares Traegheitsmoment: *polar moment of inertia.* An areal moment of inertia of a plane figure, but with respect to a line perpendicular to the plane instead of to a line lying in the plane.

Polarimeter: *polarimeter.* A polariscope provided with circles or other equipment for making quantitative observations upon the state of polarization.

Polarisation: *polarization.* (1) (Dielectric.) In re a polarized dielectric: the electric moment per unit volume. (2) (Electrolytic.) An alteration of the p.d. in an electrolytic cell by reason of a poorly conducting electrolytic deposit. (3) (Magnetic.) Syn. Magnetization. (Rare.).

Polarisationsebene: *polarization plane.* A plane associated with a ray of plane-polarized radiation, believed to correspond to the vibrations of the magnetic vector as the wave progresses. If the polarization is produced by reflection, it coincides with the plane of that reflection.

Polarisationsfarbe: *polarization tint.* A coloration of the field of a polariscope analyzer when using a white-light source, due to the emergence of the different wave lengths from the analyzer with altered relative intensities.

Polarisationskapazitaet: *polarization capacitance.* The capacitance of the condenser formed by the two electrodes of a cell.

Polarisationskreis: *polarization cycle.* A closed figure formed by the terminus of the vector representing the vibrations in a beam of radiation polarized in any given manner. For plane-polarized light, it is a straight line; for elliptically polarized light, it is an ellipse; etc.

Polarisationsphotometer: *polarization photometer.* A photometer in which the intensity of the light from one or both sources is varied by the use of polarizing apparatus.

Polarisationswinkel: *polarizing angle.* The angle at which light must be incident upon the surface of a dielectric reflector in order to experience maximum plane-polarization. Syn. Brewster angle.

Polarisator: *polarizer.* A Nicol prism or other device for polarizing light, esp. one introduced into a polariscope to receive the light as it enters.

Polarisierbarkeit: *polarizability.* A quantity a pertaining to the molecules of a dielectric and defined as the molecular electric dipole moment per unit electric intensity. It is connected with the dielectric constant κ through the relation.

$$a = \frac{3M}{4\pi N} \frac{\kappa - 1}{(\kappa + 2)\rho},$$

in which M is the molecular weight, N the Avogadro number, and ρ the density.

polarisieren: *polarize.* (1) To endow with poles, as a magnet. (2) To produce an electrical separation or orientation, esp. in the molecules of a dielectric. (3) To impress some spatial characteristic, as upon the vibrations identified with radiation; e.g., in elliptically polarized light.

Polariskop: *polariscope.* An instrument for examining the state of polarization of light or other radiation, or for studying the polarizing properties of bodies.

Polaritaet: *polarity.* (1) The electrically positive or negative condition of a battery or generator terminal. (2) The magnetically positive (north) or negative (south) character of a magnetic pole. (3) The degree in which a molecule is polar.

Polaritaetseffekt: *polarity effect.* An asymmetry or inequality in the current through a series of partial conductors, such as metallic sulphides or oxides, according to which way it is caused to flow; illustrated by crystal detectors.

Poleffekt: *pole effect.* A discrepancy observed in the wave lengths of spectral lines when the light comes from the vicinity of the electrodes in an arc.

Polhode: *polhode.* The curve which marks the intersection of the energy ellipsoid and the momentum ellipsoid of a free rigid body. The term is due to Poinsot.

polydispers: *polydisperse.* In re a disperse system: having particles of different sizes.

Polykristall: *polycrystal.* A body made up of a number of small crystals in a mass.

Polymer: *polymer.* (1) One of two or more isomers having different molecular weights, e.g., C_2H_2 (acetylene) and C_6H_6 (benzene). (2) A complex molecule, or molecular aggregate, which may be considered as a multiple of some simpler molecule, e.g., $H_4O_2 = 2\ H_2O$.

Polymorphismus: *polymorphism, Syn. allotropy, allotropism.* But with especial reference to differences in the crystal structure.

polytrop: *polytropic.* Pertaining to a change during which the pressure and the volume vary in accordance with the relation pv^n = constant (the polytropic equation), in which n has special constant values in different cases. E.g., for the Boyle law, n = 1.

Porro'sches Prisma: *Porro prism.* A triangular optical prism having one 90- and two 45-degree angles. Light entering perpendicular to the hypothenuse face emerges from the same face after two international reflections. Two of these are used in each telescope of the prism binocular.

positiver Kristall: *positive crystal.* A unaxial, birefringent crystal in which the extraordinary wave has the less velocity, e.g., quartz.

positive Saeule: *positive column.* A striated, luminous region adjacent to the anode in a Crookes tube at moderate pressure.

positive Strahlen: *positive rays.* A stream of positively charged atoms or molecules, produced by a suitable combination of ionizing agents, accelerating fields, and limiting apertures.

Positron: *positron.* A positive charge having a mass equal to that of the electron, and electrically its counterpart. Its existence was first announced by Carl Anderson. Syn. positive electron.

Potential: *potential.* A term applied to several different scalar quantities, the measure of each of which involves energy as a function of position or of condition (potential energy).

Potentialfunktion: *potential function.* A function which constitutes the variable factor in the expression for any physical potential.

Potentialgalvanometer: *potential galvanometer.* An instrument of the galvanometer type, having such high resistance as to take practically no current, so that the readings can be taken to indicate the p.d. between its terminals.

Potentialloch: *potential hole, p. well.* A region toward which the electric potential drops abruptly and throughout which its value is distinctly lower than on either side; a term common in nuclear physics.

Potentialschranke: *potential barrier.* See Energiewall.

Potentialschwelle: *potential barrier.* See Energiewall.

Potentialstroemung: *potential streaming.* Fluid motion in which the velocity is the negative of a velocity potential gradient, so that the flow is irrotational. If the fluid is incompressible, the lines of flow coincide with the lines of a possible electric field in empty space.

Potentialwall: *potential barrier.* See Energiewall.

potentielle Energie: *potential energy.* Any form of energy which is not demonstrably kinetic.

Potenz: *Power (math.).* A number multiplied by itself any number of times; the result of taking any number of times as a factor.

Poundal (engl. Einheit): *poundal.* The absolute English (foot-pound second) unit of force which, acting upon a free mass of 1 lb, would impart to it an acceleration of 1 ft/sec^2.

Powell-Bande: *Powell bands.* Interference bands produced by the insertion of a transparent plate into a hollow prism which contains a liquid and is used to

produce a spectrum, when the plate, with its edge parallel to the prism edge, covers only one half of the field.

Poynting'scher Lehrsatz: *Poynting theorem.* States that the transmission of energy in an electromagnetic field takes place in a direction perpendicular to both electric and magnetic components, and that the rate of energy transfer is proportional to the vector product of those components (electric and magnetic intensities), called the Poynting vector or vector radiant.

Poynting'scher Vektor: *Poynting vector.* See Poynting'scher Lehrsatz.

Praedissoziation: *predissociation.* (1) A state that exists in a diatomic or polyatomic molecule which, usually after the absorption of light, has a tendency to dissociate spontaneously, usually into two uncharged parts. The resulting absorption bands are diffuse, lacking the usual rotational fine structure. (2) The process of decomposition from the state described under (1).

Prezession: *precession.* A motion of the axis of a symmetrical rotating body, which slowly describes a cone with the centroid as vertex, due to the action of a small torque tending to change the direction of the axis; illustrated by a spinning top or gyroscope. The axis of the cone is the precession axis.

Primaerelektron: *primary electron.* (1) An electron belonging to a primary emission. (2) That electron which, after a collision of two electrons, has the greater energy.

Primaeremission: *primary emission.* Incident emission, which may excite secondary emission from the irradiated matter. If it is of the nature of radiation (ultraviolet, X-rays, etc.), it is usually called primary radiation.

primaerer Photoeffekt: *volume photoelectric effect.* See innerer photoelektrischer Effekt.

Primaerfarben: *primary colors.* Additive primaries are three colors which, added in proper proportions, produce a sensation of white; those usually chosen are red, green, and blue. Their complementaries, blue-green, purple, and yellow, respectively, are substractive primaries; if white light is passed in succession through transparent screens of these colors, it is completely absorbed.

Primaerschaltung: *primary circuit.* A circuit, the variation of the current in which induces an e.m.f. in a coupled, secondary circuit as in a transformer. Often abbreviated to primary.

Primaerstandard: *primary standard.* A unit directly and originally defined and established by some authority. e.g., the standard meter at Sèvres.

Primaerstruktur: *primary structure.* See Sekundaerstruktur.

Primaerzelle: *primary cell.* A battery cell whose energy is intrinsic in the substances originally composing it, and not derived from charging as in a storage (secondary) cell.

Prinzip der geringsten Arbeit: *least-work principle.* A special case of the principle of least energy which states, in reference to an elastic structure having redundant bars or members, that the stresses developed in the members by the application of loads are such as to render the total internal work throughout the structure a minimum.

Prinzip der geringsten Energie: *least-energy principle.* States that a dynamic system is in stable equilibrium only for configurations in which the potential energy of the system as a whole has minimum values.

Prinzip des geringsten Interwalls: *least-interval principle.* A principle analogous to the principle of least time or the principle of least action, but which requires that any natural sequence of events take place in such a manner that the section of the world line connecting them in the space-time continuum shall be shorter than for any other, arbitrary sequence of events.

Prinzip der geringsten Wirkung: *least-action principle.* States that if a dynamic system passes spontaneously and without change in total energy from one configuration to another, the action involved in the process is a minimum; or (an equivalent statement) that the line integral of the momentum of each particle is a minimum. Enunciated by Maupertuis.

Prinzip der kleinsten Quadrate: *least-squares principle.* A principle of the theory of errors, based upon the normal law of error, which states that the best estimate of an experimental quantity, deducible from a number of observations, is that for which the sum of the weighted squares of the residuals is least.

Prinzip der kuerzesten Zeit: *least-time principle.* For points in two homogeneous media separated by a plane surface, or for reflection in a single homogeneous medium by a plane surface, the time is a minimum, in which case the law is commonly known as the principle of least time.

Prinzip der virtuellen Arbeit: *virtual-work principle.* States that a condition for the equilibrium of a system is that the total virtual work due to all internal and

external forces acting upon the system is zero; or in other words, that the potential energy of the system is a minimum or a maximum or a constant.

Prisma mit konstanter Ablenkung: *constant-deviation prism.* A triangular prism so designed that the deviation of a ray of light entering it by one face and leaving it by another after internal reflection at the third face is always equal to the angle between the two refracting faces.

Probespule: *exploring coil.* A small coil which may be moved about within a magnetic field in order to test the magnetic intensity at various points by electromagnetic induction.

Produktionskoeffizient: *production coefficient.* The rate at which primary radiation produces secondary radiations with respect to the thickness of medium traversed. If dI_2 is the intensity of secondaries produced in thickness dx by primary radiation of intensity I_1, the coefficient is

$$\beta = \frac{dI_2/dx}{I_1}$$

Prometazentrum: *prometacenter.* The center of curvature of a curve of buoyancy at any point.

Proton: *proton.* An elementary particle, of mass about 1.66×10^{-24} g (1845 times that of the electron) and with a positive charge equal to that of the electron (4.77×10^{-10} e.s.u.). The nucleus of the ordinary hydrogen atom is thought to be a single proton.

Prototyp: *prototype.* An accurate copy of a primary standard unit. Syn. secondary standard.

Prozentbruecke: *percentage bridge.* A type of slide-wire bridge, so adjusted that a change of 0.01 percent in the ratio of the two resistances compared requires, for balancing a change of one division on the slide scale. Devised by H. C. Parker.

pseudomorph: *pseudomorphic.* Having a definite geometrical form for the external surface, but made up structurally of smaller crystals of a form quite different.

Psychrometer: *psychrometer, Syn. wet-and-dry-bulb thermometer.* A hygrometer consisting of two identical thermometers, the bulb of one of which is kept wet with water supplied by a wick. The lowering of the temperature by evaporation indicates the relative humidity of the air.

Pufferspannung: *floating electromotive force.* The e.m.f. supplied by a storage battery placed across a d.-c. power line usually near the far end, which automatically adjusts the voltage to a varying load. The battery discharges on heavy load and recharges when the load is light.

Puffergefaess: *surge chamber.* A cavity connecting with a water pipe or other conduit and containing air, which acts as a cushion to shocks caused by sudden pressure or stoppage of the flow, e.g., in a force pump.

Pulverdiagramm: *powder pattern, Syn. Hull ring, Debye r., Debye-Scherrer r.* Sometimes called Halo, esp. in connection with diffraction effects from amorphous materials. A pattern of parallel lines or bands of ferromagnetic powder deposited on the surface of a magnetized crystal. Syn. Bitter pattern.

Pulvermethode: *powder method.* A method of crystal analysis, devised independently by Hull and by Debye and Scherrer, in which the varied orientation of the particles of the finely pulverized substance produces the same diffraction-ring pattern as would result from giving a single crystal all possible orientations.

Punkt: *dot.* (1) A notation, attributed to Newton, consisting of a dot placed over the symbol for a variable, and signifying the derivative of that variable with respect to time. Such quantities as velocity and acceleration are frequently thus represented. (2) One of the symbols of vector multiplication; placed between the symbols for two vectors, it designates their scalar product.

Punktfunktion: *point function.* A variable quantity which is a function of the position of a point in space. E.g., the electric potential, the temperature, the value of g, etc., are point functions.

Punktgruppe: *point group, Syn. space group.* A group of points in space which has one of the types of symmetry exhibited by crystals.

Punktpol: *point pole.* A sharply defined magnetic pole, from which the field radiates almost as if from a point. Syn. magnetic charge.

Punktsymmetrie: *point symmetry.* The term point symmetry or radial symmetry is used if the reference zero is a point. See also Symmetrie.

punktzentrisch: *homocentric, Syn. stigmatic.* In re a bundle of rays: passing through a common point, or traversing lines which, if produced, would pass through a common point.

Pyknometer: *specific-gravity bottle.* A small flask with a perforated stopper, which may be filled completely

full of a liquid for the purpose of obtaining its density and specific gravity by weighing.

Pyranometer: *pyranometer.* An instrument which measures the intensity of the radiation received from any portion of the sky.

pyro-elektrisch: *pyro-electric.* Characterized by the property, exhibited by certain asymmetric crystals, of becoming electrically polarized and of developing charges of "pyro-electricity" upon change of temperature. The true pyro-electric effect results directly from the temperature change; there is a pseudo-pyro-electric effect which arises from strains due to alteration of temperature and which is therefore an indirect piezo-electric effect.

pyro-elektrische Konstante: *pyro-electric constant.* Change in the electric polarization of a pyroelectric crystal per unit change in temperature.

Pyroheliometer: *pyroheliometer, pyrheliometer.* An instrument for measuring the total intensity of solar radiation, both direct and scattered by the surrounding atmosphere. Syn. solarimeter.

Pyrometer: *pyrometer.* Any instrument for the measurement of high temperatures.

Pyroskop: *pyroscope.* A form of optical pyrometer, devised by Shore.

Q Zweig: *Q branch.* A set of molecular spectrum lines corresponding to changes in vibrational energy with none in rotational energy.

Quadrantenelektrometer: *quadrant electrometer.* An electrometer consisting of a light, elongated metallic plate suspended horizontally within a flat metallic cylinder divided into quadrants. The electric reaction between the charged plate and the charged quadrants causes the former to turn against the torsion of the suspending wire.

quadratische Skala: *squared scale.* A linear scale so graduated and numbered as to indicate the square of the distance from the zero point; used on some photometer benches.

Quadruplett: *quadruplet.* A group of lines in an atomic spectrum, arising from transitions between the different components of two multiple spectral terms and hence exhibiting the characteristic frequency differences of these terms. The number is 4.

Quadrupol: *quadrupole, quadripole.* A system consisting of two equal dipoles parallel to each other, but with their corresponding charges reversed.

Quadrupollinien: *quadrupole lines.* A type of "forbidden" spectral lines, whose infrequency of occurrence is interpreted as due to the action of the atom as an electric quadrupole instead of as the more usual dipole. Such lines exist, however, in the spectra of nebulae and the aurora.

Qualitaet: *quality.* (1) That characteristic of a musical sound which is dependent upon the wave form and hence upon the harmonic components and their relative intensities. Syn. timbre, tone color. (2) In re a system composed of the liquid and the vapor states of a pure substance the ratio of the mass of the vapor to the total mass of both phases. Syn. dryness.

Quant: *quantum, quant.* (1) A discrete portion of energy, of definite amount, first associated with intraatomic or intramolecular processes involving changes among the electrons and with the corresponding radiation. (2) Any supposed smallest portion of a magnitude; e.g., the electronic charge is sometimes called a quantum of electricity.

Quantenausbeute: *quantum efficiency.* The number of photoelectrons emitted from a metal per quantum of incident radiation. Syn. quantum yield.

Quantenaequivalenzprinzip: *quantum equivalence principle.* The principle that when, in a photoelectric or photovoltaic process of any kind, a quantum of radiation is "absorbed," its entire energy reappears in some other definite form, such as the kinetic energy of a released photoelectron, or the energy of an ionized atom.

Quantenbedingung: *quantum condition.* The mathematical condition which must be satisfied for any given quantum state of an atom or other system to be possible.

Quantendefekt: *quantum defect.* The principal quantum number for the electron responsible for a spectral series, minus the square root of the Rydberg denominator for any actual spectral term of the series. It is usually, but not always, positive.

Quantengewicht: *quantum weight, Syn. statistical weight.* An integer corresponding to the number of different levels into which a given state is subdivided when the degeneracy is completely removed.

Quantenkorrektion: *quantum correction.* A correction required by any classical law or formula to bring it into harmony with the quantum theory.

Quantenmechanik: *quantum mechanics.* (1) A general physical theory which seeks to deal with atomic structure and related problems in terms of only those quantities which can be actually measured, and excluding such purely inferential concepts as the position or the velocity of an electron in a supposed orbit. It embraces the matrix mechanics of Heisenberg, the wave mechanics of Schroedinger, and the transformation theory of Jordan and Dirac. (2) The mechanics of phenomena which are subject to quantum conditions, such as the processes going on within and among atoms and molecules.

Quantenstoss: *photo-impact.* See Photonenstoss.

Quantuebergang: *quantum transition.* An abrupt readjustment which is accompanied by the emission or the absorption of a quantum of radiant energy. Syn. quantum jump.

Quantenzahl: *quantum number.* An integral number which is characteristic of the statement of a quantum condition. E.g., for a hydrogen atom (disregarding relativity and spin corrections) the energy corresponding to any quantum state is inversely proportional to the square of the (principal) quantum number.

Quantenzahlenvergroesserung bei Elektronen: *electron promotion.* See Elektronenuebergang.

Quantenzustand: *quantum state.* See Energieniveau.

Quarzfadenmanometer: *quartz-fiber manometer.* A type of manometer in which the pressure of a gas is measured by the damping which it offers to the vibrations of a quartz fiber. Devised by Haber and Kerschbaum.

Quincke'sche Roehre: *Quincke tube.* An acoustic wave filter consisting of a short tube with a semicircular side branch.

r Einheit: *r unit.* See Roentgen.

R Zweig: *R branch.* A set of moelcular spectrum lines corresponding to unit decreases in rotational quantum number.

Rabi'sche Feld: *Rabi field.* A magnetic field used to deflect particles having an intrinsic magnetic moment. It is a nonuniform field, the portion used being that in the plane midway between parallel, flat, rectangular pole pieces.

Radialgeschwindigkeit: *radial velocity.* The component of linear velocity in line with the observer.

radiale Quantenzahl: *radial quantum number.* A quantum number associated with radial motion, which must be an integer for any allowed stationary state of a particle moving subject to a central field.

radioaktives Element: *radioelement.* A radioactive element.

radioaktives Gleichgewicht: *radioactive equilibrium.* A relationship between a radioactive substance and its parent substance, in which at any instant the rate of disintegration of the former is equal to its rate of formation from the latter. The equilibrium is "transient" if the balanced rates change rapidly, "secular" if the parent substance has a very long period.

radioaktiver Niederschlag: *radioactive deposit.* A film of radioactive matter formed from the disintegration of a radioactive emanation (radon, thoron, actinon) and of the subsequent products. Such films may be found upon solid objects which have been in contact with any one of these emanations.

radioaktives Produkt: *radioactive product.* A substance which results from the radioactive disintegration of another (parent) substance.

radioaktive Reihen: *radioactive series.* A succession of radioactive elements, each of which is derived from the disintegration of the one preceding.

Radioaktivitaet: *radioactivity.* A property of certain elements, which involves the spontaneous emission of alpha particles or of beta particles from the nucleus of the atom. Gamma rays, also of nuclear origin, may accompany or immediately follow the disintegration, but are a byproduct of that process.

Radioaktivitaetswaerme: *heat of radioactivity.* The heat generated per unit time by the radioactive disintegration in unit mass of a radioactive substance.

Radioelement: *radioelement.* See radioaktives Element.

Radiofrequenz: *radio frequency.* Any frequency, usually above the audible range, suitable for the transmission of radio signals.

Radiogramm: *Radiogram.* A wireless telegraph message.

Radiograph: *radiograph.* An X-ray or radium photograph, showing the nonuniform density of the structure through which the rays pass.

Radiologie: *radiology.* (1) That branch of physics which deals with X-rays, radioactivity, and other h.-f. radiation. (2) The art of diagnosis and treatment of diseases by means of X-rays, radium, or ultraviolet radiation.

Radiolumineszenz: *radioluminescence.* Luminescence stimulated by radioactive emission or by X-rays.

Radiometeorograph: *radiometeorograph.* A meteorograph which, when sent up in a balloon, automatically reports atmospheric conditions by radio to receiving apparatus at the ground station.

Radiometer: *radiometer.* See Lichtmuehle.

Radiomikrometer: *radiomicrometer.* An instrument, devised by Boys, consisting of a short-circuit thermocouple suspended in a strong magnetic field, and sensitive to very feeble thermal radiation.

Radiophotolumineszenz: *radio-photoluminescence.* Luminescence exhibited by certain minerals, as kunzite and fluorite, as a result, first of irradiation with beta and gamma rays, followed by exposure to light; first observed by K. Przibram.

Radiothermolumineszenz: *radio-thermoluminescence.* Luminescence exhibited by certain vitreous and crystalline substances as a result, first of irradiation with beta and gamma rays, or by Entladungsstrahlen, followed by heating; first observed by E. Wiedemann.

Raman Effekt: *Raman effect.* The presence, in scattered light, of frequencies differing from that of the incident light by various values characteristic of the scattering substance but independent of the incident frequency. Discovered by C. V. Raman in 1928. The scattered or "modified" lines constitute the Raman spectrum of the scatterer.

Raman'sche Viskositaetsformel: *Raman viscosity formula.* Expresses the viscosity coefficient η of a liquid in terms of the absolute temperature T, as follows:

$$\eta = Ae^{\frac{B}{T}},$$

in which A and B are constants.

Ramsauer Effekt: *Ramsauer effect.* (1) The absorption of slow-moving electrons by intervening matter, somewhat as alpha particles are absorbed by gases.

Ramsden-Okular: *Ramsden eyepiece.* An eyepiece for optical instruments, consisting of two similar plano-convex lenses with their convex faces facing each other and at a distance equal to two-thirds the focal length of either.

Rankine'scher Kreis: *Rankine cycle.* A type of thermodynamic engine cycle in which the isothermal compression is continued until the original volume is attained, and the cycle is then completed by an increase of pressure at that volume. The ordinary steam engine approximates this cycle.

Rankine'scher Zyklus: *Rankine cycle.* See Rankine'scher Kreis.

Raoult'sches Gesetz: *Raoult law.* A more specific form of the van't Hoff law; viz.: the fractional lowering of the vapor pressure of a solvent by a nonvolatile solute is equal to the ratio of the number of molecules of the solute to the total number of molecules of both solute and solvent.

rationalisierte Einheit: *rationalized unit, Syn. Heaviside-Lorentz unit.* See Heaviside-Lorentz Einheit.

Raumfunktion: *space function.* A quantity connected with a region of space in such a way that its value depends upon the extent and the boundaries of that region. The "space" referred to may be of any number of dimensions. The element of such a function, used in integration, is equal to the element of space multiplied by some function of the co-ordinates of the space element. E.g., an element of mass is equal to the density of the substance (which may vary from point to point) multiplied by the element of volume.

Raumgruppe: *space group.* A group of points in space which has one of the types of symmetry exhibited by crystals.

Raumladung: *space charge.* A charge of electricity distributed more or less continuously throughout a volume; as in any part of the electron stream in a thermionic vacuum tube or in a photoelectric cell.

Raumladungsgleichung: *space-charge equation.* An equation which expresses the space-charge-limited current between a plane cathode and a parallel plane anode in a gas:

$$I = \frac{\sqrt{2}}{9\pi}\sqrt{\frac{e}{m}}\,\frac{V^{3/2}}{x^2};$$

in which e and m are the electronic charge and mass, V is the voltage, and x the distance between electrodes. A similar but more complex equation holds for a cylindrical cathode inside a cylindrical anode.

Raumphotometer: *sphere photometer.* An integrating photometer in which the source of light is placed inside a spherical cavity with white walls, the light from which, reflected through a suitably placed opening, is used in the measurement of the mean spherical candle power of the source.

Raumquantelung: *space quantization, Syn. directional quantization.* The application of quantum conditions to the orientation of a system in space traversed by a field of force; which limits, e.g., the number of possible orientations of an atom in a magnetic field.

Raumverteilung: *spatial distribution.* A definite arrangement of particles or points in any type of space, usually specified by means of equations which express the number located in any element of space in terms of the co-ordinates of the element.

