

The image shows the front cover of an antique book. The cover is decorated with a traditional marbled paper pattern, featuring a base of deep blue with intricate, branching veins of red and yellow-green. The spine, visible on the left, is bound in a dark, textured material, likely black leather. A rectangular white paper label is pasted onto the upper portion of the cover, containing the title in a cursive hand. The text on the label reads "Maryland Agricultural College".

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HAND BOOK

OF

PRACTICAL CHEMISTRY,

PRINTED (NOT PUBLISHED) FOR

THE USE OF THE STUDENTS

IN THE

AGRICULTURAL COLLEGE

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A SYNOPSIS

OF THE MOST IMPORTANT TESTS FOR ASCERTAINING
THE PRESENCE OF THE MORE COMMON CHEMICAL COM-
POUNDS, ESPECIALLY WHEN IN SOLUTION.

1. *Alkalies and their Salts.*

THESE are not precipitated by carbonate of ammonia, sulphuretted hydrogen (H S), or sulphuret of ammonium (N H_3 , H S).

2. *Salts of Potassa.*

Tartaric acid, in excess and in a concentrated solution, produces, especially after violent agitation, a white crystalline precipitate. (Tartar, § 194.)

Platinum solution gives a yellow crystalline precipitate. (Chloride of platinum and potassium, § 394.)

3. *Salts of Soda.*

Antimoniate of potassa produces, in neutral or alkaline solutions of soda salts, a white precipitate. (Antimoniate of soda, § 404.)

4. *Salts of Ammonia.*

Caustic lime or *caustic potassa*, especially on heating, liberates the ammonia, which is easily recognized by its pungent odor. Heated on platinum foil, the salts of ammonia are readily volatilized. (§ 229.)

Platinum solution reacts in the same manner as with potassa salts. (§ 392.)

5. *Alkaline Earths.*

These are precipitated by *carbonate of ammonia*, as carbonates of a white color, but not by H S or N H_3 , H S .

6. *Salts of Baryta and Strontia.*

Sulphuric acid produces a white precipitate, insoluble in acids (sulphate of baryta and of strontia.) The baryta salts impart a yellowish color, and the strontia salts a crimson color, to the flame of alcohol. (§ 248.)

7. *Salts of Lime.*

Sulphuric acid produces only in concentrated solutions of lime a precipitate, which is redissolved in a large proportion of water. (§ 241.)

Oxalic acid and ammonia indicate mere traces of lime by a milky turbidness. (Oxalate of lime, §197.)

8. *Salts of Magnesia.*

Sulphuric acid causes no precipitate or turbidness. (§ 249.)

Phosphate of Soda and Ammonia produce, but not immediately, in diluted solutions, a white crystalline precipitate. (Phosphate of magnesia and ammonia, § 251.)

9. *Salts of Alumina.*

These are precipitated by *ammonia, carbonate of ammonia*, and also by NH_3 , H_2S , as hydrate of the oxide of alumina. *Potassa* in excess dissolves the hydrate of oxide of alumina, which is again precipitated by *chloride of ammonium*. (§ 260.) They are colored blue on being heated to redness with cobalt solution. (§ 262.)

10. *Metallic Salts.*

Ammonia precipitates from their solutions the oxides as hydrates; *carbonate of ammonia* also precipitates them (partly as carbonates, and partly as hydrated oxides.)

H_2S added to an acid solution precipitates the following metallic oxides as sulphurets:

a.) Black; lead, bismuth, copper, silver, mercury, platinum, gold.

b.) Dark brown; tin (protoxide.)

c.) Orange; antimony.

d.) Yellow; tin (peroxide), cadmium, arsenic.

Of these, the sulphurets of platinum, gold, tin, antimony, and arsenic, are soluble in NH_3 , H_2S .

NH_3 , H_2S precipitates also as sulphurets the following, which are not precipitated by sulphuretted hydrogen alone from their acid solutions:

a.) Black; iron, cobalt, nickel.

b.) Flesh-colored; manganese.

c.) White; zinc (also alumina and oxide of chromium as hydrates.)