Raumwinkel: *solid angle.* A portion of the whole of space about a given point, bounded by a conical surface with vertex at that point and measured by the area cut by the bounding surface from the surface of a sphere of unit radius centered at that point.

Raumzeit: *space-time.* A four-dimensional continuum in which the four variable co-ordinates are the three ordinary space co-ordinates (as x, y, z) and the time t. The last may be expressed with an imaginary coefficient in order to make the resulting mathematical expressions closer in form to those of ordinary geometry. A concept due to Minkowski.

raumzentriert: *body-centered.* In re a unit cell of crystal structure; having an atom at its center of figure. Syn. space centered.

Rauscheffekt: *flicker effect.* A variation in plate current in a radio tube, due to variations in the surface condition of the filament.

Rayleigh'sches Gesetz: *Rayleigh law.* States that at very low values of the maximum magnetic induction, the hysteresis loss in a magnetic cycle is proportional to the cube of that induction.

Rayleigh'sche Linie: *Rayleigh line.* That component of a spectrum line in scattered radiation which has the same frequency as the corresponding incident radiation, arising simply from ordinary or Rayleigh scattering, not from the Compton or the Raman effect.

Rayleigh-Jean'sches Gesetz: *Rayleigh-Jean law.* A law intended to express the spectral energy distribution of black-body radiation at a given absolute temperature T in terms of wave length λ. The emissive power of the black body within the wave-length range is given as

$$dE_\lambda = 2\pi ck\, T\lambda^{-4}\, d\lambda;$$

in which c is the electromagnetic constant and k, the Boltzmann constant. The law fails to meet the experimental facts except at long wave lengths.

Rayleigh'sche Scheibe: *Rayleigh disk.* A light disk which, placed in a sound field, tends to set itself at right angles to the direction of motion of the particles of the medium.

Rayleigh'sche Streuung: *Rayleigh scattering.* The selective scattering of light by very small particles suspended in the air, such as dust or even the molecules of the air itself.

razemisch: *racemic.* Not optically active; e.g. racemic quartz in which the two kinds are twinned so as to compensate each other. A substance having this characteristic is called a racemate, and the acquisition of the property is racemization.

Reaktanz: *reactance.* (1) (Inductive.) That component of the impedance of a circuit which is due to inductance; expressed by $2\pi nL$. (2) (Capacitive.) That component which is due to capacitance; expressed by $1/2\pi nC$. Both are measurable in ohms.

Réaumur'sche Skala: *Réaumur scale.* A thermometric scale on which the freezing point of water is 0 degrees and the boiling point 80 degrees. Introduced by René de Réaumur about 1730, and still largely used in Central Europe.

rechtsdrehend: *dextrogyrate.* See dextrogyr.

rechtwinkelig abbildend: *rectilinear.* In re an optical system: forming images without distortion, so that the image of a straight line is straight, etc.

reduzierter Brennpunktabstand: *reduced focal length.* The first focal length of a spherical refracting surface, or of a lens, divided by the refractive index of the medium in which the light is incident; or the second focal length divided by the index of the medium into which the rays emerge.

reduzierte Masse: *reduced mass.* In re a heteropolar molecule: the value of the quantity:

$$\frac{M_1\, M_2}{M_1 + M_2},$$

in which M_1 and M_2 are the masses of the two ions. (2) In re an orbital electron: the value of

$$\frac{m\, M}{m + M},$$

in which m is the mass of the electron and M, that of the nucleus.

reduzierte Zustandsvariablen: *reduced variables of state.* The values of the pressure, specific volume, and absolute temperature of a gas expressed (as abstract ratios) in terms of their critical values, i.e., the values of p/p_t, v/v_o, T/T_c.

Reflecktionsfaktor: *reflection factor.* The ratio of the total luminous flux reflected by a given surface to that incident upon it. Syn. reflectance.

Reflecktionskoeffizient: *reflection coefficient.* The square root of the reflectivity of a surface for any type of radiation. It is the ratio of the amplitude of the reflected radiation to that of the incident radiation.

Reflecktionsmesser: *reflectometer.* An instrument for measuring the reflection factors of reflecting surfaces.

Reflectionsvermoegen: *reflecting power, Syn. reflectivity.* The fraction of the radiant energy of a given character, normally incident upon the surface of a body, which is reflected by that surface.

Reflectionswinkel: *reflection, angle of.* The angle between the direction of propagation of a reflected emission and the normal to the reflecting surface.

Reflectometer: *reflectometer.* See Reflektionsmesser.

Refraktionsindex: *refractive index.* See Brechungsindex.

Refraktometer: *refractometer.* An instrument for masuring the refractive indices of liquids or of solids, usually by determining the critical angle.

Regeneration: *regeneration.* A general term denoting various processes, the characteristic of which is that the result automatically enhances the cause, the action therefore tending to build itself up to greater and greater intensity. E.g., in a regenerative vacuum-tube amplifying circuit, the fluctuations of the plate current, by means of a feedback arrangement, re-enforce the variations in grid potential, and thus increase the fluctuations in the plate current itself.

regulaere Brechung: *regular refraction.* Refraction in a definite direction, not diffused or scattered.

regulaere Durchlaessigkeit: *regular transmission.* Transmission in a definite direction, not diffused or scattered.

regulaere Reflektion: *regular reflection.* Reflection in a definite direction, not diffused or scattered. Syn. specular reflection.

Reibung: *friction.* The rubbing together of two bodies, or the hindrance to motion so produced; attrition.

Reibungskoeffizient: *friction coefficient.* The ratio of the tangential force of sliding friction between two surfaces to the force, normal to the surfaces, which presses them together. It depends upon the nature of the two surfaces, and is in general greater for static than for kinetic friction.

Reibungsfaktor: *friction factor.* A coefficient by which a dynamic quantity, calculated without reference to friction, must be multiplied in order to correct for friction.

Reichweite: *range.* (1) The distance to which a corpuscular emission, as alpha rays, will penetrate a given substance before all its energy is absorbed. (2) The distance from its starting point, on a horizontal plane, at which a projectile again reaches the plane.

Reihe: *series.* An arrangement of electrical conductors, generators, condensers, etc. in succession without any branching, so that each carries the whole conduction or displacement current.

Reihenschaltung: *series-connection.* A mode of arranging the separate parts of a circuit by connecting them successively end to end to form a single path for the current.

reines Spektrum: *pure spectrum.* A spectrum of which each point corresponds to one and only one wave length or frequency of the dispersed radiation.

Rekaleszenz: *recalescence.* The sudden evolution of heat by solid iron and some other ferromagnetic metals at certain high temperatures as the metal cools; probably due to some exothermic structural transition.

Rekombinationskoeffizient: *recombination coefficient.* A coefficient which appears in the law expressing the rate of recombination of ions in a gas. If n_+ and n_- are the respective numbers of the two kinds of ions,

$$\frac{dn_+}{dt} = \frac{dn_-}{dt} = -An_+ n_- .$$

A is the recombination coefficient.

Rekombinationsspektrum: *recombination spectrum.* A faint, continuous spectrum ascribed to the recombination of ions in an ionized gas.

Relais: *relay.* Any device used to communicate or pass on impulses from one system to another system.

relative Apertur: *relative aperture.* In a telescope or a camera: the ratio of the focal length of the objective to the diameter of the entrance-pupil; it determines the photographic speed of the objective. Syn. F-number.

relative Feuchtigkeit: *relative humidity.* The fraction of saturation of the water vapor in the air.

relative Oeffnung: *relative aperture.* See relative Apertur.

Relativitaet: *relativity.* A modern system of natural philosophy, characterized by its recognition of the interdependence of the basic entities of matter, space, and time; introduced and largely developed by Albert Einstein.

Relativitaetskontraktion: *relativity contraction, Syn. Lorentz-Fitzgerald contraction.* A hypothetical shrinkage of all matter in the direction in which it moves through the ether, such that all dimensions in this direction are reduced in the ratio

$$\sqrt{1 - \frac{u^2}{c^2}} : 1 ;$$

where u is the speed of the motion and c, the speed of light.

Relativitaetskorrektion: *relativity correction.* A correction which must be applied to a formula derived or to a value calculated in accordance with classical theory in order to bring it into agreement with the relativity theory.

Relaxationszahl: *relaxation number.* The reciprocal of the relaxation time (2).

Relaxationszeit: *relaxation time.* (1) The time required for the electric polarization at any point of a suitably charged dielectric to fall from its original value to 1/e of that value, due to the electric conductivity of the dielectric. (2) In general, the time required for an exponential variable to decrease to 1/e of its initial value. (3) The time required for a gas, in which the Maxwell distribution of velocities has been temporarily disturbed, to recover that state. (4) The time required for the shearing stress in a flowing viscous substance to disappear after the flow has ceased.

Reluktanz: *reluctance.* The ratio of the magnetomotive force acting upon any part of a magnetic circuit to the resulting magnetic flux.

Reluktivitaet: *reluctivity.* The ratio of the magnetic intensity H to the magnetic induction B in the same region. If B and H are parallel, the reluctivity is the reciprocal of the magnetic permeability. Syn. specific reductance.

remanente Magnetisierung: *remanent magnetization.* The magnetization I retained by a substance undergoing a symmetrical hysteresis cycle, when the magnetic intensity H is reduced to zero; represented by either intercept of the H-I hysteresis curve on the I axis.

Remanenz: *remanence.* The residual magnetic induction B in a substance undergoing a symmetrical hysteresis cycle, when the magnetic intensity H is reduced to zero; represented by either intercept of the H-B hysteresis curve on the B axis.

Rheograph: *rheograph.* A type of magnetic vibration galvanometer or oscillograph, devised by Abraham, in which the effects of inertia and damping are neutralized by special means.

Resonanz: *resonance.* A term denoting a variety of phenomena characterized by the abnormally large response of a system having a natural vibration period to a stimulus of the same, or nearly the same, frequency.

Resonanzbruecke: *resonance bridge.* A type of a.-c. bridge, in one arm of which an inductance and a capacitance are adjusted to such values that the bridge is in resonance; their product is then equal to $1/4\pi^2n^2$, where n is the frequency.

Resonanzdurchdringung: *resonance penetration.* The penetration of an atomic nucleus by a charge changed particle whose energy corresponds to one of the energy levels in the nucleus. The probability of penetration by such a particle is comparatively large.

Resonanzpotential: *resonance potential, Syn. radiation potential.* The p.d., in volts, corresponding to the energy, in electron-volts, required to excite an atom or a molecule to emit one of its characteristic radiation frequencies. The first r.p. excites the lowest frequency, etc.

Resonanzradiometer: *resonance radiometer.* A modification of the thermo-relay, for relative measurements of small radiation intensities in infrared spectrometers.

Resonanzschwingung: *covibration.* A resonant vibration, i.e., a natural vibration of the same frequency as the stimulating or exciting impulses.

Resonanzstrahlung: *resonance radiation.* Radiation from a gas or a vapor, due to states of excitation which may be brought about by radiation of the same frequencies; as in the case of sodium vapor traversed by sodium light. When so excited, it may be regarded as a type of fluorescence without degradation of frequency. First intensively studied by R. W. Wood.

Resonanzzustand: *resonance state.* A state of excitation which gives rise to resonance radiation.

Resonator: *resonator.* An apparatus designed to resonate, or respond as the result of resonance, to a stimulus of given frequency.

Rest: *residual.* The result of a measurement upon a quantity, minus the most probable value of that quantity.

Restdruck: *residual stress.* A stress which persists in a solid, due not to the existence of external forces but apparently to the fact that certain portions have been stressed beyond the elastic limit while the adjacent portions have not.

Restionisation: *residual ionization.* Ionization of air or other gas in a closed vessel, not accounted for by recognizable agencies in the immediate neighborhood (X-rays, radioactivity, etc.). Formerly supposed to be an inherent property of the gas, but now attributed to the cosmic rays.

Restladung: *residual charge.* The charge on the plates of a condenser, which remains temporarily bound, after an initial discharge, by that part of the polarization of its imperfect dielectric which is due to electron migration.

restliche magnetische Induktion: *residual magnetic induction.* The magnetic induction in a ferromagnetic body after the removal of the magnetizing force. It depends upon the material, the shape, and the previous history of the specimen.

Reststrahlen: *reststrahlen (Ger.), Syn. residual radiation.* A nearly monochromatic infrared radiation isolated from the output of a white hot solid by successive reflections from surfaces of a given crystalline material, as quartz or rock salt; a method due to Rubens and Nichols, who termed the rays Reststrahlen.

Reststrahlung: *residual radiation.* See Reststrahlen.

reversible: *reversible.* In re a succession of changes in a system: such that if the order in time of the changes is reversed, the only alteration in the corresponding changes in energy is reversal of sign.

reversible Maschine: *reversible engine.* A heat engine working in a reversible thermodynamic cycle, e.g., a Carnot cycle.

reversibles Pendel: *reversible pendulum.* A pendulum provided with two pivots at conjugate points, from which it swings in equal times.

Reynolds'sche Gesetze: *Reynolds laws.* (1) States that for a mobile liquid in a straight tube, the gradient of the head is proportional to the speed of flow up to the critical velocity; whereas, at speeds above this, it is proportional to a higher power of the speed. Thus

$$\frac{dH}{dx} = -Av^n$$

where $n \leqq 1$. (2) States that the critical velocity of a liquid flowing in a straight tube is inversely proportional to $\rho\phi r$, in which ρ is the density and ϕ the fluidity coefficient of the liquid and r is the radius of the tube.

reziproker Viskositaetskoeffizient: *fluidity coefficient.* The reciprocal of the viscosity coefficient.

Reziprozitaetsgesetz: *reciprocity law (photographic).* States that the time of exposure and the illumination required to produce a given photographic effect on a plate or film are in reciprocal relation to each other; so that exposures having the same value of the product It will, after the same development, result in the same density of image. The law is not strictly true.

Reziprozitaetslehrsatz: *reciprocity theorem.* One of several analogous theorems, e.g.: (1) A principle of electric networks, in accordance with which the current in any branch A due to an e.m.f. in any other branch B is equal to the current B due to an equal e.m.f. in A. (2) In re a vibrating string: the amplitude of vibration at a point A due to a periodic force applied at another point B is equal to the amplitude produced at B by an equal periodic force of the same frequency applied at A.

Rheologie: *rheology.* That branch of physics which deals with the permanent or plastic deformation or the flow of matter.

Richardson'sche Gleichung: *Richardson equation.* An expression for the saturation current density of thermionic emission, in terms of the absolute temperature T of the filament:

$$I = AT^n e^{-\frac{B}{T}}.$$

Richardson used $n = \frac{1}{2}$; others have found $n = 2$ more accurate, B involves the thermionic work function.

Richard'sche Regel: *Richard rule.* States that the ratio of the molar heat of fusion to the absolute temperature of the melting point is the same for various solids.

Richtungsabhaengigkeit: *directional derivative.* Of a scalar point function F with respect to any direction in space: the scalar (dot) product of the gradient of F by the unit vector in the given direction.

Richtungsquantelung: *directional quantization.* The application of quantum conditions to the orientation of a system in space traversed by a field of force; which limits, e.g., the number of possible orientations of an atom in a magnetic field. Syn. space quantization.

Righi-Leduc'scher Effekt: *Righi-Leduc effect.* A difference of temperature which develops between the two edges of a strip of metal, in which heat is flowing longitudinally, when the plane of the strip is placed perpendicularly across a magnetic field.

Ritz'sche Formel: *Ritz formula, Rydberg-Ritz f.* A somewhat complicated modification of the Rydberg (spectral series) formula, in which allowance is made for the variation of f with the number of the line in the series.

Ritz'sches Prinzip: *Ritz principle.* States that every wave number occurring in the spectrum of a substance may be expressed as a difference between two of a much smaller group of terms characteristic of the substance. These terms correspond to what are now recognized as quantum states, in accordance with the "combination principle" of Ritz.

Rochon'sches Prisma: *Rochon prism.* A type of polarizer, consisting of two Iceland-spar prisms, one with its axis parallel to the entering beam of light, the other with its axis perpendicular to that beam. Upon passage from one prism into the other, the extraordinary ray is refracted while the ordinary is not, the separation being further increased upon emergence from the second prism.

Roehrenelektrometer: *tube electrometer.* An adaptation of the thermionic vacuum tube to use as an electrometer.

Roehrenkoeffizienten: *tube coefficients.* The constants which serve to describe the characteristics of a thermionic vacuum tube, viz., the amplification factor, the mutual conductance, the a.-c. filament-to-plate resistance, the detection coefficient, etc.

Roehrenspannungsmesser: *tube voltmeter.* An adaptation of the thermionic vacuum tube to the measurement of small a.-c. voltages.

Roehrenspektrometer: *tube spectrometer.* A type of photographic X-ray spectrometer, devised by Siegbahn and Larsson.

Roehrenvoltmeter: *tube voltmeter.* See Roehrenspannungsmesser.

Roentgen: *roentgen.* The absolute unit of X-ray dosage, viz., that obtained from the X-ray energy which, when the secondary electrons are fully utilized and secondary radiation from the wall is avoided, produces in 1 cm^3 of air at N.T.P. such a degree of conductivity that the quantity of electricity measured at saturation current is 1 e.s.u. Syn. r unit.

Roentgenlehre: *roentgenology.* That branch of science which deals with X-rays, esp. with their biological effects and uses, including applications to medical diagnosis and therapy.

Roentgenmesser: *roentgenmeter.* An instrument of the ionization-chamber type for measuring the intensity of X-rays or gamma rays.

Roentgenologie: *roentgenology.* See Roentgenlehre.

Roentgenspektrometer: *X-ray spectrometer, x-r. spectrograph.* An apparatus for measuring the wave lengths of X-rays by means of their reflection by crystals; somewhat analogous to a grating spectrometer for light, the crystal taking the place of the grating. In the spectrograph form the reflected rays are photographically recorded.

Roentgenstrahlen: *Roentgen rays, Syn X-rays.* A type of electromagnetic radiation of wave length varying from 10^{-9} to 10^{-7} cm, and highly penetrating; discovered by Roentgen in 1895.

Roentgenvakuum: *X-ray vacuum.* A region in which the gas pressure has been reduced below 0.01 mm; so called because a pressure as low as this is necessary in an X-ray tube.

Roentgenverfaerbung: *roentgenization.* The discoloration which develops in some transparent substances, such as glass, after prolonged irradiation with X-rays.

Roget'sche Spirale: *Roget spiral.* A helix of wire which contracts in length when a current is sent through it, because of the mutual attraction of the turns.

Rotation: *rotation.* A motion of a body or a figure, in which all the particles or points move in circles about the same axis with the same angular velocity.

Rotation eines Vektors: *curl.* A vector differential operator, much used in physics, which, applied to a vector point function F, is denoted by the symbol $\nabla \times F$ and read "curl F" or "del cross F". If the three components of the vector F are iF_1, jF_2, kF_3, then the operator is defined by the determinant

$$\nabla \times F = \begin{vmatrix} i & j & k \\ \delta & \delta & \delta \\ \hline \delta x & \delta y & \delta z \\ F_1 & F_2 & F_3 \end{vmatrix}$$

Rotationsachse: *rotation axis.* A line within the structure of a unit crystal cell, about which atoms are arranged in regular plane polygons centered upon the axis; so that only simple rotation would be required to bring any atom into coincidence with another in the same plane.

Rotationsanalyse: *rotational analysis.* (1) The analysis of a molecular rotation spectrum, i.e., a setting forth of the constants relating to the series of lines constituting such a spectrum. (2) The analysis of the rotational fine structure of an atom spectrum, due to nuclear spin.

Rotationsdiagramm: *rotation diagram.* The photographic record of diffracted beams produced when a slender beam of homogeneous X-rays impinges upon a rotating single crystal.

Rotationsdispersion: *rotatory dispersion.* A type of optical dispersion arising from the fact that the polarization plane of polarized light of different wave lengths is rotated at different rates by optically active substances, so that the light emerges from such a substance with different colors polarized in different planes.

Rotationsentropie: *rotational entropy.* That part of the entropy of a body which is concerned with molecular rotation.

rotationsfreie Bewegung: *irrotational.* (1) Free from rotatory motion; esp. in re the motion of a fluid. (2) In re a vector: Syn. lamellar, noncircuital.

Rotationsintegral eines Vektors: *circuitation.* The line integral of a vector point function taken around a closed path.

rotationsintegral: *circuital.* In re a vector point function: having a circuitation not equal to zero; not lamellar. Syn. rotational.

Rotationspolarisation: *rotatory polarization, Syn. optical rotation.* See optische Rotation.

Rotationsquantenazhl: *rotational quantum number.* A

quantum number which determines the total angular momentum of a molecule, exclusive of nuclear spin, and either inclusive or exclusive of electron spin (for which it is denoted, respectively, by J and K).

Rotationsspektrum: *rotation spectrum.* An X-ray spectrum or diffraction pattern, produced by a crystal which is rotated while an X-ray beam traverses it.

Rotationsstruktur: *rotational structure.* (1) The fine structure of an atomic spectrum supposed to be due to the rotation of the nucleus in conformity with quantum conditions. (2) The structure of a molecular rotation spectrum.

Rotationstemperatur: *rotational temperature.* The temperature of an excited vapor as indicated by the radiation energy distribution in the rotational spectrum. This may be quite different from the temperature deduced from the translational energy distribution, i.e., from the true temperature as usually defined.

Rotationstraegheit: *rotational inertia, Syn. moment of inertia.* Of a rigid body with respect to any axis: the volume inegral of the product of the element of mass by the square of its distance from the given axis. It represents the torque required, per unit angular acceleration in radian measure, to change the speed of rotation of the body about that axis.

Rotationsvermoegen: *rotatory power.* The amount of optical rotation produced in a beam of polarized light by an optically active substance, per unit length of path, in degrees per millimeter or per centimeter. Divided by the density, it gives the specific rotatory power. Molar (or atomic) rotatory power is the specific rotatory power multiplied by the molecular (or atomic) weight. The Verdet constant is sometimes called specific magnetic rotatory power.

Rotationsvoltmeter: *rotary voltmeter.* A type of electrostatic voltmeter for high voltages.

Rotationszustand: *rotational state.* One of the quantum states or energy levels of molecular rotation, changes in which are responsible for molecular rotation spectral lines.

Rotator: *rotator.* (1) An optical apparatus, as a quartz plate cut perpendicular to the optic axis, which rotates the polarization plane of light traversing it. (2) In quantum theory: a point-mass endowed with uniform motion about a fixed center. (3) A mechanism for giving objects mounted upon it a motion of rotation.

Rotor: *rotator.* See Rotator.

Rotorfeld: *rotary field.* A magnetic field, of which the direction of the magnetic-intensity vecor rotates about an axis perpendicular to itself. Such fields are commonly produced by means of magnets excited by polyphase currents, e.g., in induction motors.

Rotverschiebung: *red shift.* (1) A general shift of the lines of a spectrum in the direction of longer wave length, due to the Doppler or other effect. (2) In particular, an increase in wave length observed in the spectra of distant spiral nebulae or galaxies, which appears to be progressively greater with greater distance, and the cause of which is not definitely known.

Rowland'sches Gesetz: *Rowland law.* See Bosanquet'sches Gesetz.

Rowland'sche Gittermontage: *Rowland mounting.* A mounting for concave gratings, in which the slit is at the vertex of a right-triangular frame and the grating and the eyepiece or camera are at opposite ends of the (movable) hypothenuse.

Rowland'scher Kreis: *Rowland circle.* The circle upon which lie the slit, grating, and line images in a Rowland concave grating spectrograph.

Rowland'scher Ring: *Rowland ring.* A sample of magnetic material, prepared in the form of a ring in order to test its magnetic properties by using it as the core of a transformer arrangement.

Rueckkehrkoeffizient: *restitution coefficient.* The ratio of the relative speed of two elastic spheres, after a collision in their line of centers, to the relative speed before the collision. According to Newton's experiments, this ratio is constant for the same two spheres.

Rueckkehrungskoeffizient: *restitution coefficient.* See Rueckkehrkoeffizient.

Rueckkopplung: *feedback.* An arrangement of a radio receiving apparatus in which the plate circuit of the detector tube is coupled to the grid circuit of the same tube, thus rendering it regenerative and very sensitive.

Rueckstoss: *recoil.* The motion of an atom because of the emission of an alpha particle, a beta particle, a neutron, or (possibly) a quantum of radiation; or the motion of an electron because of having functioned in the Compton effect. Recoil rays are streams of such recoiling particles.

Rueckstossfaktor: *recoil factor.* The ratio of the intensity of scattered X-rays modified by the Compton effect, as calculated on the quantum theory, to its classical value.

Ruhelagewinkel: *angle of friction.* The angle whose tangent is the friction coefficient.

Ruhemasse: *rest mass.* The mass of a body in the classical or Newtonian sense, i.e., not including the additional mass which, according to the relativity theory, the body acquires when set in motion.

Ruhepotential: *rest potential.* A residual p.d. between an electrode and the electrolyte, which remains after the electrode has become polarized; as distinct from the true electrokinetic potential developed when the solid and the liquid are in contact.

Rumpf: *Rumpf (Ger., "trunk").* The very stable electron group which remains when a chemically active atom is ionized by the removal of its incomplete outer shell of electrons. See also Kern.

Rumpfatom: *kernel.* See Kern.

Runge'sches Gesetz: *Runge law.* States that the wave number for the first line of the second (diffuse) subsidiary series of the line spectrum of an element is equal to the difference between that for the common limit of the two subsidiary series and that for the limit of the fundamental or Bergmann series.

Runge'scher Nenner: *Runge denominator.* The smallest integer r such that the positions of the lines in a Zeeman pattern are integral multiples of 1/r, when the unit used is the Lorentz unit.

Runge'sche Regel: *Runge rule.* States that in the anomalous Zeeman effect the separation in frequency, or resolution, for a given line bears a simple commensurable ratio (2:3, 5:3, etc.) to the separation in the normal Zeeman effect.

Rupert'sches Troepfchen: *Rupert drop.* A globule of glass which has been suddenly congealed by allowing the fused drop to fall into water, and in which there are residual stresses which will cause it to explode violently upon a slight shock.

Russell-Saunder'sche Kopplung: *Russell-Saunders coupling.* A condition in an atom in which the torques between spins and those between orbital angular momenta are much stronger than the torque between the resultant of all spins and the resultant of all orbital angular momenta.

Rutherford-Bohr'sches Atom: *Rutherford-Bohr atom.* See Bohr'sches Atom.

Rutherford'sches Streuungsgesetz: *Rutherford scattering law.* A (classical) expression for the effective cross section about the nucleus of an atom, which an alpha particle must enter in order to be scattered into a solid angle $d\omega$ at a deviation Θ from the initial direction; viz., $(EE'/2mv^2)^2 \csc^4 \frac{1}{2}\Theta d\omega$, in which E and E' are the charges (in electronic units) of the nucleus and the alpha particle and m is the mass and v the speed of the alpha particle.

Rydberg'sche Formel: *Rydberg formula.* An approximate formula for the wave numbers of lines in hydrogen-like atomic spectral series, viz.,

$$\frac{1}{\lambda} = \frac{1}{\lambda_\infty} - \frac{R(z+1)^2}{(m+f)^2};$$

in which λ_∞ is the wave length for the series limit, R is (approximately) the Rydberg constant, z indicates the state of ionization (0 if not ionized, 1 if singly ionized, etc.), f is a fraction common to all the lines of the series, and m = 2, 3, 4, ...

Rydberg-Frequenz: *Rydberg fundamental frequency.* The frequency equivalent to the wave number expressed by the Rydberg constant R, therefore equal to cR, in which c is the speed of light. Its value for hydrogen is 3.2878×10^{15}/sec. *Note.* Some authors have called this quantity the Rydberg constant.

Rydberg Konstante: *Rydberg constant.* The coefficient R in the Rydberg formula for wave numbers of spectral lines. Its theoretical value is

$$R = \frac{2\pi^2 me^4}{ch^3\left(1 + \frac{m}{M}\right)};$$

in which m and e are electronic mass and charge, M is the molecular mass, c is the electromagnetic constant, and h is the Planck constant. For hydrogen its value is 109677.76 cm^{-1}; for an infinite nuclear mass it would be 109737.42 cm^{-1}.

Rydberg'scher Nenner: *Rydberg denominator.* The denominator (2^2, 3^2, etc.) of a spectral term.

Rydberg-Ritz'sche Formel: *Rydberg-Ritz formula.* See Ritz'sche Formel.

Rydberg-Schuster'sches Gesetz: *Rydberg-Schuster law.* States that the wave number for the first line of the principal series of the line spectrum of an element is equal to the difference between that for the limit of the principal series and that for the common limit of the two subsidiary series.

S-Elektron: *s-electron.* An orbital electron for which the azimuthal quantum number is zero.

S-Zustand: *S-state, S-level.* The state of an atom in which the azimuthal quantum number is zero.

Sabin: *sabin.* A unit of (acoustic) equivalent absorption, equal in its absorbing effect to 1 ft^2 of a completely absorbing surface. Named for W. C. Sabine.

Sabine'sches Gesetz: *Sabine law.* Expresses the reverberation time of a hall or auditorium, in seconds, as

$$T = \frac{0.164V}{aS}$$

in which V is the volume of the room in m^3, S the total area of its exposed surfaces in m^2, and a the mean acoustic absorptivity of those surfaces for vocal sounds.

Saccharimeter: *saccharimeter.* A form of polariscope for measuring the rotatory power of sugar solutions and similarly active liquids.

Sackur'sche Gleichung: *Sackur equation.* An expression for the molar entropy of a perfect monatomic gas in terms of its volume v, its atomic weight w, and its absolute temperature T viz.,

$$s = R \log_e (vw^{3/2}T^{3/2}) + s_o,$$

in which R is the ideal gas constant. S_0 is the Sackur-Tetrode constant, the value of which is about —11.05 cal/mol deg.

Saettigung: *saturation.* (1) The condition of a space in which the vapor pressure of some substance contained therein has reached the highest value possible at the existing temperature; or that of a solution when at maximum concentration for the existing temperature. (2) (Magnetic.) The condition of a magnetic substance whose magnetization has reached its highest possible value. (3) That attribute of a chromatic color which determines its degree of difference from an achromatic color of the same brilliance.

Saettigungsanteil: *fraction of saturation.* The ratio of the actual pressure of a vapor to the maximum, or saturated, vapor pressure at the same temperature.

Saettigungsstrom: *saturation current.* The limit which the current through an ionized gas, the thermionic current, or the photoelectric current approaches with increasing voltage, i.e., its value when the ions are carried off as fast as they are released.

Saeule: *head.* See Kopf.

Saint-Venant'sche Gleichuny: *Saint Venant equation.* An equation relating to the adiabatic flow of a fluid, the form of which is

$$\tfrac{1}{2}(V_2^2 - V_1^2) = \int_{p_2}^{p_1} v\,dp\ ;$$

where p is pressure (in absolute units), v is specific volume, and V is speed of flow, corresponding to two points denoted by the subscripts 1 and 2. It is due to Saint Venant and Wantzel.

Sammelpunkt (opt.): *center of collineation.* See Kollineationszentrum.

Sammler: *accumulator.* See Akkumulator.

Satellit: *satellite.* One of the fainter components of a multiplet spectral line.

Sauerstoffpunkt: *oxygen point.* The equilibrium temperature between liquid and gaseous oxygen at 760 mm pressure; a standard temperature point, taken as —182.97 degrees C.

Savart'sche Platte: *Savart plate.* A device consisting of two calcite plates of equal thickness, cut parallel to the natural cleavage faces and mounted with corresponding edges at right angles. Used to detect the presence of polarized light by means of interference fringes, on a principle first described by Brewster.

"Scale of eight": *scale of eight.* A vacuum tube circuit for counting pulses, in groups of eight, from ion or photon counters.

Schale: *shell.* (1) (Electronic.) A group of electrons, supposed to form part of the outer structure of an atom, and having a common energy level. (2) A lamina of magnetic material in which the lines of induction are in the direction of its thickness. Its strength is the magnetic moment per unit area.

Schallenergiefluss: *sound energy flux.* The average rate of flow of sound energy through any specified area, taken over a complete period.

Schallintensitaet: *sound intensity.* The sound energy flux per unit area of a plane or spherical sound wave front.

Schallintensitaetsmesser: *phonometer.* See Phonometer.

scharfe Serie: *sharp series.* One of several spectral series in the characteristic spectrum of an element; so called because of the small half-widths of the lines. Sometimes called second subordinate series.

Schatten: *shade.* A chromatic color of relatively low saturation and relatively low brilliance.

Schattierung: *hue, tint.* See Faerbung, Nuance.

Schauer: *shower (cosmic-ray).* The production of from two to several associated ion pairs at the same instant, apparently due to cosmic rays.

scheinbare Kerzenstaerke: *apparent candle power.* A measure of the equivalent luminous intensity of an extended source of light at a specified distance, viz., the candle power of a point source which would produce the same illumination at the same distance.

scheinbarer Durchmesser: *apparent diameter.* The angle subtended at the eye of the observer by the diameter of any object. Syn. angular diameter.

scheinbare Leistung: *apparent power.* The product of the effective e.m.f. and the effective current in an a.-c. circuit. Multiplied by the power factor, it gives the average power.

scheinbares Loesungsvolumen: *apparent volume in solution.* The volume of a solution minus the volume of the pure solvent entering into it at the same temperature. Apparent specific volume in solution: the apparent volume in solution per unit mass (mol or gram) of solute.

Scherspannung: *shear.* A type of strain in which adjacent laminar elements have a progressive relative displacement; so that a cube is skewed into a rhombic prism, etc. Its measure is the amount of relative displacement per unit thickness perpendicular to the direction of the displacement; or, the tangent of the angle of shear.

Scherungsdruck: *shearing stress.* The stress which accompanies shear in an elastic body; measured by the tangential force per unit area parallel to the relatively displaced laminar elements.

Scherungsgrenzenmesser: *pachimeter.* See Pachimeter.

Scherungskoeffizient: *rate of shear.* The derivative of the speed of flow of a fluid with respect to distance measured at right angles to the relatively moving layers.

Scherungsmodul: *rigidity modulus, Syn. shear modulus.* The ratio of the shearing stress in an elastic substance to the strain (shear) which accompanies it.

Scherungswinkel: *angle of shear.* The angle through which any plane, originally perpendicular to the displacement laminae, is skewed in the process of shear, and whose tangent is the measure of the shear.

Schicht: *sheath.* A part of an electric discharge in a rarefied gas, in which there is a space charge because of the great predominance of particles of one sign over those of the other.

target. (1) Syn. anticathode. (2) A cold plate placed in the path of a beam of molecular rays, which condense in a spot on the cold surface.

Schirmgitterroehre: *screen-grid tube.* A form of amplifier vacuum tube in which the plate is surrounded by a positively charged wire mesh, in order to prevent variations of plate potential from affecting the grid filament circuit and thus causing feedback.

schlagen: *hammer, hammering.* See klopfen.

Schleife: *loop.* (1) Syn. antinode. (2) A graph in the form of a cyclic closed curve, e.g., a hysteresis loop.

Schleifdrahtbruecke: *slide-wire bridge.* A bridge circuit, one or more branches of which are controlled by a sliding contact whose position can be adjusted along a wire stretched upon a linear scale.

Schleifenelektrometer: *string electrometer.* An electrometer consisting of a conducting fiber stretched midway between two conducting plates parallel to it. The field between the plates displaces the fiber laterally by an amount dependent upon the p.d.

Schleifengalvanometer: *string galvanometer.* See Einthoven-Elektrometer.

Schlupf: *slip.* The excess of the angular speed of the rotating field of an induction motor over that of the rotor, expressed either in rpm or as a fraction or percentage of the field speed.

Schmelzkurve: *fusion curve.* The fusion curve follows the equilibrium between solid and liquid states.

Schmelzwaerme: *heat of fusion.* The quantity of heat absorbed by a substance, per unit mass, upon passing from the solid to the liquid state, or released upon solidification; in either case without change of temperature.

Schnecken-oder Schraubenlinie: *helix.* (1) A space curve which lies in the surface of a cylinder, and resembles a corkscrew. (2) A coil of wire wound in the approximate form of a geometrical helix.

Schnittmodul: *section modulus.* The ratio of the sectional moment of inertia of the cross section of a beam

or rod to the distance from the neutral axis to the most distant point of the section.

Schnittraegheitsmoment: *sectional moment of inertia.* The areal moment of inertia of the cross section of an elastic beam or column with respect to the neutral axis; a constant which appears in formulas for the flexure of such members.

Schottky-Effekt: *Schottky effect.* (1) The dependence of the saturation current in a thermionic vacuum tube upon the electric intensity E at the cathode; expressed by

$$I_s = \frac{1.91}{T}\sqrt{E}$$

in which T is the absolute temperature of the cathode. (2) Syn. shot effect.

Schroedinger'sche Gleichung: *Schroedinger equation.* A wave equation set up by Schroedinger to represent the de Broglie wave. It contains the wave function Ψ in the form

$$\nabla^2\Psi + \frac{8\pi^2 m}{h^2}(W - V)\,\Psi = 0$$

in which m is the particle mass, W the total energy, V the potential energy, and h the Planck constant.

Schroteffekt: *shot effect.* A statistical irregularity in the emission of thermions or photoelectrons, which, upon amplification, may be detected by a popping noise in a telephone receiver. First explained by Schottky. Syn. Schottky effect.

Schueler'sche Roehre: *Schueler tube.* A vacuum tube having a hollow cathode, used for the production of ionized gas or vapor spectra.

Schumann Bereich: *Schumann region.* A range of very short ultraviolet wave lengths, extending down to about 1200 Å.

Schumann Gebiet: *Schumann region.* See Schumann Bereich.

Schumann Platte: *Schumann plate.* A type of photographic plate, containing very little gelatin, prepared by V. Schumann, and especially adapted to use in the extreme ultraviolet and in positive-ray analysis.

Schutzring: *guard ring.* An outer region A surrounding any enclosure or area B in which it is desired to maintain uniform conditions throughout or to avoid edge effects; B being shielded from nonuniformity by creating in A approximately the same conditions as those required in B.

Schwaechung: *attenuation.* The falling off of the flux density, as of radio waves, with distance from their source, due to any cause.

Schwaechungsfaktor: *attentuation factor.* A measure of the transparency of a layer of absorbing medium for an emission traversing it. It is the ratio of the flux density I of the emergent emission to the flux density I_0 of the incident emission, for an exponentially absorbed emission, the value of the factor, for thickness x of a medium whose absorption coefficient is μ, is $e^{-\mu x}$. Syn. transmission factor.

Schwankung: *hunting.* (1) The alternate lag and advance of a synchronous motor with respect to the current, or of one of two coupled alternators with respect to the other. (2) A condition of instability in a control device, such as the thermostat or an engine governor, resulting in large fluctuations in the quantity which the device is intended to keep constant.

Schwankungskurve: *rocking curve.* The graph or contour of the intensity variation of the X-ray reflection from a crystal with the angle of incidence in the neighborhood of a diffraction maximum. The amplitude of variation of the incidence angle is the rocking angle.

Schwankungsphotometer: *flicker photometer.* A photometer in which the matching of illuminations is determined by the absence of flicker when one is rapidly substituted for the other in the field of view.

schwarzer Koerper: *black body.* See idealer Strahler.

schwarze Koerperfunktion: *black-body function.* (1) The product σT^4, representing the emissive power of a black body at absolute temperature T, in accordance with the Stefan-Boltzmann law; σ being the S.-B. constant. (2) The function expressing the value of $dE\lambda/d\lambda$ in the Planck equation.

schwarze Koerperkonstante: *black-body constant, Syn. Stefan-Boltzmann constant.* The constant of proportionality in the Stefan-Boltzmann law for the emissive power of a black body. Its experimental value is 5.735×10^{-5} erg cm^{-2} sec^{-1} deg^{-4}.

schwarze Koerperstrahlung: *black-body radiation, Syn. cavity radiation.* See Hohlraumstrahlung.

schwarze Koerpertemperatur: *black-body temperature.* The temperature of any body as indicated by a radiation pyrometer which has been calibrated by the use of a black body.

Schwebung: *beat.* A maximum or minimum of intensity arising from the interference of two wave trains of unequal frequency.

Schwebungston: *beat tone.* A musical tone due to beats, produced by the interference of two h.-f. wave trains, as in radio reception.

Schwellenfrequenz: *threshold frequency.* See langwellige Grenze.

Schwere: *gravity.* (1) The resultant effect, upon any body of matter belonging to the earth or other planetary mass, of the gravitational field of the mass and the centrifugal force of the body due to the planetary rotation. (2) The intensity of the effect (1), as measured by the force per unit mass of the body, or by the resulting acceleration of the body if free to move; commonly denoted by g. Its standard terrestrial value is taken by international agreement as 980.665 cm/sec^2.

Schwerdruck: *gravity force.* Is the force which the earth exerts on a body and which is distributed evenly throughout that body. This force can be thought to be concentrated at the center of gravity.

Schwerepotential: *gravitational potential.* See Gravitationspotential.

schwerezentrisch: *centrobaric.* Having a true center of gravity. A rigid body is centrobaric if the resultant gravitational attraction of an external particle for it is equivalent to a single force which always passes through one point fixed relatively to the body (its center of mass), irrespective of its orientation and position. E.g., a homogeneous sphere or spherical shell is centrobaric, but bodies in general are not. Syn. baricentric.

Schwerdruckzentrum: *center of gravity.* Is that point in body, at which the total weight of the body can be assumed to be concentrated.

Schwerkraftkonstante: *gravitation constant.* See Gravitationskonstante.

Schwerpunkt: *center of gravity.* The c.m. of a centrobaric body. Center of gravity and center of mass have come to be synonymous in common usage; but in a nonuniform gravitational field a center of gravity, in its true sense, exists only for centrobaric bodies.

Schwimmflaeche: *flotation plane.* The plane of the level surface of the liquid in which a body floats.

Schwingzeit: *period.* See Periode.

Schwingungsanalyse: *vibrational analysis.* The analysis of a molecular spectrum into bands, with the assignment of a definite pair of vibrational quantum numbers to each band, and the determination of a formula for all the bands in terms of these two quantum numbers.

Schwingungsdauer: *period.* See Periode.

Schwingungsgalvanometer: *vibration galvanometer.* A type of a.-c. galvanometer in which the natural oscillation frequency of the moving element is equal to the frequency of the a.-c. applied to it.

Schwingungsgenerator: *circuit driver.* A source of h.-f. e.m.f., esp. of the vacuum-tube-controlled type, for experimental use. Syn. radio-frequency generator.

Schwingungsmesser: *vibroscope.* An apparatus, consisting of tuning forks vibrating at right angles, used by Lissajous for studying harmonic motions.

Schwingungsquantenzahl: *vibrational quantum number.* A quantum number, associated with the vibration of the atoms about mean positions in a molecule, which must be an integer for any permissible stationary state of such vibration.

Schwingungsspektrum: *vibration spectrum.* See Molekuelspektrum.

Schwingungstransformator: *oscillation transformer.* A helix of many turns in which very high p.d.'s are produced by means of inductive coupling with a circuit containing a condenser and a spark gap. A transformer having such a coil as its secondary, with the condenser and gap in the primary circuit, is called a Tesla oscillation transformer.

Schwingungszentrum: *center of oscillation, center of suspension.* (1) One of two conjugate points of a gravity pendulum, of which the other is the center of suspension. (2) One of two conjugate points of a gravity pendulum, of which the other is the center of oscillation.

sechseckig: *hexagonal.* See hexagonal.

Seebeck'scher Effekt: *Seebeck effect, Syn. thermoelectromotive force.* The e.m.f. given by two contacting metals and depending upon the metals and upon the temperature distribution in them. In a circuit of different metals joined in series, the resultant e.m.f. is the algebraic sum of the e.m.f.'s due to the several conjoined pairs. Discovered by Seebeck in 1821.

Sehachse: *visual axis.* The line joining the fixation point of the ocular field of view with the first nodal point of the eye.

Sehwinkel: *visual angle.* The angle formed at the eye by any two rays of light entering it.

Seismograph: *seismograph.* An apparatus for record-

ing the time, the direction, and the intensity of seismic disturbances (earth tremors).

Seitenband: *side band.* A component of a modulated carrier current (or carrier wave) which comprises frequencies either above or below the carrier frequency, including those current (or wave) components whose frequencies are the sum or the difference of the carrier and the modulation frequencies; called the upper and the lower side band, respectively.

Sekundaerelektron: *secondary electron.* (1) An electron belonging to a secondary emission, as those emitted in various directions by substances bombarded by cathode rays. (2) That electron which, after a collision of two electrons, has the less energy.

Sekundaeremission: *secondary emission.* An emission from matter which results from exposure to a primary emission; e.g., fluorescence or photoelectrons. If it is in the nature of radiation, it is usually called secondary radiation.

Sekundaerfluoreszenz: *sensitized fluorescence.* A "second-hand" fluorescence, viz., the emission of radiation by one atom due to energy received in collision with another atom which has been excited by radiation.

Sekundaerkreis: *secondary circuit.* The circuit in which an e.m.f. is induced by the variation of the current in another circuit, the primary, as in a transformer.

Sekundaerspektrum: *secondary spectrum.* (1) The spectrum of the hydrogen molecule as distinct from that of the atom. (2) A spectrum overlapping from another order. (Rare or obs. in this sense.)

sekundaerer Standard: *secondary standard.* See Prototyp.

Sekundaerstandard: *secondary standard.* (1) A unit defined as a specified multiple or submultiple of a primary standard; e.g., the centimeter and the foot, based, respectively, upon the standard meter and the standard yard. (2) Syn. prototype.

Sekundaerstruktur: *secondary structure.* A regularly recurring variation which may exist in the atomic lattice arrangement or primary structure of a crystal by reason of electric or other stresses inherent in its physical make-up and which is manifested as a distortion of the lattice and a variation of the lattice "constant" from point to point.

Sekundaerzelle: *secondary cell, Syn. storage cell.* See Primaerzelle.

Selbstinduktion: *self-induction.* An e.m.f. induced in a circuit, due to the change in the magnetic flux linked with it as a result of the variation of current in the circuit itself.

Selbstionisation: *auto-ionization.* An automatic dissociation of a molecule, which occurs when the sum of its vibrational and electronic energies exceeds the energy necessary for dissociation.

selbstphotoelektrisch: *autophotoelectric.* See autophotoelektrisch.

Selbsttransformator: *autotransformer.* See Autotransformator.

Selektanz: *selectance.* Any one of several measures for the falling off of the response of a resonance device with departure from resonance; e.g., the ratio of the amplitude of response at resonant frequency to that at some frequency differing from it by a specified amount.

selektiv: *selective.* (1) Operating on a group of individuals, in different degrees depending upon some variable attribute of the members of the group. E.g., a selective reflector reflects a larger proportion of some wave lengths than of others. (2) In re an emitter of radiation; yielding radiation of different spectral energy distribution from that of a black body at the same temperature.

Selektivitaet: *selectivity.* The degree in which any operation is selective, expressed in suitable measure, e.g., selectance, spectral resolving power, etc.

Selenzelle: *selenium cell.* An arrangement in which is suitably mounted a thin film of selenium provided with electric terminals, for utilizing the photoconductive property of that element.

Sellmeier'sche Dispersionsformel: *Sellmeier dispersion formula.* See Ketteler-Helmholtz Dispersionsformel.

semipermeable Membran: *semipermeable membrane.* See halbdurchlaessige Membrane.

senkrecht: *vertical.* (1) The direction of gravity. (2) (Geocentric.) The direction of the radius of the earth. The two cioncide, in general, only at the poles and at points on the equator.

Serie: *series.* See Reihe.

Seriengrenze: *series limit.* The convergence frequency of a series of spectral lines. No line occurs at this point, but a related continuous spectrum may begin just beyond it.

Shenstone'scher Effekt: *Shenstone effect.* An increase in the photoelectric emission of certain metals immediately after having been traversed by an electric current.

Shower: *shower.* See Schauer.

Shunt: *shunt.* See Nebenschluss.

sichtbar: *ocular.* See augenscheinlich.

Sichtbarkeitsfaktor: *visibility factor.* For radiation of a given wave length: the ratio of the luminous flux at that wave length to the corresponding radiant flux. For the normal eye it has a maximum in the green, of about 660 lumens per watt. An expression for this factor in terms of wave length is called a visibility function.

Sichtbarkeitsfunktion: *visibility function.* See Sichtbarkeitsfaktor.

Sichtbarkeitsmesser: *visibility meter.* An instrument for measuring the clearness of definition with which an object can be seen under given circumstances.

Sieden: *ebullition.* See Kochen.

Siedepunkt: *boiling point (of a liquid).* The temperature at which the maximum vapor pressure of the liquid is in equilibrium with the superimposed pressure. If the latter is the normal atmospheric pressure (760 mm), this temperature is the normal boiling point.

Siedepunktsgesetz: *boiling-point law.* States that the boiling point of a solvent is elevated by the addition of a nonvolatile solute in proportion to the molar concentration of the solute. The boiling-point constant is the elevation in boiling point produced by adding 1 mol of a solute to 1000 g of solvent.

Siedepunktskonstante: *boiling-point constant.* See Siedepunktsgesetz.

Sigma-Wert: *sigma value.* The value of the quantum number which quantizes the component of angular momentum of spin about the axis of figure in a diatomic molecule.

Silikastab: *silica pencil.* A rod of silica, electrically heated and used as a source of infrared.

singender Lichtbogen: *singing arc.* An electric arc of such characteristics as to generate an oscillating current of audio frequency when an inductance and a condenser are connected across it; e.g., the Duddell carbon arc or the Poulsen carbon-copper arc. Syn. oscillating arc.

singende Roehre: *singing tube.* A pipe or resonator set into musical vibration by local heating. Special forms have been devised by Bosscha, Knipp, Rijke, and others.

singulaerer Punkt: *singular point (or line).* A point (or line) in a field of force, at which (or along which) the field intensity or the potential gradient is zero.

singulaere Temperatur: *singular temperature.* A temperature at which some property of a substance becomes discontinuous, e.g., a transition temperature at which the specific heat has a discontinuity.

Sinusbedingung: *sine condition.* A condition, stated by Abbe, which is fulfilled by any aplanatic optical system. If n_1 and n_2 are the refractive indices of the media in which the object and the image lie, if a_1 and a_2 are the angles made with the axis by any ray as it leaves the object and as it reaches the image, and if y_1 and y_2 are corresponding linear dimensions of object and image, the condition is expressed by

$$\frac{\sin a_1}{\sin a_2} = \frac{n_2 y_2}{n_1 y_1}.$$

sinusfoermig: *sinusoidal.* Varying in proportion to the sine (or the cosine) of an angle or of a time function.

Sinusgalvanometer: *sine galvanometer.* An instrument resembling a tangent galvanometer, but in which the coil is turned until it lies in the plane of the deflected needle. The sine of the deflection is then proportional to the current.

Sirene: *siren.* An acoustic instrument consisting of a revolving disk perforated with equally spaced holes, through which blasts of air escaping in rapid succession produce a musical tone.

skalares Produkt: *scalar product.* In re two vectors, P_1, P_2: the product of the magnitudes of the two vectors by the cosine of the angle between them. Syn. dot product, because of the use of a dot between the two vector symbols to indicate it: $P_1 \cdot P_2$.