11. *Salts of Protoxide of Iron.*

Ammonia; a greenish-white precipitate, passing to dark green, and finally to reddish-brown. (Hydrated protoxide of iron, § 285.)

Ferrocyanide of potassium; a light blue precipitate, becoming finally dark blue. (§ 292.)

Tincture of nutgalls; a violet precipitate, passing gradually to blue-black. (Tannate of protoxide of iron, § 285.)

12. *Salts of Sesquioxide of Iron.*

Ammonia; a reddish-brown precipitate. (Hydrated sesquioxide of iron, § 285.)

Ferrocyanide of potassium; a dark-blue precipitate. (Prussian blue, § 292.)

Tincture of nutgalls; a blue-black precipitate. (Tannate of sesquioxide of iron, § 285.)

13. *Salts of Manganese.*

Ammonia; a white precipitate, soon passing to light and then dark brown. (Hydrated protoxide of manganese, § 300.)

H S; a flesh-colored precipitate. (Sulphuret of manganese, § 300.)

14. *Salts of Cobalt.*

Potassa; a blue precipitate, gradually becoming green. (§ 307.)

Blowpipe; melted with borax, they give a blue bead. (Cobalt glass, § 304.)

15. *Salts of Nickel.*

Potassa; a light green precipitate. (Hydrated protoxide of nickel, § 307.)

16. *Salts of Zinc.*

Ammonia; a gelatinous white precipitate (hydrated oxide of zinc,) which redissolves in an excess of ammonia; white sulphuret of zinc is precipitated from this solution by NH_3 , H S.

Blowpipe; heated with carbonate of soda upon charcoal, a yellow incrustation is formed, which becomes white on cooling. (Oxide of zinc, § 310.)

17. *Salts of Tin.*

Solution of gold causes in solutions of protoxide of tin a purple-red color or precipitate. (Gold purple, § 322.)

H S; in the protoxide solutions, a dark-brown precipitate (protosulphuret of tin); in the perchloride solutions, a yellow precipitate. (Bisulphuret of tin, § 325.)

18. *Salts of Lead.*

Sulphuric acid; a white precipitate insoluble in acids. (Sulphate of lead.) The same is rendered black immediately by NH_3 , H S. (§ 335.)

Blow-pipe; heated with carbonate of soda upon charcoal, malleable metallic beads are formed, together with a yellow incrustation upon the coal. (§ 331.)

19. *Salts of Bismuth*

Water, added largely to solutions of bismuth, causes a white turbidness, with a precipitation of a basic salt of bismuth. (§ 347.)

Blowpipe; if heated with carbonate of soda upon charcoal, we obtain brittle metallic beads. (§ 345.)

20. *Salts of Copper.*

Ammonia causes a greenish-blue precipitate, which redissolves in an excess of ammonia, forming a deep blue liquid. (§ 353.)

Ferrocyanide of potassium; a purple red precipitate. (Ferrocyanide of copper, § 292.)

Polished iron; a deposition of metallic copper. (§ 152.)

Blowpipe; when heated with carbonate of soda upon charcoal, and washed with water, spangles of metallic copper are obtained. (§ 355.)

21. *Salts of Mercury.*

Potassa precipitates from protoxide salts black protoxide of mercury (§ 368); from the peroxide salts, yellowish-red peroxide of mercury. (§ 371.)

Protochloride of tin precipitates on boiling metallic mercury. (§ 375.)

Copper, on being rubbed with a solution of mercury, assumes a silvery appearance. (369.)

22. *Salts of Silver.*

Muriatic acid; a white, curdy precipitate, soluble in ammonia. (Chloride of silver, § 381.)

Blowpipe; heated with carbonate of soda upon charcoal, glistening malleable metallic beads are formed. (§ 381.)

23. *Salts of Gold.*

Protochloride of tin; a purple-red precipitate. (Gold purple, § 388.)

Green vitriol; a precipitate of gold powder. (§ 387.)

24. *Salts of Platinum.*

Potassa; a yellow crystalline precipitate. (Chloride of platinum and potassium, § 394.)

Blowpipe; reduces the salt to a metal. (§ 393.)

25. *Salts of Sesquioxide of Chromium.*

Potassa; a bluish-green precipitate (hydrated oxide of chromium,) soluble in an excess of potassa, forming a dark green solution. (§ 400.)

26. *Salts of Chromic acid.*

Sugar of lead; a yellow precipitate. (Chrome yellow, § 399.)

Sulphuric acid and alcohol; conversion of the yellow or red color into green by heating. (§ 400.)

27. *Compounds of Antimony.*

H S; an orange-colored precipitate. (Sulphuret of antimony, § 407.)

Blowpipe; heated with carbonate of soda, brittle metallic globules are formed; and also white fumes and a white incrustation upon the charcoal. (§ 403.)

Marsh's test (§ 418.)

28. *Compounds of Arsenic.*

H S; a yellow precipitate. (Sulphuret of arsenic, § 416.)

Reduction test (§ 413.)

Marsh's test (§ 417.)

29. *Salts of Sulphuric Acid.*

Chloride of barium; a white pulverulent precipitate, insoluble in acids. (Sulphate of baryta, § 171.)

Sugar of lead; a white precipitate, insoluble in diluted acids. (Sulphate of lead, § 335.)

30. *Salts of Sulphurous Acid.*

Sulphuric acid evolves a gas having the odor of burning sulphur. (§ 174.)

31. *Salts of Phosphoric Acid.*

Chloride of barium; a white precipitate soluble in acids.

Silver solution; a yellow precipitate. (Phosphate of silver, § 176.)

Solution of magnesia and ammonia; a white precipitate. (See No. 8.)

32. *Salts of Boracic Acid.*

Chloride of barium; a white precipitate soluble in acids.

Sulphuric acid and alcohol, when heated with them, present a green flame. (§ 182.)

33. *Salts of Nitric Acid.*

Indigo solution and sulphuric acid; by boiling, the feeble blue-colored liquid is changed in color by the liberated nitric acid.

Glowing charcoal causes a deflagration of the nitrates. (§ 207.)

34. *Salts of Chloric Acid*

Act like the nitrates towards *solution of indigo*, and upon glowing charcoal; but when heated with muriatic acid, they evolve the odor of chlorine. (§ 150.)

35. *Chlorides or Salts of Muriatic Acid.*

Silver solution; a white, curdy precipitate of chloride of silver, readily soluble in ammonia. (§ 186.)

Peroxide of manganese and sulphuric acid; evolution of chlorine on heating. (§ 151.)

36. *Iodides.*

Silver solution; a yellowish precipitate of iodide of silver difficultly soluble in ammonia.

Peroxide of manganese and sulphuric acid evolve iodine in violet fumes. (§ 210.)

Starch paste and nitric acid; blue color. (Iodide of starch, § 155.)

37. *Sulphurets.*

Muriatic acid evolves from most of them a gas having the odor of rotten eggs. (H S, §§ 132, 213.)

38. *Salts of Carbonic Acid.*

Muriatic acid liberates from them with effervescence an odorless gas. (§§ 202, 237.)

Lime-water is rendered milky by them. (Carbonate of lime, § 115.)

39. *Salts of Oxalic Acid.*

Solution of gypsum causes a white precipitate. (Oxalate of lime, § 197.)

Heated upon platinum foil, they are decomposed without charring. (§ 197.)

40. *Salts of Tartaric Acid.*

Potassa precipitates tartar, as in No. 2. (§ 194.)

Heated on platinum foil, they are decomposed with separation of much carbon, and give off the odor of burnt sugar. (§ 194.)

41. *Salts of Acetic Acid.*

Sulphuric acid produces on heating an odor of vinegar.

Sulphuric acid and alcohol, an odor of acetic ether. (§ 198.)

Heated, they are charred, and give off the odor of vinegar. (§ 198.)