Skiaskop: *skiascope.* An instrument for studying the optical refraction within the eye.

Skineffekt: *skin effect.* See Hauteffekt.

Slug (engl. Masseneinheit): *slug.* A name proposed for a unit of mass in the British gravitational system; defined as the mass of a free body which, if acted upon by a force of 1 lb, would experience an acceleration of 1 ft/sec^2. Its value is thus about 32.17 lb.

smetisch: *smetic.* See mesomorph.

Smith-Helmholtz'sche Formel: *Smith-Helmholtz formula.* An invariant relation concerning the imagery produced by paraxial rays in a centered system of spherical refracting surfaces. If Θ_1, Θ_2, Θ_3, etc., denote the angles which a ray makes with the axis in the successive media of indices n_1, n_2, n_3, etc. and if the magnification ratios at the points where the ray crosses the axis are $y_2:y_1$, $y_3:y_1$, etc., then

$$n_1y_1\Theta_1 = n_2y_2\Theta_2 = n_3y_3\Theta_3 = \cdots\cdots$$

Snell'sches Gesetz: *Snell law.* The law of ordinary refraction of light, which states that the angles of incidence and of refraction have sines in a constant ratio to each other, and lie in the same plane. The constant ratio of the sines is equal to the refractive index.

Sol: *sol.* A highly disperse colloid (Graham).

Solarimeter: *solarimeter.* A pyrheliometer devised by L. Gorczynski for direct readings of solar radiation intensity from sun and sky.

Solarisation: *solarization.* (1) An actinic effect of sunlight or of artificial ultraviolet upon glass, which results in a reduction of its transparency to ultraviolet and is also usually accompanied by a permanent coloration. (2) A reversal of gradation sequence in a dense photographic image sometimes observed when the normal development is applied after overexposure. Still greater exposure may restore the original sequence, or may even result in a second reversal.

Solarkonstante: *solar constant.* The total intensity of the solar radiation at the outer limit of the atmosphere, hence unaffected by atmospheric absorption. Its value is about 0.032 cal/cm²sec or 1.34×10^6 ergs/cm² sec.

Soleil'sche Platte: *Soleil plate.* A type of optical compensator, somewhat like that of Babinet, but so constructed as to introduce the same relative phase change over the entire field at once, instead of varying it progressively across the field.

Solenoid. *solenoid.* A helix or cylindrical coil of wire, used to produce a magnetic field or to excite an electromagnet.

Sommerfeld'sche Konstante: *Sommerfeld constant.* A dimensionless constant, equal to $2\pi e^2/hc$; in which e is the elementary charge in e.s.u., h the Planck constant, and c the electromagnetic constant. Its value is about 0.007284.

Sonnenwaermemesser: *pyrheliometer, pyroheliometer.* See Pyroheliometer.

Soret'scher Effekt: *Soret effect.* An inequality of concentration which develops in different parts of a solution, initially homogeneous, when these parts assume different temperatures; the cooler portions becoming more concentrated than the warmer.

Sorption: *sorption.* A term including both (molecular) absorption and adsorption.

Spaltung: *cleavage.* The tendency of a crystalline substance to split along definite planes, called cleavage planes, which correspond to the layers of atoms making up the crystalline structure.

Spannung: *pull; voltage, tension.* (1) Electromotive force as measured or expressed in volts. (2) A force applied to a body in such a way as to produce elongation in the direction of the force.

Spannungsmesser: *voltmeter.* An instrument for measuring e.m.f., usually directly in volts or in multiples or submultiples thereof.

Spannungsvervielfacher: *voltage multiplier.* A series arrangement of condensers charged by rapidly rotating brushes, resulting in a high d.-c. voltage.

Spektralanalyse: *spectrum analysis.* The analysis of chemical substances by means of their spectra.

Spektralapparat: *spectroscope.* Any one of various forms of instrument for dispersing radiation and observing the resulting spectrum.

Spektralbolometer: *spectrobolometer.* An infrared spectrometer utilizing a bolometer as the receiving instrument.

spektrale Empfindlichkeit: *spectral sensitivity, Syn. photoelectric yield.* The rate of photoelectric emission from a metal per unit radiant flux of any given frequency.

Spektralenergieverteilung: *spectral energy distribution.* The distribution of the intensity of radiation throughout the spectrum, i.e., of the monochromatic flux density as a function of the wave length or frequency. Such distributions are commonly represented by graphs, viz., by spectral energy curves.

Spektralfarbe: *spectral color.* The color sensation produced by a narrow frequency range of stimulating radiation, i.e., by monochromatic light. (A similar sensation may, however, be produced in other ways; the eye being unable to make the distinction.)

Spektralhelioskop: *spectrohelioscope.* An instrument for observing an image of the entire sun by light of

one wave length. If used photographically, it is called a spectroheliograph.

Spektralkomparator: *spectrocomparator.* A comparator designed especially for the measurement of line spectra.

Spektrallinie: *spectrum line.* (1) A definite wave length or very narrow range of wave lengths; the spectrum of monochromatic radiation. It corresponds to a distinct image of the spectroscope slit made by the single wave length. (2) One of the traces made by a mass spectrograph, which correspond to atoms of different mass.

Spektrallinienverbreiterung durch Ionen-oder Atomstoss: *collision damping.* An effect upon the amplitude or phase of the radiation from an atom due to collision with other atoms, which results in one type of broadening of the spectrum lines.

Spektralphotometer: *spectrophotometer.* A combination of a photometer and a monochrometer, used for making spectroradiometric measurements in the visible.

Spektralphotometrische Analyse: *spectrophotometric analysis.* A quantitative analysis based upon the spectral energy distribution in the absorption spectrum of a substance in solution.

spektralphotoelektrisch: *spectrophotoelectric.* Pertaining to the dependence of photoelectric or photovoltaic phenomena upon the wave length of the incident radiation.

Spektralpyrheliometer: *spectropyrheliometer.* An instrument used for the determination of the spectral distribution of the total solar radiation.

Spektralradiometer: *spectroradiometer.* (1) An instrument for ascertaining the spectral energy distribution of any type of radiation, e.g., a spectrophotometer, but esp. in the infrared. (2) An infrared spectrometer. (3) An apparatus of the wavemeter type arranged to analyze the wave-length-intensity characteristic of the output from a radio transmitter.

Spektralreihen: *spectral series.* A series of frequencies occurring in a characteristic radiation or absorption spectrum, which converge, or appear at progressively shorter intervals, in the direction of decreasing wave length and in accordance with a definite numerical law. In general, the spectrum of an element may have several series, designated as principal, first subordinate or diffuse, second subordinate or sharp, fundamental or Bergmann, etc.

Spektralschwerpunkt: *spectral centroid.* The wave length which corresponds to the center of area of the wave-length-intensity (spectrophotometric) curve for light of a given quality.

spektrale Selektivitaet: *spectral selectivity.* The variation of some property of a substance or a surface with the wave length or frequency of incident radiation.

Spektralserien: *spectral series.* See Spektralreihen.

Spektraltermen: *spectral terms.* The fractions occurring in the binomials which are proportional to the frequencies or wave numbers of a spectral series.

Spektralthermograph: *spectrothermograph.* A spectrograph for the study of thermal radiation.

Spektrograph: *spectrograph.* A spectroscope which records a spectrum photographically.

Spektrometer: *spectrometer.* A spectroscope provided with a graduated circle or other equipment for measuring the deviations, and, indirectly, the wave lengths, corresponding to spectral lines.

Spektroskop: *spectroscope.* See Spektralapparat.

Spektrum: *spectrum.* The result of separating or dispersing an emission (such as light) and arranging it in accordance with some progressive property (as its frequency), which thus constitutes a systematic analysis.

Spekulum (Legierung): *speculum metal.* An alloy of tin and copper, (about 33 percent Sn), capable of taking a very high polish; used for optical mirrors and especially for reflecting gratings.

Sperrschicht: *blocking layer.* The surface of contact between a metal and a semiconductor (e.g., copper and cuprous oxide), which acts as a rectifier and, when illuminated, is the seat of a photovoltaic e.m.f. Syn. barrier layer.

spezifische Brechbarkeit: *specific refractivity.* The refractivity divided by the density.

spezifisches Brechungsvermoegen: *specific refractive power.* See Lorenz-Lorentz'sche Beziehung.

spezifische Elektronenwaerme: *electron specific heat.* That part of the specific heat of a metal which is due to the free electrons; usually negligible compared with that due to the atomic lattice. It becomes significant at very low temperatures and, for ferromagnetic metals, near the Curie point.

spezifische Energie: *specific energy.* The internal energy per unit mass of a body.

spezifische Entropie: *specific entropy.* The entropy per unit mass of a body.

spezifisches Gewicht: *specific gravity, specific weight.* (1) The ratio of the density of any substance to the maximum density of water. (2) The weight of a substance per unit volume; in absolute equal to the density multiplied by gravity.

spezifische induktive Kapazitaet: *specific inductive capacity, Syn. dielectric constant.* (1) The ratio of the dielectric constant of a substance to that of a vacuum. (2) The ratio of the capacitance of a condenser filled with a given dielectric to that of the same condenser when evacuated. See also dielektrische Konstante.

spezifische Kohaesion: *specific cohesion.* A term used, in connection with Laplace's theory of surface tension, to denote twice the ratio of the surface tension to the density of a liquid.

spezifische Ladung: *specific charge, Syn. charge-mass ratio.* The ratio of the electric charge carried by an electrified particle or ion to the mass of the particle.

spezifisch-magnetisches Rotationsvermoegen: *specific magnetic rotary power, Syn. Verdet constant.* The angle of optical rotation per oersted intensity per centimeter thickness in the Faraday effect.

spezifische Magnetisierung: *specific magnetization.* See Magnetisierung.

spezifische Rotationswaerme: *rotational specific heat.* That part of the specific heat of a substance which pertains to the energy of molecular rotation, as distinct from translational motion and internal vibration.

spezifisches Rotationsvermoegen: *specific rotatory power.* See Rotationsvermoegen.

Sprengel'sche Pumpe: *Sprengel pump.* A type of mercury air pump, dependent upon the dropping of mercury down a tube.

spezifische Schwingungswaerme: *vibrational specific heat.* That part of the specific heat of a substance which pertains to the energy of internal vibration within the molecule, as distinct from translational motion and rotation.

spezifische Suszeptibilitaet: *specific susceptibility.* See Suszeptibilitaet.

spezifische Viskositaet: *specific viscosity.* The ratio of the viscosity coefficient of a fluid to that of some standard substance, usually water at a specified temperature.

spezifisches Volumen: *specific volume.* The volume of a substance per unit mass; the reciprocal of the density.

spezifische Waerme: *specific heat.* (1) The thermal capacity per unit mass of a substance; usually expressed in cal/g°C. (2) The abstract ratio of the thermal capacity of any mass of a substance to that of an equal mass of water at 15 degrees C.

spezifischer Widerstand: *resistivity, Syn. specific resistance.* That factor of the resistance of a conductor which depends upon the material and its physical condition. Its measure is the resistance of a specimen, in the form of a rod of unit length and unit cross section, to a current traversing it longitudinally. Usually expressed in ohm-centimeters.

spezifische Zaehigkeit: *specific viscosity.* See spezifische Viskositaet.

sphaeroidaler Zustand: *spheroidal state.* A term applied to the condition of a liquid in apparent contact with a hot solid, but with a layer of the liquid's vapor between; e.g., a drop of water on a hot plate.

Sphaerometer: *spherometer.* One of several types of instrument for measuring the curvature of spherical surfaces, e.g., of lens surfaces.

Spiegelungsfaktor: *reflectance, Syn. reflection factor.* The ratio of the total luminous flux reflected by a given surface to that incident upon it.

Spinnkopplung: *spin coupling.* The interaction between the fields due to the spins of electrons. The energy differences between singlets and triplets are associated with differences in resultant spins. The term is also occasionally used for the interaction of the resultant electron spin with the resultant orbital angular momentum. Syn. spin-spin interaction.

Spinnmoment: *spin moment.* The rotational moment of momentum of an electron on its own axis.

Spinnquantenzahl: *spin quantum number.* The quantum number associated with the quantization of the angular momentum arising from the internal spin of the electrons. For a system containing a single electron, its value is $\frac{1}{2}$; in general, it is an odd or even multiple of $\frac{1}{2}$ according as the number of electrons is odd or even.

Spinor: *spinor.* A two-dimensional, complex vector; so named because it may be used to define the spin of an electron.

Spitzeneffekt: *edge effect.* See Kanteneffekt.

Spreitungskoeffizient: *spreading coefficient.* The absolute value of the change in free energy which takes place when one liquid spreads on the surface of another, e.g., a drop of oil on water.

sprunghafte Temperaturabnahme: *decalescence.* The reverse of recalescence; i.e., an abrupt decrease in the rate of temperature rise as heat is applied to the metal, indicating an endothermic structural change.

Spule: *coil.* A ring or spiral formed by winding.

Stabilitaet: *stability.* (1) That property of the stable equilibrium of a body or a system, which is measured by the amount of energy which must be applied to render it unstable. (2) The reciprocal of the sensitiveness of an instrument such as a balance.

Stabilitaetsbereich: *range of stability.* The angle through which a floating body may be rotated from its equilibrium position without capsizing, i.e., before the restoring torque becomes zero.

Staerke: *strength, force.* Any cause that produces, stops, changes, or tends to produce, stop, or change, the motion of a body.

Stalagmometer: *stalagmometer, Syn. stactometer.* An instrument for measuring the size of liquid drops, or for measuring the liquid by drops; esp. in the study of surface tension.

Standardkapazitaet: *capacitor.* A condenser of fixed capacitance used as a standard or as a capacitance load.

Stark-Effekt: *Stark effect.* A somewhat complicated effect upon the spectral series of gaseous elements, produced by subjecting the radiating atoms to a strong, transverse electric field (e.g., 100,000 v/cm); discovered in the case of hydrogen by J. Stark in 1913. Each spectral line becomes split up into polarized components.

Stark-Lunelund'scher Effekt: *Stark-Lunelund effect.* The polarization of light emitted by a beam of moving atoms in the absence of a field.

Statik: *statics.* See Gleichgewichtslehre.

stationaere Schwebungen: *stationary beats.* See Dissonanz (2).

stationaere Welle: *stationary wave.* A condition of equilibrium at certain points or along certain lines or surfaces (nodes) in a medium, with regions of vibration between them; brought about by the interference of similar wave trains traveling in opposite directions. Syn. standing wave.

statisch: *static.* (1) (adj.) Pertaining to the phenomena and laws of statics. (2) (n) Radio disturbance due to natural causes, of whatever origin.

Statisches Atom: *static atom.* See Lewis-Langmuir'sches Atom.

statische Elektrizitaet: *static electricity.* Electricity in the form of a charge in equilibrium, or considered irrespective of the effects of its motion.

statisches Gleichgewicht: *static equilibrium.* Equilibrium in which all parts of the system are relatively at rest.

statische Hysteresis *static hysteresis.* A type of permanent deformation or elastic lag in a stressed solid, which is independent of the rate of loading.

statische Laenge *static length.* The length of a body in the classical or Newtonian sense, i.e., not affected by the Lorentz-Fitzgerald contraction.

statische Maschine: *static machine.* A machine for generating electric charges, usually by electric induction. Syn. electrostatic machine, induction machine.

stationaere Linie: *stationary line.* An absorption line in the spectrum of a star which does not exhibit the Doppler shift observed in the other lines, and is attributed to the existence of absorbing gas in interstellar space. Syn. interstellar line.

statistisches Gewicht: *statistical weight.* See Quantengewicht.

statistisches Gleichgewicht: *statistical equilibrium.* That state of a statistical variable in which all variations are due to a distribution of chance causes. E.g., the molecular velocities in a gas at constant volume and temperature are in state of statistical equilibrium, which is altered to another such state when the volume is changed.

statistische Mechanik: *statistical mechanics.* That branch of physical science in which the laws describing the gross behavior of systems composed of many particles (e.g., molecules) are investigated by statistical methods.

statistische Variable: *statistical variable.* A variable whose observable magnitude is subject to chance, i.e., is under incomplete control; e.g., accidental error, the range of individual alpha particles in air, etc.

statistische Veraenderliche: *statistical variable.* See statistische Variable.

Statoskop: *statoscope.* A very sensitive aneroid altimeter.

Stefan-Boltzmann'sches Gesetz: *Stefan-Boltzmann law.* States that the total emissive power of a black body is proportional to the fourth power of its absolute temperature. First arrived at empirically by Stefan and later deduced theoretically by Boltzmann.

Stefan-Boltzmann'sche Konstante: *Stefan-Boltzmann constant.* See schwarze Koerperkonstante.

stehende Welle: *standing wave.* See stationaere Welle.

Steilheit: *mutual conductance.* In re a grid-controlled tube: the increment of plate current per unit change of grid potential. Syn. transconductance.

Steinmetz'sche Formel: *Steinmetz formula.* An empirical formula for the magnetic hysteresis loss of energy per unit volume per cycle, viz.,

$$w = aB_m^{1.6};$$

in which B_m is the maximum induction during the cycle, and a a constant known as the Steinmetz coefficient (q.v.), hysteretic constant, or hysteresis-loss constant.

Steinmetz'scher Koeffizient: *Steinmetz-coeffcient.* See Hysteresiskonstante.

Stellarinterferometer: *stellar interferometer.* An attachment for astronomical telescopes, consisting of an opaque cover over the objective in which are two parallel slits at an adjustable distance apart. Two images thus produced overlap and give rise to interference phenomena by means of which angular diameters of very small objects may be measured. Developed by Michelson.

Stereophotometer: *stereophotometer, Syn. stereoscopic photometer.* A type of photometer in which light from the two sources compared falls simultaneously upon the same moving object. If a straight path is to appear straight, the two illuminations must be equal. Devised by Pulfrich.

stereoskopisch: *stereoscopic.* Exhibiting a three-dimensional character, as in binocular vision of nearby objects.

stereoskopischer Radius: *stereoscopic radius.* The greatest distance at which the stereoscopic effect can be perceived. For the unaided eyes, it is about 1500 ft; with the aid of a prism binocular, it is greater.

Stereovermoegen: *stereo power.* In re a prism binocular or similar optical system: the ratio of the distance between objective axes to the distance between eyepiece axes, multiplied by the magnifying power. It indicates how many times the stereoscopic radius is increased by the instrument.

Stern-Gerlach'sches Feld: *Stern-Gerlach field.* A special, nonhomogeneous magnetic field used in studying molecular rays. It is produced by a wedge-shaped pole piece facing another pole in which there is a deep notch or channel.

Stern-Gerlach'scher Versuch: *Stern-Gerlach experiment.* An experiment in which a stream of metallic atoms, deflected by a strong, nonuniform magnetic field, is split into two parts, one part deflected toward the higher magnetic intensity, the other toward the lower. It gives evidence of directional quantization, and thus supports the quantum theory of atomic magnetic moments.

Stern'scher Vervielfacher: *Stern multiplier.* A device due to Stern for converging a number of narrow beams of molecular rays at one point, thus securing an enhanced effect.

stetiger Fluss: *steady flow.* A condition of flow such that the velocity of the fluid at any fixed point in the space occupied by the flow remains unchanged; though the velocity of any given particle of the fluid may be continually changing.

stigmatisch: *stigmatic.* (1) In re a bundle of rays: Syn. homocentric. (2) In re an optical system: having equal focal power in all meridians.

Stilb: *stilb.* A name proposed by Blondel for the unit of brightness of a luminous surface, viz., 1 candle/cm^2.

Stimmgabelsirene: *tuning fork siren.* An apparatus designed by Lord Rayleigh, having an adjustable slit in the side of a wind chest, the width of which is controlled by the vibrations of a tuning fork. When air emerges through the slit, the tuning fork is thereby maintained in vibration.

Stoerstelle: *fault.* See Fehler.

Stoerstrom: *parasite.* See Parasit.

Stoerung: *distortion. a.* A change in wave form in the transmission of a composite electric wave over a communication line, in which different component frequencies are transmitted with different speeds or with unequal attenuation. In a distortionless line, this effect is minimized by the use of certain devices. *b.* An im-

perfection in an optical image, due to spherical aberration or similar defects of the optical system.

perturbation. a. (Spect.) An irregularity in the spacing of the lines of a band spectrum. *b.* A deviation of the values of terms in a spectral series from the appropriate series formula. *c.* (Cryst.) The influence of thermal agitation on the relations between atoms in a crystal or in a molecule. A deviation of a celestial body from the ideal orbital motion, due to some disturbing force.

Stokes'sche Gesetze: *Stokes laws.* (1) States that the force required to propel a spherical body of radius r at uniform speed v through a viscous medium of viscosity coefficient η is $6\pi\eta vr$. (2) States that the wave length of luminescence excited by radiation is always greater than that of the exciting radiation; in general valid, but with notable exceptions.

Stokes'sche Linie: *Stokes line.* A line of the Raman spectrum which is displaced toward the long-wave-length side of the incident light; so called by analogy with the Stokes law (2) of luminescence. Lines displaced to the short-wave-length side are called anti-Stokes lines.

Stoss: *Stoss (Germ.), collision.* See Kollision.

Stossen, stossweises Sieden: *bumping.* Sudden, explosive ebullition.

Stossfluoreszenz: *impact fluorescence.* Fluorescence produced in atoms of one element by collisions (of the second kind) with excited atoms of another. Syn. impact radiation.

Stossparameter: *impact parameter.* The distance of the initial line of motion of a scattered particle from the center of the scattering field, e.g., of the path of an incident electron from the nucleus of the scattering atom.

Stosspolarisation: *impact polarization.* Partial polarization detected in radiation excited by impact.

Stosstrahlung: *impact radiation, Syn. impact fluorescence.* See Stossfluoreszenz.

Stosswahrscheinlichkeit: *collision probability.* In re collosions of electrons with the atoms of a gas: the number of collisions per unit electron current, per unit path length, per unit pressure at 0 degree C.

Stosswelle: *surge.* (1) A highly accelerated flow, e.g., that due to suddenly applied pressure or voltage. (2) A general change of atmospheric pressure, distinct from local cyclonic and diurnal changes.

Stosszentrum: *center of percussion.* One of two conjugate points of a free body acted upon by an impulse, the other of which lies on the axis of instantaneous rotation.

Strahleninterferometer: *beam interferometer.* A form of stellar interferometer in which the effective distance between the slits is increased by means of mirrors mounted on a rigid beam beyond the edge of the objective. First used by Michelson to measure apparent diameters of stars.

Strahlenpfeil: *sagittal ray.* Any one of a narrow bundle of rays in a symmetrical optical instrument which lies in the longitudinal section of the bundle made by the plane containing the chief ray and perpendicular to the meridian section.

Strahlung: *radiation.* See Radiation.

Strahlung des schwarzen Koerpers: *cavity radiation, Syn. black-body radiation.* See Hohlraumstrahlung.

Strahlungsdaempfung: *radiation damping.* A decrease in the amplitude of an electric oscillation due to the emission of energy by radiation; distinct from that due to ohmic resistance.

Strahlungsdiagramm: *radiogram.* An X-ray pattern produced by crystal diffraction.

Strahlungsdruck: *radiation pressure.* A pressure exerted upon a surface exposed to light or other electromagnetic radiation, the value of which is proportional to the radiant energy density in the space to which the surface is exposed.

Strahlungsenergie: *radiant energy.* Energy transmitted through the agency of electromagnetic radiation.

strahlungserzeugt: *radiogenic.*

Strahlungsgleichgewicht: *radiative equilibrium.* The maintenance of a constant temperature by the absorption and emission of radiant energy at the same rate.

Strahlungsintensitaet: *radiant intensity.* In re a point source of radiation: the radiant flux emitted per unit solid angle (spheradian) in a specified direction.

Strahlungsmanometer: *radiometric gauge.* Any low-pressure gas manometer dependent upon the inequality of pressure due to molecular bombardment on opposite sides of a suspended vane; e.g., the Knudsen gauge.

Strahlungsmesser: *radiometer.* See Lichtmuehle.

Strahlungspotential: *radiation potential.* The p.d. in volts, corresponding to the energy, in electron-volts, required to excite an atom or a molecule to emit one of its characteristic radiation frequencies. The first r.p. excites the lowest frequency, etc. Syn. resonance potential.

Strahlungspotentiometer: *radiation potentiometer.* An apparatus for studying the spectral energy distribution of thermal radiation, by the potentiometer comparison of the thermoelectric effects of radiation from limited spectral ranges with that of the total radiation.

Strahlungspyrometer: *radiation pyrometer.* A pyrometer which gives the temperature of the heated body by measuring the total intensity or the spectral energy distribution of the thermal radiation emitted by it.

Strahlungsrueckwirkung: *radiation reaction.* A force acting upon a body by reason of its emission of radiation, the direction of the force being opposite to that in which the radiation is emitted. It is the counterpart of force involved in radiation pressure.

Strahlungstemperatur: *radiation temperature.* See effektive Temperatur.

Strahlungsvektor: *vector radiant.* See Poynting'scher Vektor.

Strahlungsvermoegen: *radiant flux, r. power.* Rate of emission of energy in the form of radiation, expressed in watts or other power units.

Strahlungswiderstand: *radiation resistance.* That part of the apparent or measured resistance of an oscillating circuit which is due to the loss of energy through Hertzian radiation.

Stratosphaere: *stratosphere.* The atmosphere above the tropopause. Through its explored portion (the lower 20 km or so), the temperature normally changes but little with altitude, vertical convection is slight, and the winds are essentially horizontal; the term is limited by some to this portion. Syn. isothermal region.