T A B L E

SHOWING THE ACTION OF REAGENTS ON OXIDES AND ACIDS. (Alphabetically arranged.)

1. METALLIC BASES, (IN COMBINATION.)

Name of Base.	Symbol.	Hydro-sulphuric Acid (Sulphuretted Hydrogen) (HS), in an acidified solution.	Hydro-sulphate of Ammonia (NH ₄ S, HS).	Carbonate of Soda (Na ₂ O, CO ₂).	Carbonate of Ammonia (2NH ₄ O, 3CO ₂).	Potash (KO).	Ammonia (NH ₃).	Ferrocyanide of Potassium (K ₄ FeCy ₆).	Blowpipe.	Remarks.
ALUMINA.	Al ₂ O ₃ .	○	White; insol. in excess.	White; insol. in excess.	White; insol.	White; sol. in excess.	White; insol.	○	Blue with nitrate of cobalt.	These precipitates are insoluble in muriate of ammonia.
ANTIMONY oxide of	SbO ₃ .	Orange red.	Orange red; sol. in excess.	White; sparingly soluble.	White; sp. sol.	White; sp. sol. in excess.	White; insol.	White.	With soda in deoxidizing flame, reduced, and gives off white fumes of oxide.	The chloride decomposed by water.
BARYTA.	BaO.	○	○	White; insol. in excess.	White; insol.	○	○	○	○	Thrown down immediately with sulphates and sulphate of lime.
BISMUTH, oxide of	Bi ₂ O ₃ .	Brown-black.	Brown-black; insol. in excess.	White; insol. in excess.	White; insol.	White; insol.	White; insol.	White.	With soda on charcoal reduced; brittle bead of metal.	Nitrate decomposed by water.

CADMIUM, oxide of.	CdO .	Bright yellow.	Bright yellow; insol. in excess.	White; insol. in excess.	White; insol.	White; insol.	White; insol.	White; sol. in excess	White.	With soda on char- coal reduced and metal volatilized; leaves a reddish brown deposit.	The yellow sulphide, insol. in hydrosulph. of ammonia, is highly characteristic.
CALCIUM (LIME).	CaO .	○	White; insol. in excess.	White; insol.	White; insol.	○	○	○	○	Radiates a brilliant light. Gives a red color to the flame.	Oxalate of ammonia causes a white pre- cipitate even in very dilute solutions.
CHROMIUM, oxide of.	Cr_2O_3 .	○	Green.	Green.	Green.	Green; sol. in excess.	Green; sol. in excess.	Green; insol.	○	Emerald green with fluxes.	The oxide when fused with nitre, gives chromate of potash.
COBALT, oxide of.	CoO .	○	Pink; insol. Bluish on boiling.	Pink; sp. sol. in ex. solution purple.	Green; sol. in ex. becoming greenish; dirty red on boiling.	Blue; sol. in ex. forming a brownish red sol.	Blue; sol. in ex. forming rich blue solution.	Pale green or gray.	○	Blue glass, with borax in both flames.	Readily distinguished with the blowpipe.
COPPER, oxide of.	CuO .	Black.	Greenish blue, becom- ing dark brown on boiling.	Greenish blue, sol. in ex. forming deep blue solution.	Greenish blue, becom- ing dark brown when boiled.	Pale blue, becoming dark brown when boiled.	Pale blue, forming rich blue solution.	Mahogany colored; insol.	○	With soda on char- coal reduced. With borax and mic. salt in outer flame, green; in inner flame red.	Precipitated in the metallic state by clean iron; and as the black oxide by zinc.
GLUCINA.	GlO ₆	○	White; sp. sol.	White; sol. in ex.	White; sol. in ex.	White; sol. in ex.	White; insol.	White; insol.	○	With nitrate of carb. cobalt, dark gray or black.	Glucina dissolves in cold solution of carb. ammonia, and is thrown down on boiling.
GOLD, teroxide of.	AuO .	Black.	○	Yellow; insol.	Yellow; insol.	Yellowish brown.	Yellowish brown.	Yellow; insol.	○	Reduced.	Thrown down in the form of a brown, metallic powder, boiled with proto- sulph. iron.
IRIDIUM, sesquioxide of.	Ir_2O_3 .	Slight brown.	Brown red; sp. sol.	Bleaches the solution.	Slight brown The solution becomes first colorless, and subse- quently bluish.	As with potash. On exposure to the air a slight blue precipitate falls.	As with potash. On exposure to the air a slight blue precipitate falls.	Solution slowly dis- colored.	○	Reduced.	The solutions have a deep brown color.
IRON, protoxide of.	FeO .	○	White, then green, and ultimately rust-colored.	As with carbonate of soda.	White beco- ming green, and on stand- ing, rust- colored.	As with potash; but becoming brown more rapidly.	As with potash; but becoming brown more rapidly.	White; instantly changing to light blue.	○	With the fluxes in the outer flame, brownish-yellow; in the inner flame, light green.	Deep blue precipitate with ferricyanide of potassium.

Name of Base.	Symbol.	Hydro-sulphuric Acid (HS) in an acidified solution.	Hydro-sulphate of Ammonia (NH_4S , HS).	Carbonate of Soda (Na_2CO_3).	Carbonate of Ammonia ($2\text{NH}_4\text{CO}_3$, 3CO_2).	Potash (KO).	Ammonia (NH_3).	Ferricyanide of Potassium (K_3FeCy_6).	Blowpipe.	Remarks.
IRON, peroxide of	Fe_2O_3	Yellowish white precipitate of sulphur.	Black.	Rust-colored.	Rust-colored.	Rust-colored.	Rust-colored.	Deep-blue.	As the protoxide.	Black with infusion of nutgalls.
LEAD, oxide of.	PbO	Black.	Black.	White; insol.	White; insol.	White; sol.	White; insol. with the acetate.	White.	With soda on charcoal reduced; yellow deposit also formed on the charcoal.	Precipitated by soluble sulphates, and the precip. blackened by hydrosulphate of ammonia. Bright yellow with chromate of potash and iodide of potassium.
LITHIA.	LiO	○	○	Faint white in concentrated sol.	As carb. soda.	○	○	○	Gives red color to the flame.	Phos. of soda and ammonia gives a white precipitate.
MAGNESIA.	MgO	○	○	White; insol.	○	White; insol.	White; insol.	○	Light pink with nitrate of cobalt.	Crystalline precipitate with phosphate of soda and ammonia. The carbonate and hydrate sol. in muriate of ammonia.
MANGANESE, protoxide of.	MnO	○	Flesh colored.	White; insol.	White; insol.	White, becoming brown.	White; becoming brown.	White.	With soda a green bead. With borax in outer flame an amethyst bead, which loses its color in the reducing flame.	The presence of ammoniacal salts prevents more or less completely the precipitation of manganese by the alkalis.
MERCURY, protoxide of.	HgO	Black.	Black.	Dark-gray.	Dark-gray.	Black; insol.	Black; insol.	White.	Mixed with soda and heated in a tube, the metal sublimes.	White precipitate with chlorides, blackened by ammonia. Volatilized or decomposed by heat.
MERCURY, peroxide of.	HgO_2	White, turning to black.	White, turning to black.	Reddish brown; insol.	White; insol.	Yellow; insol.	White; insol.	White.	As the protoxide.	Volatized or decomposed by heat. Beautiful scarlet with iodide of potassium.