Streckungsgrenzflaeche: *limiting surface of stress.* A surface, the rectangular coordinates of whose points represent the three principal stresses in an elastic substance when its elastic behavior reaches the stage of plasticity.

Streckungslinie: *line of stress—principal stress trajectory.* An imaginary line extending through a stressed elastic substance in the direction of principal tension, compression, or shear. Syn. principal stress trajectory.

Streifen: *fringe.* A band or stripe of maximum or minimum illumination, due to interference or diffraction.

Streifenbildung: *striation.* (1) A striped appearance of the positive column in a Crookes tubes at suitable pressures, consisting of transverse, alternate bright and dark bands. (2) One of the minute, parallel ridges sometimes visible on the natural faces of crystals.

streuen: *scatter.* To diffuse in various directions by reflection from molecules, atoms, electrons, or other particles; e.g., radiation and corpuscular emissions are scattered upon encountering matter.

Streufaktor: *scattering factor.* The ratio S of the actual intensity of X-rays scattered in any direction by electrons to that which would exist if, in accordance with the classical theory of J. J. Thomson, the electrons acted independently. Syn. S-value.

Streukoeffizient: *scattering coefficient.* That part of the extinction coefficient which is due to scattering. It is defined in a manner similar to the absorption coefficient and is added with it to form the total attenuation or extinction coefficient. Distinction must be made between the spatial scattering coefficient (for a given stactering angle) and the total or spherical s.c. (including all angles). The mass s.c. is the s.c. divided by the density.

straggling coefficient. A measure of the straggling observed in the range of alpha particles in an absorbing medium, relative to the range itself. Its value is approximately 2.096 times the ratio of the probable error of the (Gaussian) straggling distribution to the mean range of the particles.

Streuung: *straggling.* The statistical variation in the range different alpha particles, all of the same initial speed, in the same gas. The (Gaussian) distribution corresponding to this variation is represented by the straggling curve, similar to the normal error curve.

Streuvermoegen: *scattering power.* The ratio of the total energy of scattered radiation per unit length of path in a scattering medium to the energy of the incident beam.

Streuwinkel: *scattering angle.* The angle between the original direction of an emission and its direction after scattering.

Stripped Atom: *stripped atom.* See elektronenberaubtes Atom.

Stroemungspotential: *streaming potential.* A p.d. produced by the flow, under pressure, of a liquid through a capillary tube or a membrane. It may be regarded as the inverse of electro-osmosis. Syn. flow potential.

Strombrechung: *current refraction.* A change in the direction of an electric current at an interface between two conductors of different conductivity.

Stromdichte: *current density.* The magnitude of a current per unit cross-sectional area; in the case of the electric current, it is commonly expressed in amperes per square centimeter.

Stromlinie: *streamline.* The contour of a longitudinal section of an object, such as a boat or an airplane, so shaped as to move through a fluid medium with minimum friction. Syn. line of flow.

Stromlinienflaeche: *hydrofoil.* A blade or vane set in such a way as to experience a lateral thrust as it moves through the water, e.g., a rudder, or one of the blades of a screw propeller.

Stromlinienkoerper or Fluegel: *aerofoil.* A blade or wing set in such a way as to experience a lifting force as it moves through the air, e.g., the wing of an airplane.

Stromroehre: *stream tube.* See Flussroehre.

Stromstaerke fuer den Ausschlag 1 (Empfindlichkeit): *figure of merit.* In re a galvanometer: that current which will produce a deflection of one scale division.

Stromunterbrecher: *interrupter.* See elektrischer Hammer.

Strukturfaktor: *structure amplitude factor, structure factor; Syn. atom form factor.* A quantity occurring in the expression for the intensity of an X-ray beam reflected by a crystal, whose value depends upon the varying configuration of the electrons in the crystal atoms relative to the center of the atom, as well as upon the angle of incidence and the wave length of the X-rays.

Stufe: *pitch.* That characteristic of a musical sound which is determined by the position to which the normal ear assigns it in the musical scale.

Sublimation: *sublimation.* The transition of a substance from the solid directly to the vapor state, or vice versa. In the latter case, the solid formed is called a sublimate, e.g., white frost.

Sublimationsdruck: *sublimation pressure.* The solid vapor equilibrium pressure of a volatile solid at a given temperature.

Sublimationskurve: *sublimation curve.* See Gleichgewichtskurve.

Sublimationswaerme: *heat of sublimation.* The heat liberated or absorbed, per unit mass, upon the sublimation of a substance.

subtraktive Farbe: *subtractive color.* A color produced by the removal of some part of white light, as by passage through one or more filters.

Summationston: *summation tone.* A combination tone, heard under certain circumstances, whose pitch corresponds to a frequency equal to the sum of the frequencies of the two components.

Summenregel: *sum rule, Syn. permanence principle.* Either of two "sum rules" relating, respectively, to the sums of the Landé factors and interval factors of the components in the Zeeman effect; which state that the sum of the values of the factor in question for all the J values, other quantum numbers remaining constant, is independent of the magnetic intensity.

Sumptner'sches Prinzip: *Sumptner principle.* The principle, stated by Sumptner, which is employed in the Ulbricht sphere, viz., that when a source of light is placed at any point inside a sphere with perfectly diffusing walls, every part of the interior appears equally illuminated when viewed through an opening.

Supraleitfaehigkeit: *superconductivity, suprac.* The greatly enhanced electrical conductivity attained by certain metals when cooled to a sufficiently low temperature, at which the resistance suddenly drops to a very low value.

Suspension: *suspension.* (1) The state of a finely divided material sustained by thermal agitation in a fluid medium, as smoke particles in the air. (2) Any material so sustained. (3) A fine wire or filament by which a galvanometer coil or similar apparatus is suspended in an instrument.

Suspensoid: *suspensoid.* A colloidal sol in which the particles do not unite with the suspending medium. Called by Perrin a lyophobe sol.

Suszeptanz: *susceptance.* In re an a.-c. circuit having inductance L and capacitance C: the value of the quantity

$$\frac{1}{2\pi nL} - 2\pi nC,$$

in which n is the frequency.

Suszeptibilitaet: *susceptibility.* See elektrische Suszeptibilitaet.

Sutherland'sches Gesetz: *Sutherland law.* Expresses the viscosity coefficient η of a gas in terms of its absolute temperature T, as follows:

$$\eta = \eta_o \frac{T_o + C}{T + C} \left(\frac{T}{T_o} \right)^{3/2},$$

in which C is a constant. η_o is the value of η at the ice point T_o.

Sylphon: *sylphon.* A closed cell with thin, corrugated metal walls, resembling the bellows of an accordion; used in high-pressure research on fluids, and in certain thermostats.

Symmetrie: *symmetry.* (1) An arrangement of objects or parts of a figure with reference to a point, a line, or a plane so that for each particle or point on one side there is a corrseponding one at an equal distance on the other side of the reference zero. If the reference zero is a point, the term point symmetry or radial symmetry is used; if a line, the symmetry is said to be axial; if a plane, it is bilateral. (2) (Cryst.) An arrangement of objects or parts of a figure such that they appear to be hung, either singly or in groups of constant configuration, on a space lattice whose structure regularly repeats itself in three dimensions in space.

Symmetrieebene: *symmetry plane.* A plane which divides a body or a figure in such a way that any line perpendicular to the plane and terminated by the boundaries of the object or figure is bisected by the plane. A principal s.p. is one having at least two other s.p.'s perpendicular to it, which could be interchanged without apparently altering the orientation of the object or figure.

Symmetriezahl: *symmetry number.* The number of different symmetry planes of a body or a group of atoms. E.g., for a regular tetrahedron the number is 12. The term was applied to molecules by Ehrenfest.

sympathetische Schwingung: *sympathetic vibration.* Vibration due to resonance.

Synchronophosphoroskop: *synchrono-phosphoroscope.* An apparatus for examining phosphorescence of brief duration.

Synchroskop: *synchroscope.* A form of oscillograph used to test the phase difference or synchronism of two a.c.'s or electric oscillations.

Szintillation: *scintillation.* A minute flash of light observed when an alpha particle strikes a suitable luminescent screen in the dark.

Szintilloskop: *spinthariscope.* An instrument devised by Crookes for conveniently viewing the scintillations of alpha particles upon a luminescent screen.

Tachometer: *tachometer, tachymeter.* See Geschwindigkeitsmesser.

Tag: *day.* (1) (Mean solar.) The average interval, during the year, between successive meridian passages of the sun. It is the basic unit of time used in physics. (2) (Sidereal.) The period of the earth's complete rotation on its axis, equal to 23 h 56 m 4.09054 s mean solar time. (3) (Lunar.) The period between successive meridian transits of the moon, average about 24 h 50.5 m mean solar time.

Tageslichtfaktor: *daylight factor.* The ratio of the daylight illumination at any point in a building to the simultaneous illumination under the open sky.

Tageslichtphotometer: *hemeraphotometer.* A type of photometer used for measuring daylight factor.

Talbot'sche Bande: *Talbot bands.* Interference bands appearing in a prism spectrum when half of the aperture is covered by a thin glass plate with the edge parallel to the edge of the prism.

Talbot'sches Gesetz: *Talbot law.* States that when two or more luminous areas are presented to the eye at regular intervals, so that each is seen in turn for a certain time, e.g., on a rotating color disk, there is a definite frequency of alteration for which the resultant color impression is invariable and is identical with the impression which would result if all the lights were seen simultaneously at their mean intensities.

Tangentengalvanometer: *tangent galvanometer.* A galvanometer with a fixed field coil, for which the tangent of the deflection is proportional to the current.

Tangentenmesser: *derivator.* A device for measuring the slope of a curve at any point and hence, indirectly, the value of the derivative of the corresponding function. Syn. tangent meter.

Target: *target.* See Schicht.

Taupunkt: *dew point.* The temperature at which the condensation of the water vapor in the air begins for any given state of humidity, as the air is cooled. A dew point hygrometer indicates the dew point, from which the relative humidity may be calculated.

Teilknoten: *partial node.* See angenaeherter Knotenpunkt.

Teilton: *partial, Syn. overtone.* (1) One of the frequencies with which a vibrating body or system can freely oscillate, in addition to the lowest frequency. (2) A musical sound produced by a sonorous body vibrating with one of its higher possible frequencies.

Teilungsmaschine: *dividing machine, dividing engine, ruling engine.* (1) A mechanism operated by a long micrometer screw, for marking the divisions on instrumental scales. (2) A mechanism operated by a long micrometer screw, for ruling the equally spaced lines on optical gratings. Its principle is similar to that of a dividing machine.

Telephotographie: *telephotography.* (1) Photography of distant objects by means of a special magnifying camera objective system. (2) The reproduction of photographs or other pictures at a distance by means of electric currents or radio.

Telethermometer: *telethermometer.* An apparatus in which temperature effects are electrically communicated to a measuring or recording instrument at some distance away; commonly a thermocouple or a resistance thermometer circuit.

telezentrisch: *telecentric.* In re an optical instrument: having either the entrance-pupil at infinity, e.g., when a front stop is placed in the anterior focal plane of a convergent lens—a device commonly used in optical measurements to avoid parallax between image and scale.

Temperaturfaktor: *temperature factor.* See Debye Temperatufaktor, Debye-Waller'scher Faktor.

Temperaturkoeffizient: *temperature coefficient.* The increment of a quantity, which is a function of the temperature, due to unit change of temperature; i.e., the temperature rate or derivative of a quantity. E.g., the t.c. of a standard cell is its change in voltage per degree.

Temperaturwelle: *temperature wave.* A progressing variation of temperature, such as that inaugurated by strongly heating one end of a long bar of cold metal. A succession of such waves would result from alternately heating and cooling the end of the bar.

tempern: *anneal.* To stabilize the internal structure of a solid substance, e.g., glass or a metal, by protracted heating followed by slow cooling.

Tensor: *tensor.* The absolute or numerical value of a vector.

Tesla Spule: *Tesla coil.* A helix of many turns in which very high p.d.'s are produced by means of inductive coupling with a circuit containing a condenser and

a spark gap. A transformer having such a coil as its secondary, with the condenser and gap in the primary circuit, is called a Tesla oscillation transformer.

tetragonal: *tetragonal.* In re crystal structure: having three mutually rectangular axes, two of which only are equal.

Tetrode: *tetrode.* A vacuum tube having four electrodes, e.g., a screen-grid tube.

Thalofid: *thalofide.* A photoconductive composition of thallium, oxygen, and sulphur, developed by T. W. Case.

Thermion: *thermion.* An ion, either positive or negative, which has been emitted from a heated body. Negative thermions are electrons (thermoelectrons).

thermionische Arbeitsfunktion: *thermionic work function.* See Arbeitsfunktion, Richardson'sche Gleichung, thermionische Emissionskonstante.

thermionische Emission: *thermionic emission.* A stream of thermions emitted by a heated body.

thermionische Emissionskonstante: *thermionic emission constant.* A constant appearing in the Richardson equation for thermionic emission when written in the form

$$I = A\,T^2 e^{-\frac{w}{T}},$$

in which w is the thermionic work function. It has the same value for all metals, viz., about 120 amp/cm^{2}deg^2.

thermionischer Gleichrichter: *thermionic valve.* An electric-current rectifier based on the unidirectional character of the thermionic current.

thermische Analyse: *thermal analysis, thermoanalysis.* The investigation of physical transition processes or of chemical reactions by observing discontinuities in the absorption or evolution of heat, e.g., the recalescence transitions in iron, manifested by abrupt changes in temperature.

thermische Bewegung: *thermal agitation.* A random movement of the molecules of a substance, which is believed to give rise to the phenomena associated with heat and the kinetic energy of which is the usual interpretation of that term.

Thermische Ionisation: *thermal ionization.* Ionization due to high temperature, as in the electrically conducting gases of a Bunsen flame. Syn. temperature ionization.

thermische Stroemung: *thermal transpiration.* A pressure difference which develops between two bodies of gas, initially at the same low pressure but at different temperatures, when they are joined by a capillary tube. The flow is from the colder to the warmer gas. Discovered by Federsen and Reynolds. Syn. thermal effusion, thermodiffusion.

Thermodynamik: *thermodynamics.* That branch of physical science which treats of processes involving the conversion of heat into other forms of energy, and vice versa.

thermodynamische Gesetze: *thermodynamic laws.* Two laws upon which rests the classical thermodynamic theory: (1) When work is expended in generating heat, the quantity of heat produced is proportional to the work expended; and, conversely, when heat is employed in the performance of work, the quantity of heat which disappears is proportional to the work done. (Joule.) (2) It is impossible for a self-acting machine, unaided by any external agency, to convey heat from a body of lower to one of higher temperature. (Clausius.) Or, it is impossible to derive mechanical work from heat taken from a body unless there is available a body of lower temperature into which the residue not so used may be discharged, (Kelvin.) (3) In addition to these, some writers refer to the following as the "third law of thermodynamics": Every system has a finite, positive entropy, but at the absolute zero of temperature, the entropy may become zero, and does so become in the case of perfect crystalline substances. This statement, formulated by Planck, is closely related to the Nernst heat theorem.

thermodynamisches Gleichgewicht: *thermodynamic equilibrium.* The condition of a system whose members have conformed to the principle of equipartition of energy.

thermodynamischer Kreis: *thermodynamic cycle.* A cyclic change of state of a body or a system which involves changes of temperature or the transmission of heat to or from the body or system.

thermodynamisches Potential: *thermodynamic potential.* In re any thermodynamic state of a substance: a mathematical expression for the work or change in energy per unit mass involved in bringing it to that state. It is, in general, a function of the variables which determine the state of the substance. So named by reason of the analogy to such cases as the energy of a body with reference to its position in a field of force. Syn. thermal potential, thermal head.

thermodynamische Skala: *thermodynamic scale.* See Kelvin'sche Skala.

thermodynamische Transformation: *thermodynamic transformation.* A change in the state of a body or

system which involves changes of temperature or the emission or absorption of heat, e.g., the expansion of a gas, with accompanying decrease of pressure and temperature.

thermodynamische Umwandlung: *thermodynamic transformation.* See thermodynamische Transformation.

thermodynamische Wahrscheinlichkeit: *thermodynamic probability.* The probability of a given state of distribution and motion of the molecules of a body, as compared with that of some arbitrarily chosen reference state. It is proportional to the number of complexions which would result in that state.

thermoelastisch: *thermoelastic.* Pertaining to the thermodynamics of elastic processes, e.g., the heat generated by the deformation of an elastic body or the fall of temperature when it recovers etc.

thermoelastische Koeffizienten: *thermoelastic coefficients.* Two quantities relating to an elastic body, and defined by the expressions

$$-\,v(\delta p/\delta v)_T\,,\quad -\,v(\delta p/\delta v)_S\,.$$

In these v is volume, p is pressure, T is temperature, s is entropy; and the subscripts denote that the corresponding quantity is to be kept constant. These quantities are the reciprocals, respectively, of the isothermal and isentropic compressibilies.

thermoelektrisches Element: *thermocouple.* A pair of metals forming a junction (thermojunction), considered as the seat of a thermoelectromotive force.

thermoelektrische Leistung: *thermoelectric power.* The change in the thermoelectromotive force of a thermocouple per degree of change in its temperature. The thermoelectric power of any metal is that of a couple composed of the given metal against some standard metal, usually lead.

thermoelektrische Loetstelle: *thermojunction.* A pair of metals forming a junction (thermojunction), considered as the seat of a thermoelectromotive force.

thermoelektrisches Manometer: *thermoelectric manometer.* A manometer which depends upon the variation of thermoelectromotive force with pressure; devised by Rohn.

Thermoelektrisches Thermometer: *thermel.* A term used to cover all forms of thermoelectric thermometer, whether single thermocouples or series of couples (thermopiles or multiple thermels).

thermoelektrische Umkehrung: *thermoelectric inversion.* The phenomenon, exhibited by a thermocouple, of decreasing its e.m.f. with increasing temperature beyond a certain neutral point.

thermoelektromotorische Kraft: *thermoelectromotive force.* The e.m.f. given by two contacting metals and depending upon the metals and upon the temperature distribution in them. In a circuit of different metals joined in series, the resultant e.m.f. is the algebraic sum of the e.m.f.'s due to the several conjoined pairs. Discovered by Seebeck in 1821. Syn. Seebeck effect.

Thermoelektron: *thermoelectron.* See Thermion.

Thermoelement: *thermoelement.* A combination of a thermocouple with a heating filament, used for measuring small currents.

Thermogalvanometer: *thermogalvanometer.* A galvanometer for the measurement of feeble h.-f. a.c.'s by their heating effect, detected by a sensitive thermocouple. Devised by W. Duddell in 1904.

Thermograph: *thermograph.* A recording thermometer.

Thermolumineszenz: *thermoluminescence.* Luminescence exhibited by certain substances, as fluorite, when heated, but of wave length distinctly shorter than that of the incandescence corresponding to the exciting high temperature. Thus fluorite crystals heated on an iron plate may give off white light before the adjacent iron is even red hot.

thermomagnetisch: *thermomagnetic.* Pertaining to the effects of a magnetic field upon the flow of heat or the temperature distribution in a conductor; e.g., in the Nernst effect; or to the effects of temperature upon the magnetic properties of a substance.

thermomagnetische Potentialdifferenz: *thermomagnetic potential difference.* A change in the e.m.f. of a thermojunction, due to placing it in a magnetic field.

Thermomanometer: *thermogauge.* A form of optical pyrometer, devised by Morse.

Thermometerkorrektion: *stem correction.* A correction applied to the reading of a liquid-in-glass thermometer because of the fact that the liquid in the stem is at a different temperature from that in the bulb.

thermometrische Koeffizienten: *thermometric coefficients.* Two quantities relating to a body of working substance; defined by the expressions

$$\frac{1}{p}\left(\frac{\delta p}{\delta T}\right)_v\,,\quad \frac{1}{v}\left(\frac{\delta v}{\delta T}\right)_p\,.$$

In these T is temperature, v is volume, p is pressure;

and the subscripts denote that the corresponding quantity is to be kept constant.

thermomotorische Kraft: *thermomotive force.* That which, in thermal phenomena, is analogous to electromotive force in the corresponding electrical phenomena; e.g., the temperature difference developed in the Ettinghausen effect.

Thermophon: *thermophone.* (1) A musical tone generator composed of a thin strip of metal immersed in a gas or a volatile liquid and periodically heated by an d.c. (2) A form of telethermometer in which a telephone receiver is used.

Thermophosphoreszenz: *thermophosphorescence.* Phosphorescence developed by heating after exposure to some exciting agency.

Thermorelais: *thermorelay.* A device, due to Moll, for amplifying small galvanometer deflections. The galvanometer mirror reflects a bright beam of light upon a sensitive thermojunction in such a way that very slight deflections of the beam cause relatively large changes at the junction. A second galvanometer actuated by the thermocouple may thus be made to show deflections many times as large as the original.

Thermosaeule: *thermopile.* A thermel consisting of a number of thermocouples in series, which amplifies the temperature effect.

Thévenin'scher Lehrsatz: *Thévenin theorem.* States that when two points A and B of a circuit or network carrying a current (either steady or alternating) are connected by a shunt S, the resulting current in S is equal to the original p.d. between A and B, divided by the sum of the parallel impedances of the shunt S and the portion AB of the original circuit.

Thixotropie: *thixotropy.* A phenomenon exhibited by some gels, which, when gently shaken, break up and form a fluid with all the properties of the original sol, but which, when left undisturbed, resume the form of a gel again. This process may be repeated indefinitely.

Thomas'sche Praezession: *Thomas precession.* The precession of the spin axis of an electron due to the acceleration given to the electron by the electric field of the nucleus.

Thomson (Kelvin) Effekt: *Thomson (Kelvin) effect.* An effect manifested when an electric current is passed through a metallic conductor of nonuniform temperature, e.g., in the simplest case, a wire on which there is a sharp temperature maximum. When the current flows, the maximum is observed to move, with the current in some metals, against it in others.

Thomson'sche elektromotorische Kraft: *Thomson electromotive force.* A p.d. existing between two points of different temperature on a metallic conductor; studied by William Thomson (Kelvin).

Thomson'sche (Kelvin) Doppelbruecke: *Thomson (Kelvin) double bridge.* A bridge having eight arms, used for comparing two resistance standards having both current and potential terminals.

Thomson'scher Koeffizient: *Thomson coefficient.* The ratio of the Thomson e.m.f. in a metal to the corresponding difference in temperature. Syn. specific heat of electricity.

Thomson'scher Polarisationsfaktor: *Thomson polarization factor.* A factor to which the intensity of an X-ray beam reflected from a crystal is proportional and which, as derived by J. J. Thomson, is equal to the function

$$\tfrac{1}{2}(1 + \cos^2 2\Theta)$$

of the glancing angle Θ.

Thomson'sche Waerme: *Thomson heat.* The quantity of heat which must be supplied or withdrawn in order to maintain a unit temperature difference between two points of a conductor at a given mean temperature when unit quantity of electricity flows from one point to the other, and thus to neutralize the Thomson effect.

Thomson-Whiddington-Bohrsches Gesetz: *Thomson-Whiddington-Bohr law.* Expresses the depth to which cathode electrons penetrate a material target in the production of X-rays as V^2/b, in which V is the voltage and b a constant, known as the Thomson-Whiddington constant, depending upon the material and other circumstances.

Thorium Reihe: *thorium series.* One of the principal radioactive series, beginning with thorium.

Thyratron: *thyratron.* An arc discharge tube containing inert gas or vapor at low pressure, in which a grid is employed to control the starting of the discharge.

Tiefenmesser: *fathometer.* See Fadenmesser.

tieferer Zustand: *lower state.* That one of the two energy states or levels, before and after a quantum transition, in which the atom or the molecule has less electronic energy.

Tiltometer: *tiltometer.* An instrument which measures inclination to the horizontal.

toenender Lichtbogen: *singing arc.* An electric arc of such characteristics as to generate an oscillating cur-

rent of audio frequency when an inductance and a condenser are connected across it; e.g., the Duddell carbon arc or the Poulsen carbon-copper arc. Syn. oscillating arc.

Toepler-Holtz'sche Maschine: *Toepler-Holtz machnie.* A type of static machine having one stationary and one rotating plate, or a number of such pairs.

Toleranz: *tolerance.* See erlaubte Abweichung.

Tonmesser: *sonometer.* See Monochord.

Tonvariator: *tonvariator.* An adjustable resonator for comparison of musical pitches, the frequency of which is varied by means of a piston having a graduated scale. Designed by Stern.

Tonveraenderer: *tonvariator.* See Tonvariator.

Torricellisches Gesetz: *Torricelli law.* States that the speed of efflux of nonviscous fluid issuing from an orifice at a depth h below the level of the free surface in the container, under the influence of gravity alone, is $v = \sqrt{2gh}$.

Torricellisches Vakuum: *Torricellian vacuum.* A space evacuated by filling it with mercury and then lowering the reservoir more than 76 cm below the bulb, as in a barometer.

Torsion: *torsion.* The strain due to twisting a rod, wire, or filament; measured by the angle of rotation of one cross section with respect to another at unit distance from it.

Torsionskoeffizient: *torsion coefficient, t. constant.* The torque exerted in twisting an elastic rod per unit total angle of twist.

Torsionskonstante: *torsion constant, t. coefficient.* See Torsionskoeffizient.

Torsionskopf: *torsion head.* A rotary cap, often graduated in degrees, atop the vertical tube supporting a torsion suspension, e.g., in a galvanometer or a magnetometer.

Torsionsmesser: *torsometer.* An instrument for studying the elastic behavior of solids under torsion, esp. by optical methods.

Torsionsmodul: *torsion modulus, Syn. shear modulus, rigidity modulus.* The ratio of the shearing stress in an elastic substance to the strain (shear) which accompanies it.

Torsionspendel: *torsion pendulum.* A pendulum actuated by the torsion of an elastic wire.

torische Linse: *toric lens.* A lens, one surface of which is a portion of the surface of a tore. Much used for spectacles.

Totaler Absorptionskoeffizient: *total absorption coefficient, Syn. extinction coefficient.* In re any type of radiation traversing a material medium: the absorption coefficient plus the scattering coefficient.

totaler elastischer Wirkungsquerschnitt: *total elastic cross section.* In re atoms scattering electrons of given velocity: the number of electrons scattered per atom from an electron beam whose intensity is 1 electron per unit area per unit time.

totales Emissionsvermoegen: *total emissive power.* See Emissionsstaerke.

totale Quantenzahl: *total quantum number, Syn. principal quantum number.* The sum l + l', of the azimuthal and the radial quantum number in the Bohr theory, or l + l' + 1 in the new quantum mechanics (since in the latter l is one less). So called because the energy of a quantum state depends primarily upon it. The principal quantum number is usually denoted by n.

totale Reflektion: *total reflection.* Internal reflection in which the angle of incidence exceeds a value, known as the critical angle, whose sine is the relative refractive index from the more to the less refractive medium; so called because all the radiation is reflected and none transmitted.

totale Spiegelung: *total reflection.* See totale Reflektion.

Totalwaerme: *total heat.* See Enthalpie.

Townsend'sche Charakteristik: *Townsend characteristic.* The current-voltage characteristic curve for a photoelectric cell at constant illumination and at voltages below the glow potential.

Townsend'sche charakteristische Kurve: *Townsend characteristic.* See Townsend'sche Charakteristik.

Townsend'sche Entladung: *Townsend discharge.* Any space-charge-free electrical discharge in a gas at moderate pressure above 0.1 mm, whether self-or externally maintained. More loosely, Syn. corona.

Townsend'sche Gleichung: *Townsend equation.* An expression for the photoelectric current in a gas, as a

function of the distance d between plates, and having the form

$$I = I_o e^{\alpha d}$$

α is the Townsend coefficient, which may be interpreted as the number of new ion pairs produced by the impacts per unit length of electron path.

Townsend'scher Koeffizient: *Townsend coefficient.* See Townsend'sche Gleichung.

Traegheit: *inertia.* See Beharrungsvermoegen.

Traegheitsellipsoid: *inertia ellipsoid.* An ellipsoid so drawn, in reference to any point of a rigid body, that the radius vector from the center of the ellipsoid to any point on its surface represents the reciprocal square root of the moment of inertia of the body about that vector as an axis. The axes of the ellipsoid coincide with the principal axes of the body through the given point.

Traegheitsmoment: *moment of inertia.* Of a rigid body with respect to any axis: the volume integral of the product of the element of mass by the square of its distance from the given axis. It represents the torque required, per unit angular acceleration in radian measure, to change the speed of rotation of the body about that axis. Syn. rotational inertia.

Traegheitsmomentellipsoid: *momentum ellipsoid.* An ellipsoid drawn with reference to the principal axes of inertia of a rigid body in free rotation (under no external torque) about a changing instantaneous axis, and used to represent graphically the relation between the resultant angular velocity and the position of the instantaneous axis when the angular momentum is constant.

Traegheitsprodukt: *product of inertia.* In re any body, with respect to any pair of rectangular axes X and Y: the value of the volume integral $\int\int\int$ xydxdydz taken throughout the volume of the body.

Traegheitszentrum: *center of inertia, Syn. center of mass.* In re any body or system of bodies: a point such that if any plane be passed through it, the mass moments, with respect to it, of the portions on opposite sides of the plane are equal.

Transformationskonstante: *transformation, constant, Syn. disintegration constant.* The decay coefficient for radioactive disintegration.

Transformationsperiode: *transformation period.* The half-value period for the decay of the activity of a radioactive substance.

Transformationsverhaeltnis: *transformation ratio.* The ratio of the voltage in the secondary to that in the primary of a transformer.

Transformator: *transformer.* A device which, through magnetoelectric induction but without the use of moving parts, transforms alternating or intermittent electric energy in one circuit into energy of similar type in another circuit, commonly with altered values of the voltage and current.

Transkonduktanz: *transconductance, Syn. mutual conductance.* In re a grid-controlled tube: the increment of plate current per unit change of grid potential.

Translation: *translation.* See fortschreitende Bewegung.

transversale Effekte: *transverse effects.* A term collectively applied to the Hall, Ettingshausen, Nernst, and Righi-Leduc effects (q.v.).

transversale Masse: *transverse Mass.* The mass of a body measured in the relativistic sense, in a direction perpendicular to that of its motion relative to the observer; in contradistinction to its longitudinal mass (q.v.).

Trennungsfaktor: *separation factor.* See g-Faktor.

Trennungslinie: *line of separation.* The line at which the two streams along the curved surface of a body advancing through a fluid, one from the front toward the rear, the other from the rear toward the front, meet upon the surface and at which they separate from it.

Trevelyanischer mechanischer Oszillator: *Trevelyan rocker.* A mechanical oscillator which depends upon the alternate expansion and contraction, at the points of contact, of a heated solid in contact with a cold one.

triboelektrisch: *triboelectric.* Pertaining to electrification generated by friction. A triboelectric series is a list of substances so arranged that any one of them becomes positively electrified when rubbed with one farther down the list.

Triboluminеszenz: *triboluminescence.* Luminescence caused by grinding, in such substances as glass and certain crystals. Tribothermoluminescence refers to the same phenomenon, when heat is required subsequent to the grinding. Syn. piezoluminescence.

Tribophosphoreszenz: *tribophosphorescence.* The enduring or phosphorescent type of triboluminescence.

Tribothermolumineszenz: *tribothermoluminescence.* See Triboluminеszenz.

trichromatischer Koeffizient: *trichromatic coefficient.* The fraction of a three-color mixture which consists of any one of the three standard colors used to obtain a match for any given color, in accordance with the three-color method of Maxwell.

triklin: *triclinic.* In re crystal structure: having three unequal axes intresecting at angles, not more than two of which are equal, and not more than one of which is 90 degrees.

Triode: *triode.* A vacuum tube having three electrodes, viz., a filament, a grid, and a plate; used in radio and other h.-f. apparatus. Syn. radiotron, audion, pliotron.

Tripelpunkt: *triple point.* See Dreiphasengleichgewicht.

Triplett: *triplet.* A multiplet of three components.

Troepfchen: *cluster.* A group of atoms held together by the electric attraction of a charged ion, but not in permanent chemical union.

Troepfchenbildung: *coaggregation.* See Koaggregation.

Troepfchenmethode: *drop-weight method.* A method of investigating surface tension and cohesion in a liquid by weighing its drops which fall from a tube of specified dimensions.

Tropfenzaehler: *stalagmometer.* See Stalagmometer.

Tropie: *tropism.* A directional property of a substance, esp. a crystal, dependent upon the vector quantities which determine the states of the constituent atoms or molecules.

Tropopause: *tropopause.* The upper limit of the troposphere, in middle latitudes generally 10 to 12 km above the earth's surface.

Troposphaere: *troposphere.* All that portion of the atmosphere, next above the earth's surface, in which vertical convection is frequently active and in which clouds usually occur.

Trouton'sches Gesetz: *Trouton law.* States that the molar heat of vaporization of a liquid at a given temperature, divided by its absolute boiling point (the Trouton ratio), is approximately the same for all liquids.

Trouton-Noble'scher Versuch: *Trouton-Noble experiment.* An attempt to detect an ether drift by the possible electromagnetic effect of the motion of an electric charge as carried with the velocity of the earth. No effect was observed.

Truebung: *turbidity.* A property of a medium which renders it imperfectly transparent, due to having particles in suspension, e.g., milky or muddy water.

Truebungsfaktor: *turbidity factor.* The percentage of reduction of solar radiation of a given wave length received upon the earth's surface, because of haze or other type of turbidity in the atmosphere.

Truebungskoeffizient: *turbidity coefficient.* See Ångstroem Koeffizient.

Truebungsmesser: *turbidimeter.* An instrument for measuring the turbidity of a liquid, as in water-purification plants. Syn. opacimeter. See also Nephelometer.

Turbulenz: *turbulence.* Irregular motion of a moving fluid, caused by an impediment in the stream, by friction, or by vortex action. Syn. sinuosity.

Turnover: *turnover.* The lack of symmetry in the filament plate current fluctuations of a vacuum tube circuit, due to the fact that the increase in current caused by a given increase in grid potential is not equal to the decrease in current caused by an equal decrease in grid potential.

Tyndall'scher Effekt: *Tyndall effect.* The scattering of light by very small suspended particles, which was theoretically investigated by Tyndall, but first described by Faraday. The scattered light is polarized to an extent which is greater, the smaller the particles. For diameters less that 0.1 micron the polarization is complete.

Uebereinstimmung: *consistency.* (1) The approximate agreement between results of measurements on the same quantity. External consistency refers to the agreement between final adjusted results obtained by different methods; internal consistency, to that between results of repeated single measurements of the same series. (2) That quality of a material which depends upon its viscosity, plasticity viscidity, etc.

Ueberfuehrungszahl: *transport numbers, Syn. transference numbers, Hittorf numbers.* A term applied by Hittorf to the fractions of an electrolytic current carried by the anions and by the cations, respectively, the sum of which is unity.

Uebergangsphaenomen: *transport phenomena.* A class of phenomena due to the transfer of mass, energy, or momentum across any given surface or interface as a result of molecular or electronic agitation, in accordance with the kinetic theory. E.g., momentum may be so transferred from a rotating disk to an adjacent parallel disk by means of air molecules receiving momentum from the one and subsequently impinging upon the other.

Uebergangsstrom: *transient.* See Ausgleichungsstrom.

Uebergangswahrscheinlichkeit: *transition probability.* (1) The number of spontaneous transitions from one given state to another given state which a single atom would perform, on the average, in 1 sec, if the initial state were restored immediately after each transition. It is a function of the frequency of the radiation emitted, and of the atomic structure. (2) The number of induced transitions per single atom per second, as above, due to unit intensity of the incident radiation. It is likewise a function of the frequency and of the atomic structure. (3) (Radioactive) The probability that a radio-active atom of a given species will disintegrate within unit time. It is numerically equal to the disintegration constant.

Uebergangswiderstand: *passive resistance.* See passiver Widerstand.

ueberhitzen: *superheat.* (1) (v.) To raise the temperature of a vapor, as steam, above the saturation point. (2) To raise the temperature of a liquid above its boiling point at the existing pressure, without ebullition; facilitated by covering the surface with another, immiscible liquid, as oil on water. (3) (n) The number of degrees by which the temperature of a vapor at a given pressure exceeds the temperature at which the vapor is saturated.

Ueberlappung: *overlapping.* The coincidence of the long-wave end of a diffraction or interference spectrum with the short-wave end of the spectrum of the next higher order; which may give rise to confusion in spectroscopy.

Ueberpotential: *overpotential.* An excess of potential, or p.d.; esp. the p.d. required to effect the electrolysis of an electrolyte, minus that of the electrodes with the products deposited upon them after the separation has taken place. Syn. overvoltage, excess v.

Ueberschall: *supersonic, Syn. ultrasonic.* Having a frequency above that of audible sound.

Ueberschneiden: *overlapping.* See Ueberlappung.

uebersaettigen: *supersaturate.* To cause a solution to attain a condition of greater concentration than its normal saturation concentration at the existing temperature, without initiating precipitation of the solute. This may sometimes be done by careful supercooling.

Ueberstruktur: *superstructure.* A regular, periodic spacing found in the structure of a solid solution; exhibited by certain alloys. It is due to a systematic configuration of atoms of the solute in the solvent crystal, and is not characteristic of the solvent.

Ueberton: *overtone.* See Teilton.

Uebertonband: *overtone band.* A spectral frequency which bears a relation to a given spectral frequency analogous to that of an acoustic overtone to its fundamental. Syn. harmonic band.

Uebertrager: *transducer.* Any device for transmitting energy from one system to another, esp. from one electric transmission or communication system to another, e.g., a transformer.

uebrigbleibende Abweichung: *residual.* See Rest.

uebrigbleibendes Blau: *residual blue.* A phenomenon observed by Tyndall with white light scattered by small particles in suspension. Viewed through a suitably oriented nicol, the scattered light appears blue.

uebrigbleibendes Restblau: *residual blue.*

Ulbricht'sche Kugel: *Ulbricht sphere.* An integrating sphere used in a sphere photometer; so called because of the first adaptation of the Sumptner principle to this use by Ulbricht in 1900.

Ultraionisationspotential: *ultraionization potential.* A definite electron potential which elicits a responsive ionization, but which is greater than that corresponding to the ordinary excitation limit.

Ultrakurzwellen: *ultrashort waves.* See Mikrowellen.

Ultramikrometer: *ultramicrometer.* An instrument for the measurement of very small displacements, esp. by electrical means, e.g., by the variation of an electrical capacitance.

Ultramikroskop: *ultramicroscope.* An arrangement consisting of a powerful microscope whose field is illuminated by a strong beam of light from one side, so that extremely minute objects (or the diffraction patterns produced by them) are visible against a dark background.

ultrarot: *infrared.* See infrarot.

Ultraschall: *ultrasonic, supersonic.* See Ueberschall.

ultraviolett: *ultraviolet.* A range of invisible radiation frequencies immediately adjoining the visible violet, and extending into the region of low-frequency X-rays.

Umformer: *converter.* One of several types of machine consisting of an electric generator driven by an electric motor, with the purpose of changing the service in some respect; as from a.-c. to d.-c. (motor generator or rotary converter), to a different frequency (frequency converter), to a different number of phases (phase converter).

umgekehrter photoelektrischer Effekt: *inverse photoelectric effect.* The transformation of the kinetic energy of a moving electron into radiant energy, as in the recombination of an electron with an ion, or in the production of X-rays.

umgekehrter piezo-elektrischer Effekt: *inverse piezoelectric effect.* The contraction or expansion of a piezoelectric crystal along an electric axis when subjected to an electric field in that direction.

umgekehrte Spannung: *inverse voltage.* See inverse Spannung.

umgekehrter Term: *inverted term.* A spectral term in which the fine-structure level having the largest inner quantum number lies farthest down on the energy-level diagram.

umkehren (opt.): *rectify.* (1) To change from alternating to unidirectional, as an electric current. Any device for securing this result is a rectifier. (2) To replace (an inverted image) by one which is erect, as by the rectifying system in a field glass.

Umkehrstrahlen: *retrograde rays.* A type of corpuscular rays, of atomic dimensions, like positive rays, and magnetically deflected as positive rays are, but moving away from the cathode instead of toward it. They appear to be of complex character.

Umwandler: *inverter.* A device for converting d.-c. into a.-c.

Umwandlung: *disintegration, transmutation.* (1) The emission of an alpha or a beta particle by a radioactive atom. (2) The passage of a solid into a colloidal state. (3) A change from one chemical element into another, or the derivation of one element from another; sought for by the alchemists, and now recognized as actually taking place through either natural or induced radioactivity.

Umwandlungselektron: *disintegration electron.* An electron emitted from the nucleus of an atom upon radioactive disintegration, in that class of radioactive elements which emit beta rays.

Umwandlungsfaktor: *conversion factor.* A number by which the numerical value of a physical quantity as expressed in one set of units must be multiplied in order to obtain its numerical value as expressed in another similar set of units of different size. Syn. change ratio.

Umwandlungsfunktion: *transmutation function.* A function which expresses the probability of an induced nuclear transmutation in terms of the energy of the bombarding particle; the target being considered infinitely thin.

Umwandlungskoeffizient: *conversion coefficient.* An abstract fraction which represents the probability that a gamma-ray quantum, emitted from the nucleus of a radioactive atom, will give up its energy in releasing an electron from one of the outer levels. The K conversion coefficient is the probability that the release will take place at the K level, etc.

Umwandlungskonstante: *disintegration constant, Syn. transformation constant radioactive c.* The decay coefficient for radioactive disintegration.

Umwandlungsperiode: *transformation period.* The half-value period for the decay of the activity of a radioactive substance.

Umwandlungswaerme bei Eisen: *heat of recalescence.* Heat liberated per unit mass at certain temperatures by a cooling metal, due to the recalescence transformation.

Unbeschraenkt mischbar: *consolute.* See loeslich in allen Verhaeltnissen.

Unbestimmtheitsprinzip: *indetermination principle, indeterminacy p., Syn. uncertainty principle.* A feature

of the quantum mechanics of Heisenberg, which postulates that complete information as to the mechanism of processes taking place on the electronic scale of magnitude, in terms of the usual geometrical coordinates and of time, is impossible. E.g., the position and the velocity of an electron are, according to this principle, in capable of simultaneous expression in terms of these conventions.

ungerader Term: *odd term.*

ungequantelter Zustand: *unquantized state.* A state of an atom in which there are electrons whose motion is not subject to quantum conditions, and which give rise to continuous spectral bands rather than lines.

ungeradzahliges Molekuel: *odd molecule.* One of the very rare molecules having in its neutral state an odd number of extranuclear electrons.

unipolare Induktion: *unipolar induction.* See einpolige Induktion.

Univariant: *univariant.* Having one degree of freedom, i.e., variance unity.

universeller Nebenschluss: *universal shunt.* A type of shunt devised by Ayrton for use with galvanometers in order to increase their range, but without change of damping. Syn. Ayrton shunt.

unendlich weiter Punkt: *far point.* See Fernpunkt.

Unschaerfering: *blur circle, circle of diffusion.* The circular intersection of a screen, as the retina, with a conical pencil of rays from a point source whose image does not lie exactly upon the screen. Syn. circle of diffusion.

Unterdruck: *negative pressure.* (1) A pressure less than that of the atmosphere. (2) A condition of stress within a cohesive body which is subjected to equal tensions in all directions, and which is thus truly the opposite of pressure.

Unterdrueckung: *suppression.* (1) The elimination of any component of an emission, as of a given frequency in a radio wave train. (2) The nonappearance of a normally occurring natural face on a crystal, due to the adjacent faces coming together to a point or an edge.

unterkuehlen: *supercool, undercool.* To reduce the temperature of a liquid below its freezing point or that of a solution below its saturation point.

unmodifizierte Linie: *unmodifide line.* See Compton Effekt.

Unterniveau: *sublevel.* The energy level or quantum state of the electrons in an atomic subshell.

Unterstufe: *sublevel.* See Unterniveau.

Unterschale: *subshell.* A subdivision of an electron shell, all the electrons of which have the same azimuthal quantum number.

untersynchron: *subsynchronous.* Having a frequency which is a submultiple of the driving frequency.

Uranreihe: *uranium series, uranium-radium s.* One of the principal radioactive series, beginning with uranium and including radium.

Ursaechlichkeit: *causality, causation.* The doctrine that there necessarily exists an actual cause-and-effect connection between related phenomena, such that the same conditions must always bring about the same results. Syn. determinism.

Ursprung: *origin.* The zero line in a band spectrum.

urspruengliche magnetische Permeabilitaet: *initial magnetic permeability.* The magnetic permeability corresponding to an infinitely small, normal magnetic induction.

Urspruengliche Spannung: *initial stress, Syn, residual stress.* A stress which persists in a solid, due not to the existence of external forces but apparently to the fact that certain portions have been stressed beyond the elastic limit while the adjacent portions have not.

Uviolglass: *uviol glass.* A glass developed by Schott, highly transparent to ultraviolet.

Vakuumgewicht: *vacuum weight.* The weight obtained for an object when the result of weighing is corrected for the buoyancy of the air, i.e., the weight in vacuo.

Vakuumroehre: *vacuum tube.* See Entladungsroehre.

Vakuumspektrograph: *vacuum spectrograph.* A spectrograph which operates in a vacuum, so as to introduce no air-absorption of the emission under examination.

Valenz: *valence, valency.* In re an electro-negative chemical ion: the number of hydrogen ions or other univalent ions with which it is combined or is capable of combining. In re a positive ion: its combining power as compared with hydrogen, or the number of hydrogen ions which it displaces in chemical combination. Grimm defines the absolute valence of an atom as the number of its electrons which are engaged in attaching the other atoms of the molecule to it.

Valenzelektron: *valence electron, Syn. peripheral electron.* (1) One of the outer electrons of an atom, to whose activity the spectral lines of visible light and thermal radiation are attributed, and which are supposed to be responsible for chemical combination. (2) An outer electron of an atom, which does not form part fo a closed shell, and which apparently is concerned in chemical combination.

van der Bijl'sche Gleichung: *van der Bijl equation.* An empirical equation which expresses the plate current I_p in a triode in terms of the plate voltage V_p and the grid voltage V_g:

$$I_p = a(V_p + \mu V_g + c);$$

in which a and c are constants and μ is the amplification factor.

van der Waals'sche Gleichung: *van der Waals equation.* An empirical, or partially empirical, characteristic equation, the first successful approximation of the behavior of real gases:

$$\left(p + \frac{a}{v^2}\right)(v - b) = RT,$$

in which p is the pressure in atmospheres, v is the volume of the gas in terms of its volume at N.T.P. as the unit, and a and b are the van der Waals constants, dependent upon the gas.

van der Waals'she Kraefte: *van der Waals forces.* The molecular interactions in a gas, of which account is taken in the construction of the van der Waals equation; the attractive forces by the constant a and the repulsive forces by the constant b of that equation.

van der Waals'sches Potential: *van der Waals potential.* A term used in connection with the potential energies corresponding to the attractive forces between atoms and atoms or between molecules and molecules in a gas, which are taken into account by the use of the constant a in the van der Waals equation.

van't Hoff'scher Faktor: *van't Hoff factor.* A factor by which, according to van't Hoff, the molecular weight of an electrolyte as calculated from the freezing point law must be multiplied to give its true molecular weight.

van't Hoff'sches Gesetz: *van't Hoff law.* States that the vapor pressure of a solvent is lowered by the addition of a nonvolatile solute in proportion to the molar concentration of the solute. Syn. Wuellner law.

Varianz: *variance.* The number of degrees of freedom of a system.

Variationsprinzip: *variation principle.* States that if the kinetic energy minus the potential energy of a particle is denoted by L, and if we assume a slightly different, arbitrary path to be followed, in the time interval t_1 to t_2, from the one actually followed under the forces in operation, then the resulting variation of the integral

$$\int_{t_1}^{t_2} L\,dt$$

is equal to zero.

Variometer: *variometer.* (1) A variable inductance provided with a scale, arbitrary or otherwise. (2) A device for measuring or recording variations in terrestrial magnetism.

Vegard'sches Gesetz: *Vegard law.* States that when two substances A and B having similar crystalline structure form together a solid solution, the lattice constant of the solution divides the interval between the lattice constants of A and of B in proportion to the relative amounts of A and of B present.

Vegard-Kaplan'sche Bande: *Vegard-Kaplan bands.* Spectral bands due to metastable nitrogen molecules; discovered by Vegard in the spectrum of the aurora borealis and by Kaplan in the nitrogen afterglow.

Vektor: *vector.* A quantity which is fully specified when and only when there are given its magnitude and an associated direction in space; e.g., a velocity or a magnetic intensity.

Vektorpolygon: *vector polygon.* A polygon (not necessarily plane) whose sides represent a number of similar

vectors, and the completion or "closing" of which indicates that the vector sum is zero; e.g., the force polygon for a set of forces in equilibrium.

Vektorpotentialfunktion: *vector potential function.* A variable vector V, so related to another variable vector R that R is the curl of V. V is then said to be a vector potential function of R.

Vektorprodukt: *vector product.* In re two vectors, P_1, P_2: a vector whose magnitude is the product of the magnitudes of the two vectors and the sine of the angle between them; and whose direction is that of the perpendicular to both of them, such that while looking along this direction one would have to turn the vector P_1 clockwise to make it coincide with the vector P_2. Designated by $P_1 \times P_2$.

vena contracta: *vena contracta (Lat.).* The contracted jet in which a liquid emerges from an orifice. The ratio of its area of smallest cross section to the area of the orifice is the contraction coefficient.

Venturimesser: *Venturi meter.* An hourglass-shaped constriction in a pipe carrying a fluid, by means of which it is possible to compute the rate of flow from the pressure difference between the main pipe and the point of least diameter, in accordance with the Bernoulli law.

verallgemeinerte Koordinaten: *generalized coordinates.* See Koordinate.

Verbindung: *turn-flux, Syn. linkage, fluxturns.* See Kupplung.

Verbindungsaequivalent: *combining equivalent.* Of a chemical element: its atomic weight divided by its valence. E.g., the combining equivalent of magnesium is $24.32 \div 2 = 12.16$. In the case of a radical the radicular weight is divided by the valence; e.g., for SO_4, the combining equivalent is $96.06 \div 2 = 48.03$.

Verbindungsgewicht: *combining equivalent.* See Verbindungsaequivalent.

verboten: *forbidden.* A term applied to certain intra-atomic phenomena which, while they might be looked for in accordance with the general rules, apparently never or very rarely occur; e.g., some electron transitions and corresponding spectral lines.

Verdampfungskurve: *vaporization curve.* See Gleichgewichtskurve.

Verdampfungswaerme: *heat of vaporization.* The quantity of heat absorbed by a substance per unit mass, upon passing from the liquid to the vapor state, or released upon condensation; in either case without change of temperature. It is a function of the temperature at which the transformation takes place. Syn. heat of evaporation, heat of condensation (the latter if the vapor is condensing).

Verdet Konstante: *Verdet constant.* The angle of optical rotation per oersted intensity per centimeter thickness in the Faraday effect. Syn. specific magnetic rotatory power.