MOLYBDENUM, oxides of.	MoO and MoO_3	Yellowish-brown; sol.	Brown; sol.	Brown; sol.	Brown; sol.	Brown; sol.	Brown; sol.	Brown; sol.	With microcosmic salt in outer flame, a green glass.	Most readily distinguished by the blowpipe.
NICKEL, oxide of.	NiO .	Black.	Pale green; insol.	Pale green; soluble; forming green solution.	Pale green; insol.	Pale green; insol.	Pale green; insol.	Pale green; insol.	With soda on charcoal, reduced to a magnetic powder. With borax and mic. salt in outer flame, red glass, becoming colorless on cooling.	Potash throws down a pale-green precipitate from the ammoniacal solution.
OSMIUM, deutoxide of.	OsO_3	Yellowish-brown; slowly formed.	Black, slowly formed. Bluish solution.	Brown after some time.	Black on boiling.	Brown after some time.	○	○	Reduced.	Osmium is characterized by forming, when heated in the air, a suboxide, which is volatile, and has a very disagreeable smell, causing much inconvenience to the eyes and nose.
PALLADIUM, protoxide of.	PdO .	Black.	Brown; sol. Reprecipitated on boiling.	Solution decolorized, but no precipitate.	Yellowish-brown; sol.	Yellowish-brown; sol.	○	○	Reduced.	Yellowish-white with solution of cyanide of mercury.
PLATINUM, oxide of.	PtO_3	Brownish-black; formed slowly.	Yellow with carbonate of potash.	Yellow.	Yellow.	Yellow.	○	○	Reduced.	Yellow with muriate of ammonia, which is converted by heat into spongy platinum.
POTASH.	KO .	○	○	○	○	○	○	○	Violet flame.	White crystalline precipitate with tartaric acid. Yellow with bichloride of platinum.
RHODIUM, sesquioxide of.	R_2O_3	Brown, formed slowly.	Yellowish after a time.	Yellowish after a time.	Yellowish brown on boiling.	Yellowish after a time.	Dark orange.	Dark orange.	Reduced.	Many of the compounds have a rose-color.
SILVER, oxide of.	AgO .	Black.	White; insol.	White; sol.	Pale brown; insol.	Pale brown; sol.	White.	White.	Reduced.	White curdy precipitate, with hydrochloric acid and chlorides, which is sol. in ammonia and insol. in nitric acid.
SODA.	NaO .	○	○	○	○	○	○	○	Yellow flame.	The only salt which precipitates soda is the antimoniato of potash. Evaporated with bichloride of platinum gives yellow needles.

Name of Base.	Symbol.	Hydro-sulphuric Acid, (HS), in an acidified solution.	Hydro-sulphate of Ammonia (NH ₄ S, HS).	Carbonate of Soda, (Na ₂ CO ₃)	Carbonate of Ammonia (2NH ₄ O, 3CO ₂).	Potash (KO).	Ammonia (NH ₃).	Ferrocyanide of Potassium (K ₄ FeCy ₆).	Blowpipe.	Remarks.
STRONTIA.	SrO.	○	○	White; insol.	White; insol.	○	○	○	Carmine flame.	White precipitates with sulphates. Burnt with alcohol, gives carmine flame.
TIN, protoxide of.	SnO.	Brown-black.	Brown-black.	White; insol.	White; insol.	White; sol.	White; insol.	White.	With soda in reducing flame, a malleable bead of metallic tin.	Zinc throws down the metal in beautiful crystals.
TIN, peroxide of.	SnO ₂	Yellow.	Yellow; sol.	White; insol.	White; insol.	White; sol.	White; sol.	White.	Reduced with soda.	The behavior with hydrosulphate of ammonia and the blow-pipe are characteristic.
URANIUM, sesquioxide of.	U ₂ O ₃	○	Black.	Yellow; sol.	Yellow; sol.	Yellow; insol.	Yellow; insol.	Reddish-brown.	Yellow glass with borax.	When the precipitate with ammonia is heated, it is converted into the green protoxide.
VANADIUM, binoxide of.	VO ₂	○	Brown-black; sol. in excess forming a purple solution.	Dirty white.	Gray, passing to brown.	Grayish-white.	Brown.	Yellow.	With borax, yellow in outer flame; in the inner, brown, becoming green when cold.	Many of the solutions have a blue color.
YTTRIA.	YO.	○	White.	White; sp. sol.	White; sp. sol.	White; insol.	White; insol.	White.	Nothing characteristic.	Copious white with oxalic acid.
ZINC, oxide of.	ZnO.	○	White.	White; insol.	White; sol.	White; sol.	White; sol.	White.	With soda on charcoal gives a white sublimate of oxide, which is yellow when hot. With nit. cobalt, green.	Behavior with hydrosulphate of ammonia characteristic.
ZIRCONIA.	Zr ₂ O ₃	○	White.	White after a time.	White; sol.	White; insol.	White; insol.	White.	Bright flame.	Oxalic acid gives a white precipitate.