Verdraengungszentrum: *center of displacement.* In re a body submerged or partially submerged in a fluid: that point which coincides with the center of mass of the body of fluid thereby displaced. Syn. center of buoyancy.

Verduennungswaerme: *heat of dilution.* The quantity of heat absorbed or evolved per gram or per mol of a solute when a solution of given concentration containing it is infinitely diluted. It is a function of the initial concentration.

Vereinigungsebene: *plane of union.* The plane upon which the two components of a twin crystal are united. It always coincides with a possible crystal face.

Verformbarkeit: *malleability.* The plasticity of a metal, by virtue of which it may be rolled into sheets or otherwise worked into permanent shape when cold.

Verformungsarbeit: *resilience.* (1) The work required to deform an elastic body to the elastic limit. Its value depends upon the elastic constants and the dimensions of the body. (2) The ability of a material to make internal adjustment to rapid deformation without the development of excessive stress; the opposite of brittleness.

verfuegbare Energie: *available energy.* That part of the energy of a body or of a system which is in such form that mechanical work may be derived from it.

verfuegbare Waerme: *motivity.* That part of the heat energy taken in during a thermodynamic cycle which is transformed into external work, i.e., the available energy of the cycle. The term is attributed to Kelvin.

Vergenz: *vergency.* Either divergence or convergence of rays from a lens or a mirror, expressed as the reciprocal of the distance from lens or mirror to the focus of the rays.

Vergroesserungsvermoegen: *magnifying power, Syn. magnification.* (1) Of a visual instrument (telescope,

microscope, etc.): the ratio of the apparent diameter of the object as seen in the instrument to its apparent diameter as seen by the unaided eye at whatever distance it would be viewed without the instrument. (For a microscope, this distance is usually taken as 25 cm or 10 in.) (2) For a projection instrument, it is the ratio of any linear dimension of the projected image to the corresponding dimension of the object.

Verhaeltnis von Ladung zu Masse: *charge-mass ratio, Syn. specific charge.* The ratio of the electric charge carried by an electrified particle or ion to the mass of the particle.

Verlaengerung: *elongation.* (1) Any increase in length. (2) The type of strain which accompanies tension, and which is measured by the ratio of the increase in length to the normal, unstressed length. (3) The radius vector of a body or a particle moving in an orbit.

Verlust (elektr., magn.) durch hohen Widerstand: *leak, leakage.* (1) A ground or cross connection of very high resistance, e.g., a grid leak. Electric leakage is the small current traversing such a leak. (2) Magnetic leakage is a straying of lines of magnetic induction from the prescribed magnetic circuit into the surrounding space.

Vermoegen: *power.* See Leistung.

Vernichtungsstrahlen: *annihilation radiation.* Radiation produced by the collision and mutual annihilation of an electron and a positron, and usually consisting of two quanta for each such encounter, moving in opposite directions.

Vernier: *vernier.* A device applied to the graduated scale on many instruments, which serves at the same time as an index and as a means of subdividing the smallest scale unit into tenths or other aliquot parts. Named for its inventor, Pierre Vernier.

Verrueckung: *dislocation.* A disarrangement of the perfect configuration of the units of a crystal lattice, as evidenced by anomalous mechanical, optical, or magnetic properties.

Verschiebung: *dislocation, displacement.* See Verrueckung and elektrische Verschiebung.

Verschiebung: *masking.* A term used in accoustics to denote the shift of the audibility threshold of one sound, due to the presence of another. It may be expressed quantitatively in decibels.

Verschiebungsgesetz: *displacement law.* (1) (Radiation.) The first of the Wien laws of thermal radiation (q.v.). (2) (Spect.) The second of the Kossel-Sommerfeld spectroscopic laws (q.v.). (3) (Radioact.) See Fajans und Soddysche Gesetze. (4) (Chem.) A principle which recognizes the fact that an atom which has had one of its electrons removed behaves chemically like the one preceding it in the periodic table.

Verschiebungsinterferometer: *displacement interferometer.* An optical instrument consisting of an arrangement of mirrors, and used, in conjunction with a dispersive system such as a prism or a grating, for measuring small displacements.

Verschiebungslinie: *line of displacement.* That which, in a polarized dielectric, corresponds to a line of electric force in a vacuum. The lines of displacement in a nonisotropic dielectric do not, however, necessarily coincide with the lines of force of the field in which it is placed.

Verschiebungsroehre: *tube of displacement.* Defined in a manner similar to tube of force, with lines of (electric) displacement substituted for lines of force.

Verschiebungsstrom: *displacement current.* A term introduced by Maxwell to denote the effective current in a dielectric or a vacuum (as between the plates of a condenser) corresponding to the electron current in a metallic conductor (as in the wires leading to the condenser). Maxwell regarded the time rate of change of the electric intensity as equivalent to the value of an actual current. In modern usage, the displacement current density is defined as the time rate of the electric displacement, i.e., to

$$\frac{dE}{dt} + 4\pi \frac{dP}{dt};$$

in which E is the intensity and P the polarization.

verschiedenfarbig: *heterochromatic.* (1) Not monochromatic. (2) Not homochromatic.

Versor: *versor.* That factor of a vector which determines its geometrical direction and which is multiplied by the tensor to give the complete expression for the vector.

Verstaerkerschirm: *intensifying screen.* A fluorescent screen placed in close contact with a photographic plate used in radiographic work, the fluorescent light from which adds its effect to that of the invisible rays in producing the image on the plate.

Verstaerkungsfaktor: *amplification factor.* The negative of the ratio of any small change of plate potential,

in a triode, to the change in grid potential necessary to offset it and keep the plate current constant.

Versuchsballon: *sounding balloon.* A free, unmanned balloon designed to carry instruments such as thermographs, barographs, etc., into the upper atmosphere, for the purpose of obtaining meteorological or physical data.

verteilte Kapazitaet: *distributed capacitance.* That part of the capacitance of an electric circuit which is due, not to the introduction of condensers, but to the insulation of the conducting wires from the ground, or esp. from a surrounding conducting conduit or sheath.

Verteilung: *distribution, dissipation (of energy).* A statistical tabulation of one variable in terms of another which may be related to it through a distribution function (q.v.), e.g., frequency-energy distribution, velocity-angle d., etc.

Verteilungsfunktion: *distribution function.* A mathematical expression indicating the relative frequency with which the value of a statistical variable may be expected to lie within any specified interval.

Verteilungsgesetz: *distribution law, partition law.* (1) States that in a dineric solution, the ratio of the concentrations of the solute in the two solvents is independent of the quantity of solute. Attributed to Nernst. (2) The mathematical statement of statistical frequency as expressed by a distribution function, e.g., the Maxwell or the Gaussian distribution law.

Verteilungskoeffizient: *distribution coefficient, d. constant, d. ratio, partition coefficient.* The constant ratio of the concentrations of a solute dissolved in two immiscible solvents which are in contact in the same container. See also Aufteilungskoeffizient.

Verteilungskonstante: *distribution constant, d. coefficient, d. ratio.* See Verteilungskoeffizient.

Verteilungsmodul: *distribution, modulus of.* A term used by Gibbs to denote the quantity kT (Boltzmann constant $\times$ absolute temperature) as it occurs in the probability distribution function

$$e^{\frac{\Psi-\epsilon}{kT}};$$

in which Ψ is the thermodynamic potential and ϵ is the energy.

Verteilungssystem: *dissipative system.* A nonconservative system.

Verteilungsverhaeltnis: *distribution ratio, d. coefficient.* See Verteilungskoeffizient.

Vertex: *vertex.* That point of a refracting or a reflecting surface at which the axis of the optical system intersects it.

vertikal: *vertical.* (1) The direction of gravity. (2) (Geocentric.) The direction of the radius of the earth. The two coincide, in general, only at the poles and at points on the equator.

Vertikalintensitaet: *vertical intensity.* The intensity of the vertical component of the earth's magnetic field at any point.

Vervielfaeltiger: *multiplier.* A series resistance used in connection with a voltmeter so that it can be used to measure higher voltages than those indicated on the scale.

Verzoegerung: *lag, deceleration.* See Lag.

Verwirbelung: *vorticity.* A measure of the extent to which the motion of a fluid is rotational. Its value at any points is the curl of the particle velocity, or twice the angular velocity of rotation of the fluid element, at that point; it is thus a vector quantity.

Verzoegerungspotential: *retarded potential.* The electric or magnetic potential at any point due to an electric or a magnetic system at a distance r and with due allowance for the time r/c required for the electric or magnetic effect to travel over that distance; c being the electromagnetic constant.

Verzweigungsregel: *branching rule.* States that each term of the spectrum of a singly ionized atom gives rise to two groups of terms of consecutive multiplicity in the spectrum of the neutral atom; except the singlet terms, which give rise only to doublets. Formulated by Landé and Heisenberg.

Verzweigungsverhaeltnis: *branching ratio.* The ratio between the numbers of atoms of a radioactive element which undergo two different types of transformation, the one emitting an alpha particle, the other a beta particle.

Vibrationsgalvanometer: *vibration galvanometer.* A type of a.-c. galvanometer in which the natural oscillation frequency of the moving element is equal to the frequency of the a.-c. applied to it.

Victor-Meyer'scher Apparat: *Victor-Meyer apparatus.* A volumetric apparatus for measuring vapor densities of volatile substances, and hence, indirectly, their molecular weights.

Vielfaeltigkeit: *multiplicity.* The largest number of components possessed by any multiple term in a given

spectral system. Multiplicities as high as 9 are known, but not all the terms of a system have the maximum number of components.

Vielgestaltigkeit: *polymorphism.* See Polymorphismus.

Vielkristall: *polycrystal.* A body made up of a number of small crystals in a mass.

vierdimensionale Analyse: *four-dimensional analysis.* The space-time analysis of Minkowski.

viereckig: *tetragonal.* See tetragonal.

vierkantig: *tetragonal.* See tetragonal.

Virial: *virial.* A quantity which appears in the general dynamic equation of a mass of gas molecules. It is half of the sum of the average products of the coordinates of the molecules by the corresponding components of force acting upon them, and, according to the virial theorem of Clausius, is equal to the negative of the total kinetic energy of the molecules.

Virialkoeffizienten: *virial coefficients.* The coefficients A, B, ... of an inverse-power series in v representing the product pv in the equation of state for a real gas:

$$pv = A + B_v^{-1} + C_v^{-2} + D_v^{-4} + \ldots\ldots$$

The coeffcients are functions of the temperature.

virtuelle Arbeit: *virtual work.* The quantity of work done during an infinitely small displacement ds under the action of either a constant or a variable force f. If the force and the displacement are at an angle ϕ, then the virtual work is $dw = f \cos \phi \, ds$.

virtuelles Bild: *virtual image.* See Bild.

virtuelle Geschwindigkeit: *virtual velocity.* That component of the velocity (of a particle) which is in the direction of a given force, in any assumed displacement through the position of equilibrium.

virtueller Oszillator: *virtual oscillator.* An ideal electric oscillator, consisting of a charged point executing harmonic motion; a concept used in developing the classical theories of radiation.

virtuelle Verrueckung: *virtual displacement.* The projection, on the original line of action of a force, of the path followed by the point of application of the force during an infinitely small displacement.

Viskoelastizitaet: *visco-elasticity.* That property of a body, by virtue of which deformations are reversible and without dissipation of energy when produced at infinitely slow rates, but not so at finite rates.

Viskosimesser: *viscometer, viscosimeter.* An apparatus for measuring the viscosity of a fluid.

Viskositaet: *viscosity.* A property of fluids, by virtue of which they offer a resistance to flow, and which involves their yielding to a certain amount of shearing stress. A fluid is said to be viscous or limpid according as this property is conspicuous or negligible.

Viskositaetskoeffizient: *viscosity coefficient.* The shearing stress involved in maintaining the uniform flow of a fluid, per unit rate of shear. Syn. viscosity.

Viskositaetsmanometer: *viscosity manometer, v. gauge.* A low-pressure manometer dependent upon the variation of the viscosity of the gas with pressure; e.g., the molecular gauge.

vizinal: *vicinal.* In re a crystal face: lying in a subordinate plane, not one of the usual planes of cleavage or of external growth, and not in accordance with the Haüy law.

Voigt-Thomson'sche Symmetriebeziehung: *Voigt-Thomson symmetry relation.* An expression for the value of a (vector) property of a crystal in a given direction in terms of two principal values, one parallel to a rotation axis of symmetry and the other perpendicular thereto. When the relation holds, the value in a direction making an angle θ with this axis is a linear function of $\cos^2 \theta$. The two principal values correspond to $\theta = 0$ and $\theta = 90$ deg., respectively.

vollkommene Abtrennung: *exhaustion.* See Aufspaltung.

Volt: *volt.* The practical unit of e.m.f. and potential. The absolute volt is equal to 10^8 abvolts. The international volt is that e.m.f. which, when applied to a resistance of 1 international ohm, maintains a current of 1 international amp. The ratio of the international to the absolute volt is about 1.00039.

Voltameter: *voltameter, Syn. coulombmeter.* An instrument for the measurement of a quantity of electricity by the amount of electrodeposition produced from an electrolyte. Not to be confused with voltammeter (q.v.).

Voltampere: *volt-ampere.* The practical unit of apparent power (effective volts times effective amperes) in a variable-current circuit.

Voltamperemesser: *volt-ammeter.* An instrument which may be used either as a voltmeter or as an ammeter. Not to be confused with voltameter.

Voltapaar: *voltaic couple.* A pair of dissimilar metals in contact, which results in a contact p.d.

Voltascher Effekt: *Volta effect, V. potential, Syn. contact potential difference.* A difference of electric potential which develops between two dissimilar conductors when they are placed in contact; first observed by Volta.

Voltasches Gesetz: *Volta law.* States that the contact p.d. of two conductors is the same, whether they are in direct contact or joined through one or more intermediate conductors.

Voltasches Potential: *Volta potential, contact potential contact potential difference.* See Voltascher Effekt.

Voltascher Potentialunterschied: *voltaic potential difference, Volta effect—contact potential difference.* See Voltascher Effekt.

Voltelektron: *volt-electron, Syn. electron-volt.* A unit of energy equal to about 1.591×10^{-12} erg, and defined as the change in energy experienced by 1 electronic charge on passing through a p.d. of 1 volt.

Voltmeter: *voltmeter.* See Spannungsmesser.

Voltmeterwiderstand: *voltmeter resistor.* A resistance used with a galvanometer or other current-measuring instrument to convert it into a voltmeter.

Voltsekunde: *volt-second, Syn. weber.* The practical unit of magnetic flux, equal to 10^8 maxwells.

Volumengeschwindigkeit: *volume velocity.* In re any flow or flux across a plane: the product of the linear speed of flow, or of propagation, by the cross-sectional area through which the flow is considered. Multiplied by the density (quantity per unit volume), it gives the flux; in case quantity is measured by volume, it equals the flux.

von der gleichen Enthalpie: *isenthalpic.* See isenthalpisch.

von gleicher Entropie: *isentropic.* See isentropisch.

von gleicher Inklination: *isoclinic, isoclinal.* See isoklin.

von gleicher Neigung: *isoclinic, isoclinal.* See isoklin.

vorbedingte Beobachtung: *conditioned observation.* An observation upon a quantity or upon quantities subject to rigorous theoretical conditions.

Vorbeleuchtung: *priming illumination.* See Grundbeleuchtung.

Vorpumpe: *fore pump.* An auxilliary air pump, used to create a partial vacuum, preliminary to the operation of another, more effective air pump. Syn. backing pump.

Vreeland'scher Oszillator: *Vreeland oscillator.* A device for producing a sinusoidal electric current by means of a mercury arc in a periodically varying magnetic field.

Wadsworth'scher Spiegel: *Wadsworth mirror.* A plane mirror used in certain forms of prism spectrometer in which the prism is used at minimum deviation.

Waermeausbreitungsvermoegen: *thermal diffusivity.* The ratio of the thermal conductivity of a substance to the product of the density by the specific heat. Upon it depends the rate at which a temperature wave is propagated in conducting substance.

Waermediffusion: *thermodiffusion, Syn. thermal transpiration, thermal effusion.* A pressure difference which develops between two bodies of gas, initially at the same low pressure but at different temperatures, when they are joined by a capillary tube. The flow is from the colder to the warmer gas. Discovered by Feddersen and Reynolds.

Waermefunktion: *heat function.* (1) A quantity related to thermionic emission, and equal to the heat of emission per mol at constant pressure, minus

$$\frac{5}{2} RT ;$$

in which R is the gas constant and T is temperature. The heat function h is related to the work function w by the equation

$$h = w - T \frac{dw}{dT}.$$

(2) Syn. any one of the Gibbs functions.

Waermegleichgewicht: *thermal equilibrium.* That condition of a system in which the net rate of exchange of heat among its parts has become zero; a special feature of thermodynamic equilibrium.

Waermeinhalt: *heat content.* See Enthalpie.

Waermeionisation: *thermal ionization.* Ionization due to high temperature, as in the electrically conducting gases of a Bunsen flame. Syn. temperature ionization.

Waermekapazitaet: *heat capacity, Syn. thermal capacity.* The quantity of heat required to increase the temperature of a body by unity, or which the body yields when its temperature is lowered by unity, without change of state.

Waermeleitfaehigkeit: *thermal conductivity.* See Leitfaehigkeit.

Waermestrahlung: *thermal radiation, Syn. temperature radiation, heat radiation, radiant heat.* Radiation excited by the thermal agitation of molecules or atoms, irrespective of other causes of excitation. Its existence is observable from the far infrared to the extreme ultraviolet.

Waermetod: *heat death.* The final state of thermodynamic equilibrium which the material universe appears to be approaching, in accordance with the laws of dissipation of energy and increase of entropy.

Waermeuebertragung: *thermal effusion, Syn. thermal transpiration, thermodiffusion.* See Waermediffusion.

Waagerecht: *horizontal.* See horizontal.

Wagner'sche Erdung: *Wagner ground.* A device for preventing false indications of the detector in a.-c. bridge measurements, due to capacitance effects between the bridge and the ground.

Waidner-Burges'scher Standard: *Waidner-Burgess standard.* A standard of luminous intensity, designed to supplant the Bureau of Standards candle. Defined as the luminous intensity of 1 cm^2 of a black body at the melting point of platinum.

Walden'sches Gesetz: *Walden law.* States that the limiting equivalent conductance of a solution (at infinite dilution) is inversely proportional to the viscosity coefficient of the solvent, the constant being the same for all solvents.

wahre Energie: *intrinsic energy, Syn. internal energy.* See innere Energie.

wahre Kontaktpotentialdifferenz: *intrinsic contact potential difference.* The true contact p.d. between two perfectly clean metals. Its value is given by Millikan as $h(\nu_1 - \nu_2)/e$ in which ν_1 and ν_2 are the threshold photoelectric emission frequencies for the two metals, h is the Planck constant, and e is the elementary charge.

wahre magnetische Permeabilitaet: *intrinsic magnetic permeability.* The magnetic permeability minus one.

wahrscheinlicher Fehler: *probable error.* The magnitude of an error that is as likely as not to be exceeded by a single observation, or by the mean or the adjusted result from a certain number of observations. It is selected with reference to the true but unknown mean which would theoretically be obtained from an indefinitely large number of observations, and is a statistical measure of precision.

Wahrscheinlichkeitsamplitude: *probability amplitude.* A wave function, commonly denoted by Ψ, which satisfies the Schroedinger wave equation or other similar equations of wave mechanics, and corresponds to a quantum condition actually fulfilled in nature.

wahrscheinlichster Verteilungswert: *mode.* The most probable value of the variable in a statistical distribution. It corresponds to the abscissa of the highest point on the distribution curve. Adj. modal.

wahrscheinlichster Wert: *most probable value.* A hypothetical value of a measured quantity, arrived at through calculations upon the tabulated results of several measurements upon it, in accordance with the theory of errors.

Wanderung: *migration.* The relatively slow movement of the ions in electrolysis, due to the applied electric field; or any similar movement of minute particles.

Wanderungspotential: *migration potential.* A p.d. due to the settling or centrifuging of charged colloidal particles. It may be regarded as the reverse of electrophoresis.

Wasseraequivalent: *water equivalent.* The mass of water which would have the same thermal capacity as a given body, such as a calorimeter cup.

Wasserkalorimeter: *water calorimeter.* A calorimeter which measures quantities of heat by the change in temperature of a known mass of water.

Wasserstoffskala: *hydrogen scale.* A temperature scale based upon the variation of pressure in hydrogen gas kept at constant volume.

Watt: *watt.* A unit of power, defined as 1 joule of work per second.

Wattmeter: *wattmeter.* An instrument for measuring electric power in watts.

Wattstunde: *watt-hour.* A unit of work or energy, equivalent to 1 watt of power operating for 1 hr, and equal therefore to 3,600 joules or 3.6×10^{10} ergs.

Weber: *weber, Syn. volt-second.* (1) An obsolete name for the coulomb. (2) An obsolete name for the ampere. (3) An obsolete unit of magnetic pole strength, equal to 10^8 times the (c.g.s.) unit magnetic pole.

Weber'sche Einheit: *Weber unit.* An electromagnetic unit of electric current based on the millimeter, milligram, and second; hence equal to 0.01 c.g.s. electromagnetic unit (abampere). Not to be confused with weber (q.v.).

Weber'sche Energiegleichung: *Weber energy equation.* An equation developed in 1846, expressing the total mutual electric and magnetic energy of two moving charges e_1, e_2 at distance r apart, as follows:

$$\Psi = \frac{e_1 e_2}{r}\left[1 - \frac{1}{2c^2}\left(\frac{dr}{dt}\right)^2\right],$$

in which c is the electromagnetic constant.

Wechselbeziehung: *correlation.* See Beziehung.

Wechselrichter: *inverter.* See Umwandler.

Wechselstromleitvermoegen: *admittance.* The reciprocal, of the impedance of an electric circuit.

Wechselwirkung zwischen Elektronenanordnungen: *configuration interaction.* The perturbing effect of one arrangement of electrons in the atom (as represented by the assigned quantum numbers) upon another such arrangement, so that the energy levels and spectral terms corresponding to the two arrangements are altered with respect to their values when no such interaction exists.

Wehnelt'sche Kathode: *Wehnelt cathode.* A type of hot cathode consisting of a metallic core coated with alkaline earth oxides.

Wehnelt'scher Unterbrecher: *Wehnelt interrupter.* An interrupter in which the current passes between a fine wire and an electrolytic solution, and is interrupted by the formation and collapse of small bubbles of vapor.

Wellenaufzeichnungsgeraet: *phonodeik.* An apparatus which photographically records the wave form of any sound on a moving film, so that it may be studied and analyzed. Devised by D. C. Miller.

Wellenbahnfunction: *orbital wave function.* An orbital wave function pertaining to a single electron; a characteristic solution of the Schroedinger equation for a one-electron problem, excluding spin.

Wellenfilter: *wave filter.* See Filter.

wellenfoermig: *undulatory.* Pertaining to or consisting of waves.

Wellenform: *wave form.* A curve which graphically represents the magnitude of a wave variable (as ordinate) in its relation to distance along the path of propagation (as abscissa).

Wellenfront: *wave front.* A surface connecting all points of a wave-propagating medium which are in the same given phase of the same order.

Wellenfunktion: *wave function.* A point function commonly represented by Ψ, which in a wave equation

specifies the amplitude of a wave variable at any point of the region traversed by the waves.

Wellengeschwindigkeit: *wave velocity, Syn. phase velocity.* A vector whose direction is normal to the wave front and whose magnitude is the speed of propagation of a plane-wave disturbance.

Wellengleichung: *wave equation.* An equation which gives a mathematical specification of a wave process, or describes the performance of a medium through which a wave is passing.

Wellengruppe: *wave group.* The resultant of two or more wave trains of different frequency traversing the same path.

Wellenlaenge: *wave length.* The distance between successive points in the same phase along a line in the direction of propagation of a wave train.

Wellenleiter: *wave guide.* A dielectric of limited cross section, used to transmit electromagnetic waves.

Wellenmechanik: *wave mechanics.* A general physical theory which ascribes wave characteristics to the fundamental entities of atomic structure and seeks to interpret all physical phenomena in terms of hypothetical wave forms. Introduced by Schroedinger in 1926.

Wellenmesser: *wave meter.* A calibrated electric resonator of variable frequency, used for measuring electric oscillation or wave frequencies.

Wellenpaket: *wave packet.* (1) A group of wave trains so related as to wave length, velocity, phase, and amplitude that when they are combined the resultant wave is approximately a single pulse of definite amplitude advancing with a definite speed. (2) In general, a wave disturbance which is confined to a limited volume of space.

Wellenveraenderliche: *wave variable.* A quantity which varies progressively and periodically at any point in a field of waves, and whose variations, moving forward, constitute a characteristic feature of the wave propagation. E.g., in the case of sound, pressure is a wave variable.

Wellenzahl: *wave number.* The reciprocal of a wave length, i.e., the number of waves per unit distance in the direction of propagation.

Weltlinie: *world line.* The graph in space-time coordinates which represents any continuous sequence of events relating to a given particle.

weisses Licht: *white light.* Any one of a variety of spectral energy distributions producing the same color sensation as average noon sunlight.

weisse Strahlung: *white radiation.* Any radiation which produces a continuous spectrum. For X-rays there is a sharply defined short-wave length limit determined by the Duane-Hunt law.

Wertekomplex: *complexion.* Any specified set of values of the coordinates and momenta for the molecules or other particles composing a system, treated as a distribution of the particles among the phase-space elements.

Wertheim'scher Effekt: *Wertheim effect.* A change in the helical (circular) magnetization of a ferromagnetic wire or rod when twisted; detected by the corresponding longitudinal e.m.f. Discovered by G. Wertheim in 1852, and by G. Wiedemann in 1862. Syn. Wiedemann effect.

Wertigkeit: *valence, valency.* See Valenz.

Weston'sche Zelle: *Weston cell.* A standard cell whose positive electrode is mercury and negative electrode cadmium, with a saturated cadmium sulphate solution as electrolyte. Mercurous sulphate is added as a depolarizer.

Wetterkunde: *meteorology.* That branch of physical science which treats primarily of atmospheric phenomena.

Wheatstone'sche Bruecke: *Wheatstone bridge.* A branched electric circuit used for the measurement of resistances by a balance method.

Widerstand: *resistance.* That which limits the steady electric current in a conductor and is expressed by the ratio of the applied constant e.m.f. to the current.

Widerstandsapparat: *resistor.* A device, the primary purpose of which is to introduce resistance into an electric circuit.

Widerstandsbruecke: *slide-wire bridge.* See Schleifdrahtbruecke.

Widerstandsgeraet: *resistor.* See Widerstandsapparat.

Widerstandsneutralisierung: *resistance neutralization.* The effect of a triode associated with a circuit in such a way as to lower the effective resistance of certain branches.

Widerstandsthermometer: *resistance thermometer.* A

thermometer based upon the variation of the electrical resistivity of a metal, e.g., platinum, with temperature.

Wiedemann'scher Effekt: *Wiedemann effect, Syn. Wertheim effect.* Torsional magnetostriction in a ferromagnetic wire or rod; discovered by G. Wiedemann in 1862.

Wiedemann'sches Gesetz: *Wiedemann law.* States that the molar susceptibility of a substance in solution is independent of the concentration.

Wiedemann-Franz'sches Gesetz: *Wiedemann-Franz law.* States that the ratio of the thermal conductivity of a metal to the product of the electrical conductivity by the absolute temperature (Wiedemann-Franz ratio) has for all metals approximately the same value, viz., 5.345×10^{-9} cal ohm/sec deg^2. Known also as the Wiedemann-Franz-Lorenz law.

Wien'sche Bruecke: *Wien bridge.* A type of capacitance bridge circuit developed by M. Wien.

Wien'sche Verschiebungskonstante: *Wien displacement constant.* The constant which in accordance with the Wien displacement law represents the product of the maximum-emissivity wave length and the absolute temperature of the radiator. Its value is about 0.2884 cm-deg.

Wien'sche Waermestrahlungsgesetze: *Wien laws (of thermal radiation).* Three laws formulated by W. Wien in the 1890's :(1) The wave length at which the monochromatic emissivity of a black body is a maximum is inversely proportional to the absolute temperature of the body (Wien "displacement law"). (2) The monochromatic emissive power for this "peak" wave length is proportional to the fifth power of the absolute temperature. (3) The spectral energy distribution of black-body radiation for temperature T is given by the formula

$$dE_\lambda = A\lambda^{-5} e^{-\frac{B}{\lambda T}} d\lambda ;$$

in which dE_λ is the emissive power within wave-length range d.λ and A and R are constants. Not accurate at long wave lengths.

Wilson'sche Nebelkammer: *Wilson (cloud) chamber.* An inclosure containing air supersaturated by sudden expansion, in which rapidly moving particles, e.g., alpha or beta rays, produce ionization tracks by condensation on the ions. These may be observed or photographed through a suitable window.

Wilson'scher Versuch: *Wilson experiment.* An experiment of H. A. Wilson, which consisted in the rotation of a hollow dielectric cylinder about an axis parallel to a magnetic field, with arrangements for detecting the resulting electric polarization in the dielectric.

Wimshurst'sche Maschine: *Wimshurst machine.* A type of static machine having two plates, or two sets of plates, rotating in opposite directions.

Windmesser: *wind meter, Syn. anemometer.* An instrument for measuring the velocity of the wind.

Windungsfluss: *turn flux, linkage (mag.)* A measure of the interlocking of a magnetic flux wtih an electric circuit, viz., the product of the flux by the number of turns of the circuit surrounding it, expressed in maxwell-turns.

Windungslinie: *line-turn, maxwell-turn.* A unit of magnetic linkage, corresponding to one line of force surrounded by 1 turn of the circuit.

Winkel: *angle.* (1) The figure, concept, or relation of two straight lines (sides) emanating from one point (the vertex); a corner or point. (2) In the strictest mathematical sense the word angle signifies that relation of the lines which is measured by the amount of rotation necessary to make one coincide with the other. This amount is commonly expressed in degrees. When the sides of an angle are perpendicular to each other, it is a right angle; when less than a right angle, an acute angle; when greater than a right angle, an obtuse angle; when the sides go out in opposite directions, a straight angle. Any angle not a right or straight angle is an oblique angle.

Winkel an der Trennungslinie: *angle of repose.* (1) The angle of inclination assumed by the surface of a loose material, such as sand in a pile, when in equilibrium with gravity. (2) By some writers, Syn. angle of friction.

Winkeldrehmoment: *moment of momentum, angular momentum.* The angular momentum is the product of the moment of inertia of a rotating body, with respect to the (fixed) axis of rotation, by its angular velocity in radians per unit time; or, the volume integral of the products of the momenta of the elements of mass of the body by their distances from the axis of rotation.

Winkelimpuls: *angular impulse.* The time integral of a torque, esp. when applied for a short time; measured by the change in angular momentum which it would impart to a free mass if acting about a principal axis.

Winkelmesser: *goniometer.* See Goniometer.

Winkelveraenderliche: *angle of slip.* The angle between surfaces of slip or shear and the direction of

stress during flow or during the plastic deformation of a solid.

Winkelvergroesserung: *angular magnification.* The ratio of the tangent of the angle with the optic axis made by a ray upon emergence from an optical instrument to the tangent of the angle for the corresponding (conjugate) incident ray; or, approximately, the ratio of the angles themselves.

Wirbel: *vortex.* A portion of fluid which rotates about an axis with resulting centrifugal force and reduced pressure at the axis, and which is surrounded by a relatively stationary portion of the same fluid. The strength of an ideal vortex is its integrated vorticity, or twice the product of its angular speed of rotation by its cross section. See also Rotation eines Vektors.

Wirbelbildung: *vorticity.* See Verwirbelung.

Wirbelring: *vortex ring.* A type of vortex motion of a fluid, illustrated by the familiar smoke ring.

Wirbelstrom: *eddy current.* A transient and local electric current in a conductor, due to change in magnetic induction; e.g., in the core of a generator armature. Syn. Foucault current.

Wirbelstromverlust: *eddy current loss.* The power loss due to eddy currents in a core, which has been expressed by the following empirical formula:

$$p_e = A(nfB_m l)^2,$$

in which n is the frequency, B_m the maximum induction during the cycle, l the thickness of the laminations, and f a form factor. A is the eddy-current constant.

Wirbelsturm: *cyclone.* See Zyklon.

wirkliches Bild: *real image.* See Bild.

wirkliche Energie: *intrinsic energy, internal energy.* See wahre Energie.

wirksame Komponente: *effective component.* See effektive Komponente.

Wirksamkeit: *efficiency.* The ratio of the useful energy derived from a dynamic system (as an engine or other machine) to the energy communicated to it during the same process or over a protracted period of operation.

Wirkung: *action.* (1) A magnitude defined as twice the time integral of the kinetic energy of a system, the variable time being measured from an arbitrary zero up to the time in question: Thus:

$$S = 2\int_{t_o}^{t} E_{kin}\,dt.$$

It may be interpreted as twice the mean kinetic energy during the interval, multiplied by the duration of the interval. (2) In relativity dynamics, action is represented by the formula:

$$S = \int_{t_o}^{t} (\Sigma\, \dot{q}p)\,dt$$

or

$$S = \int_{t_o}^{t} (\Sigma\, \dot{q}\frac{\delta L}{\delta \dot{q}})\,dt$$

in which the $\dot{q}$'s and p's are generalized velocities and generalized momenta and L the Lagrangian function, and the summation extends over all the degrees of freedom.

Wirkungsquantum: *quantum of action.* See Planck'sche Konstante.

Wismuthspirale: *bismuth spiral.* A coil of bismuth wire, the magnetoresistance effect in which is used as a measure of the magnetic field intensity.

Woelbung: *camber.* The ratio of the sagitta (maximum ordinate) of an arc to the length of the chord; a term applied to the streamlined contours of aerofoils or similar surfaces.

wohltemperierte Tonleiter: *equally tempered scale.* A musical scale having equal intervals, therefore with frequencies in geometrical progression. Introduced by Bach. Syn. chromatic scale.

Wollaston'sches Prisma: *Wollaston prism, Syn. double-image prism.* A large, quadrilateral reflecting prism of glass, used for sketching.

Wuerfel: *cube.* A solid bounded by six equal squares and having all its angles right angles.

Wurzel: *root.* (1) A quantity that, taken a specified number of times as a factor, will give another quantity called its power; as 2 is the fourth root of 16. (2) The quantity that, when substituted for the unknown quantity in an equation satisfies the equation.

x-Einheit: *x-unit.* A unit of wave length, equal to 10^{-11} cm or 0.001 Å; commonly used for X-rays and other highly penetrating radaition.

Youngscher Interferenzversuch: *Young interference experiment.* An epochal experiment, performed by Thomas Young in 1801, which demonstrated the interference of light from two sources and thereby established its undulatory character.

Young'scher Modul: *Young modulus.* The ratio of the tensile stress, or longitudinal force per unit cross section, in a stretched elastic solid to the change in length per unit length.

Zaehfluessigkeit: *viscidity.* See Dickfluessigkeit.

Zaehlrohr: *counting tube, tube counter.* An ionization chamber used for counting electrons or other ionizing particles.

Zahl der Freiheitsgrade: *variance.* The number of degrees of freedom of a system.

Zahlenkomplex: *complexion.* Any specified set of values of the coordinates and momenta for the molecules or other particles composing a system, treated as a distribution of the particles among the phase-space elements.

Zeeman Effekt: *Zeeman effect.* An effect upon the spectral series of gaseous elements produced by subjecting the radiating atoms to a strong magnetic field; discovered by Zeeman in 1896. The lines are split up into more or less complicated multiplets, depending upon the direction of the field and other circumstances; and the effect may be either "normal" or "anomalous", i.e., it may or may not be subject to a comparatively simple quantum explanation.

Zeitintegral: *time integral.* In re any variable f which is a function of the time: the definite integral of the product of the variable by the element of time, viz., $\int f dt$ between specified limits of t.

Zeitkonstante: *time constant.* In re an electric circuit: the ratio of the inductance to the resistance; so called because it may be expressed dimensionally in time units, and measures the relaxation time of the current when the e.m.f. is removed.

Zelle verschiedener Elektrolyten: *gravity cell.* A primary cell in which the electrolyte is in two parts kept separate by their difference in specific gravity.

Zentimeter: *centimeter.* (1) 1/100 of a meter. (2) The c.g.s. electrostatic unit of capacitance. It is the capacitance of an isolated spherical conductor of radius 1 cm; equal to about

$$1.113 \times 10^{-12} \text{ f}.$$

(3) Syn. abhenry. (4) A centimeter of mercury is a unit of pressure equal to about 1333.2 bars.

Zentrifugalkraft: *centrifugal force.* The kinetic reaction exerted by a body constrained to move in a curved path, and due to inertia.

Zentrifugalmoment: *centrifugal moment, c. torque.* (1) The integrated torque of the centrifugal forces of all the particles of a freely rotating body with respect to any line through its center of mass perpendicular to the axis of rotation. (2) In general, the torque of a centrifugal force with respect to any given line.

Zentripetalkraft: *centripetal force.* The force which constrains a moving body to follow a curved path rather than a straight line; the equilibrant of the centrifugal force.

zentrobar: *centrobaric.* Having a true center of gravity. A rigid body is centrobaric if the resultant gravitational attraction of an external particle for it is equivalent to a single force which always passes through one point fixed relatively to the body (its center of mass), irrespective of its orientation and position. E.g.; a homogeneous sphere or spherical shell is centrobaric, but bodies in general are not.

Zentrode: *centrode.* The curved trace by the instantaneous center of a plane body as it moves in any manner in its own plane.

Zerfallskoeffizient: *decay coefficient.* A constant factor appearing in the exponent of the time function of decay for such phenomena as radioactivity, which obey the exponential law. E.g., the intensity of a radioactive emission of any type is given by an equation of the form

$$I = I_o e^{-\lambda t}$$

in which λ is the decay coefficient.

Zerfallsmodul: *decay modulus.* In re any variable which diminishes or "decays" exponentially, e.g., radioactivity: the time required for the variable to diminish to 1/e or 36.97 percent of its original value. It is equal to 1.443 times the half-value period, and is the reciprocal of the decay coefficient.

Zerreissfrequenz: *shatter oscillation.* An oscillation in a liquid of such frequency and amplitude as to break the continuity of the liquid.

Zerreissfestigkeit: *ultimate strength, tensile strength.* The limiting stress for which a material completely breaks down, and gives way.

Zerreissgrenze: *destruction limit.* The limiting shearing stress at which a crystal begins to lose its lattice structure, as indicated by the change in the Laue X-rays pattern.

Zerreisskegel: *cone of rupture.* A double conical surface along which a solid cylinder, when subjected to severe longitudinal compression, tends to crack and slip.

Zerreissmodul: *rupture, modulus of.* A kind of ultimate strength of a material, intermediate between the ultimate tensile and compressive strengths, which pertains to the breaking of a rod by flexure; defined as the product of the bending torque required to rupture

by the distance of the extreme fiber from the neutral axis, divided by the sectional moment of inertia.

Ziehbarkeit: *ductility.* A combination of properties in a metallic substance, including malleability and toughness, which makes it capable of being drawn into wires.

Zirkularpolarisation: *circular polarization.* Polarization in which the cycle is a circle.

Zirkulation: *circulation.* In re any closed path within a fluid: the line integral of the tangential component of the velocity of the fluid taken around the closed path.

zonale Aberration: *zonal aberration.* Spherical or monochromatic aberration of a lens of wide aperture, due to the fact that the refracting power is different for different zones concentric at the axis.

Zone: *zone.* (1) A belt of crystal faces extending around a crystal, the planes of which form a prismatic surface, e.g., the lateral facets of a quartz crystal. (2) A portion of the surface of a sphere included between two parallel circles or bounded by one circle.

Zonenachse: *zone axis, zonal axis.* (1) A line through the origin or center of a crystal which has a zone of faces, the line being parallel to each of those faces. (2) A row of atoms, ions, or molecules, located at the intersection of two or more atomic planes in a crystal.

Zonenplatte: *zone plate.* A transparent screen placed in a beam of light and having photographed on it a series of concentric opaque rings corresponding to alternate half-period elements of the intercepted waves. It exhibits effects similar to those of a converging lens.

Zuckergehaltsmesser: *saccharimeter.* See Saccharimeter.

Zuendfunker: *pilot spark.* A feeble disruptive discharge sometimes released between close spark terminals in order to promote a more violent spark in an adjacent, wider gap. The whole arrangement is called a three-point gap.

Zuendungspotential: *striking potential.* The p.d. necessary to start an electric arc.

Zuendverzoegerung: *spark lag.* See Funkenverzoegerung.

Zufuehrung: *lead.* A connecting wire to or from an electric device.

Zug: *negative pressure.* A condition of stress within a cohesive body which is subjected to equal tensions in all directions, and which is thus truly the opposite of pressure.

zulaessige Spannung: *allowable stress.* The maximum stress which will not cause a plastic or permanent deformation of the substance to which it is applied.

zusaetzlicher Pol: *consequent pole.* A magnetic pole in excess of the usual two on a magnetized body.

Zusammenstoss: *Collision.* See Stoss.

Zustandsgesetz: *law of stages.* The principle that in the process of crystallization from the liquid state, the atoms arrive at their final, permanent configuration through successive, temporary arrangements of varying stability.

Zustandsgleichung: *equation of state.* (1) An equation connecting the pressure p, the density d, and the temperature T of a fluid as any two or all of these quantities vary; e.g., for an ideal gas it has the form

$$p/dT = \text{constant}.$$

(2) In general, an equation connecting the variables chosen to specify the state of a substance.

Zustandsveraenderliche: *variables of state.* The variables, e.g., pressure, volume, temperature, and entropy, which determine the physical state of a body, and in terms of which its thermodynamic transformations are expressed.

Zweig: *branch.* (1) Part of the series of lines forming a single band in a band spektrum; the two branches proceed in opposite directions from a common zero line. (2) One of the subdivisions of a radio-active series due to transformations of different types. (3) A conductor joining any two given points of an electric network.

Zweiphasenstrom: *two-phase current.* (1) A current service delivered through two pairs of wires forming separate circuits in which a phase difference of one-quarter cycle is maintained. A two-phase generator supplies, and a two-phase motor is operated by, such a current. (2) The same as (1), except that the two circuits are connected and usually grounded at their extremities or neutral points, forming a true polyphase system of four components.

Zwillingsachse: *twin axis.* The line perpendicular to both crystalline axes of a twin crystal.

Zwillingskristall: *twin crystal.* A crystal composed of two parts having axes in different directions, usually at right angles. They may be juxtaposed twins, i.e.,

merely grown together, with a plane of separation between; or interpenetrant twins, i.e., having their structures intimately commingled.

Zwischenelektrodenkapazitaet: *interelectrode capacitance.* The capacitance of a vacuum-tube circuit due to the condenser action of two of the tube electrodes, as the filament and the plate.

Zwischenflaechenspannung: *interfacial tension.* The surface tension at the interface between two fluids, as water and oil.

Zybotaxis: *cybotaxis.* The space arrangement of molecules in a liquid, with orientation simulating crystalline structure but without stability or permanence at any point. Studied by the X-ray diffraction patterns of the liquid.

Zyklon: *cyclone.* See Wirbelsturm.

Zyklotron: *cyclotron.* An apparatus for imparting high speeds to electrons or ions by causing them to move in semi-circular paths in a magnetic field, with an acceleration and increased radius every 180 degrees due to an electric field alternating in synchronism with their motion.

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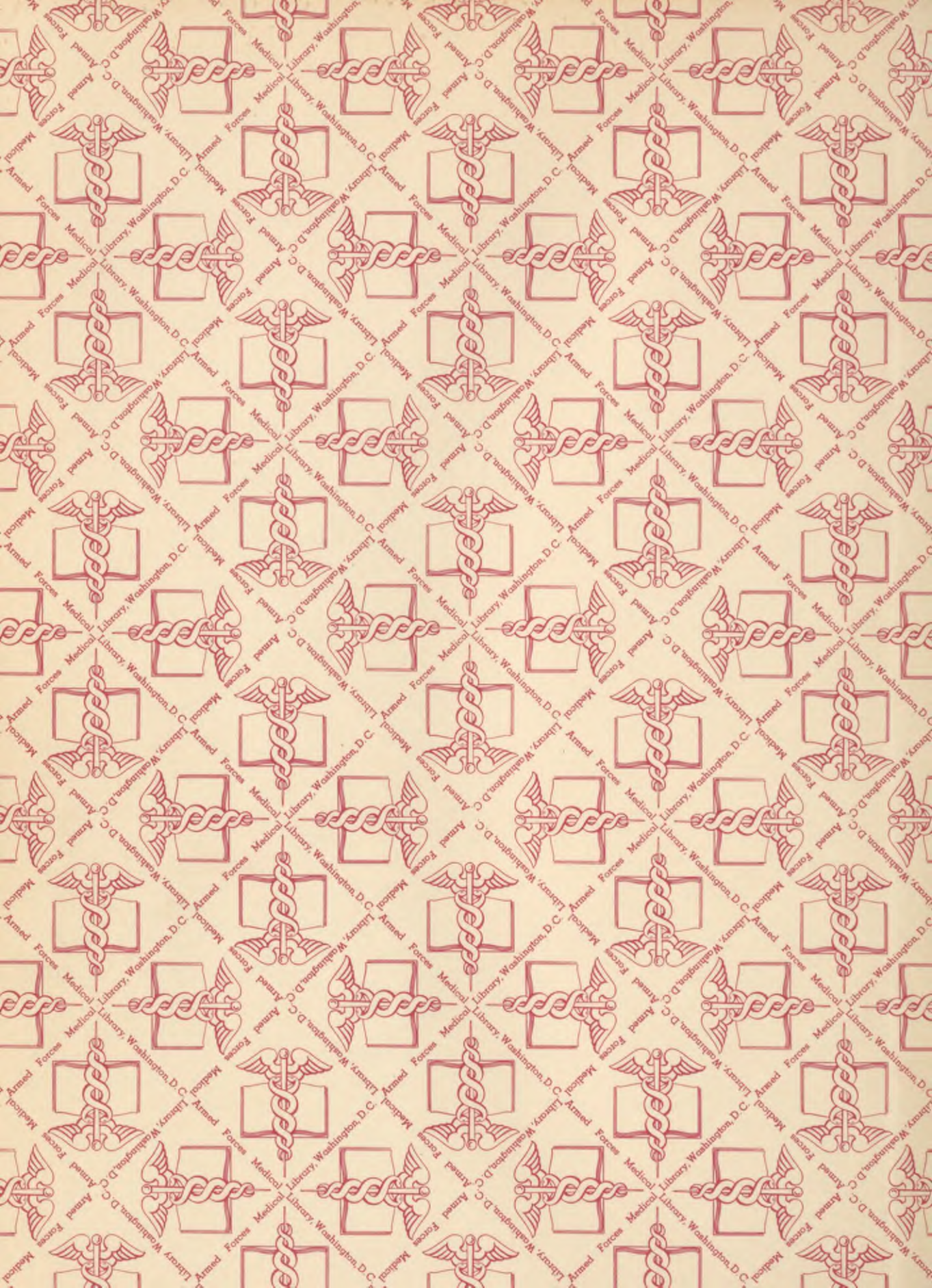
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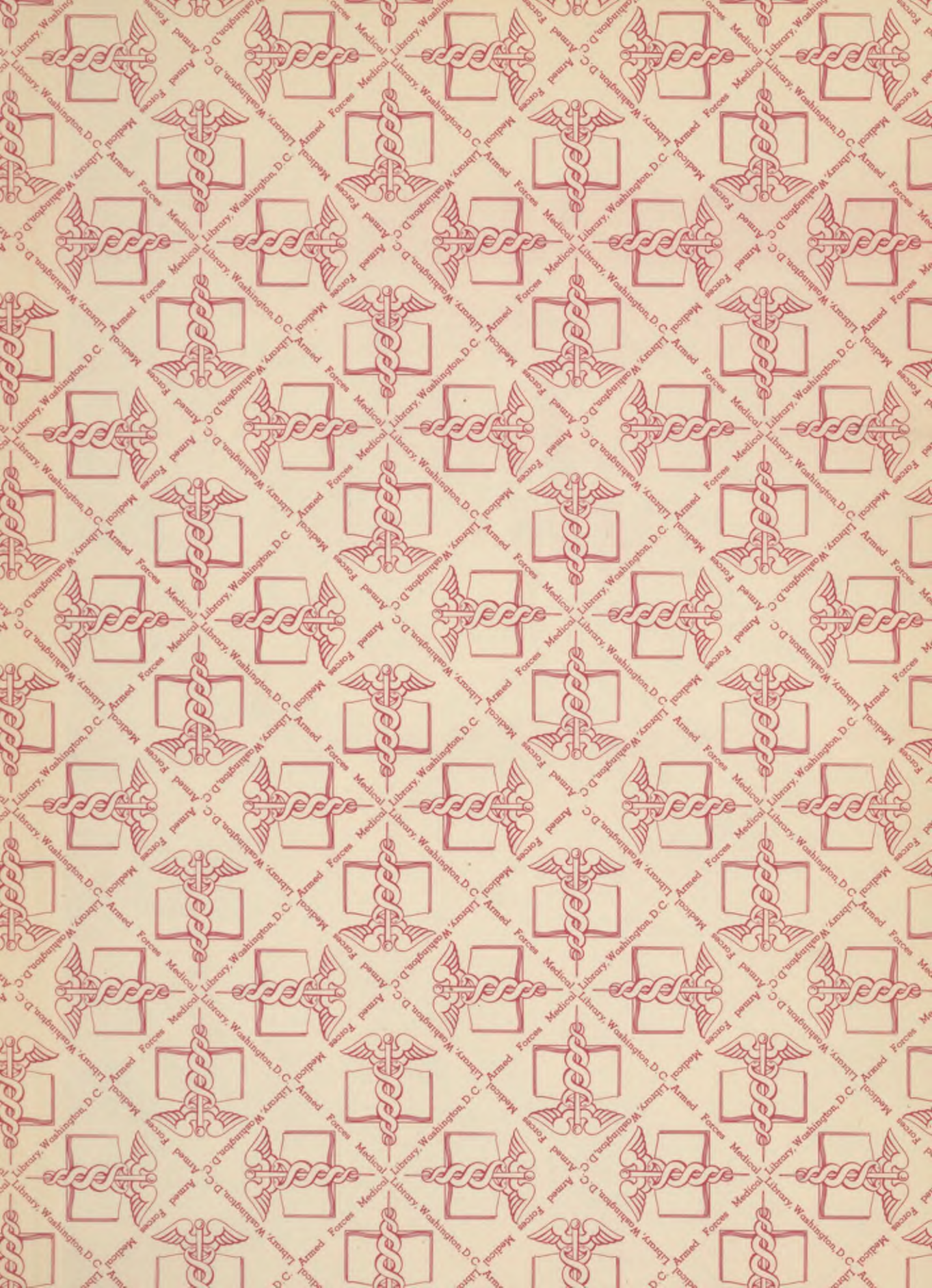
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