2. METALLIC OXIDES HAVING ACID PROPERTIES.

<i>Acids (in combination.)</i>	<i>Symbol.</i>	<i>Hydro-sulphuric Acid, in acidified solutions.</i>	<i>Hydro-sulphate of Ammonia (NH₄S₂HS).</i>	<i>Chloride of Barium (BaCl₂), (in alkaline salts of the acids).</i>	<i>Nitrate of Silver (AgO, NO₅) (in alkaline salts of the acids).</i>	<i>Nitrate of Lime (CaO, NO₅) (in alkaline salts of the acids).</i>	<i>Hydro-chloric acid (HCl).</i>	<i>Remarks.</i>
ANTIMONIOUS ACID.	SbO ₃	Orange.	Orange; sol.	White; sp. sol. in water.	White.	White; sp. sol. in water.	White.	Antimonious acid becomes pale-yellow when heated, and white again on cooling. It is insoluble in nitric acid, and difficultly soluble in hot hydrochloric acid.
ANTIMONIC ACID.	SbO ₅	Orange.	Orange; sol.	White.	White.	White.	White.	Insoluble in water and nitric acid. Soluble in hydrochloric acid, from which it is precipitated on the addition of water. When strongly heated, gives off oxygen, and becomes antimonious acid.
ARSENIOUS ACID.	AsO ₃	Yellow; soluble in alkalis and alkaline sulphides.	Yellow; sol.	White.	Pale yellow.	White.	○	Volatilizes at a low heat, and condenses in octohedral crystals. The best tests are Marsh's and Reimsch's.
ARSENIC ACID.	AsO ₅	Yellow; soluble in alkalis and alkaline sulphides. Reduced to oxide with precipitation of sulphur.	Yellow; sol.	White.	Chocolate-brown.	White.	○	Heated with black flux, gives metallic arsenic.
CHROMIC ACID.	CrO ₃	Green.	Green.	Yellow.	Reddish-brown.	Yellow in concentrated solutions.	Reduced to oxide, with evolution of chlorine.	Is decomposed by heat and by deoxidizing agents, into oxide of chromium. Salts of lead throw down a yellow precipitate.
MANGANIC ACID.	MnO ₃	○	Flesh colored.	○	Black (oxide).	Black.	Solution becomes red and chlorine is evolved.	Converted by acids into hyper-manganic acid and peroxide of manganese; the color of the solution changing from green to red.
MOLYBDIC ACID.	MoO ₃	Brown.	Brown; sol.	White.	White.	White.	White.	With microcosmic salt before the blowpipe, gives a dark-blue glass, which becomes green on cooling. When strongly heated, molybdic acid volatilizes and condenses in crystals.
TUNGSTIC ACID.	WO ₃	Slight turbidity.	Brown; sol.	White.	White.	White.	White; insol.	Does not volatilize when heated. Has a pale-yellow color, and is insoluble in water and acids.
VANADIC ACID.	VO ₃	Gray.	Brown. sol.	Orange.	Yellow.	○	Chlorine evolved.	When treated with hydrochloric acid, the mixture is capable of dissolving gold-leaf. Vanadic acid in solution is readily deoxidized, forming a blue liquid.

3. NON-METALLIC ACIDS.

Acids (neutralized.)	Symbol.	Nitrate of Barites (BaO, NO^5).	Nitrate of Silver (AgO, NO^5).	Nitrate of Lime (CaO, NO^5).	Acetate of Lead ($PbO,$ $C_2H_3O_2$).	Remarks.
BORACIC ACID.	BO_3	White.	White.	White.	White.	Slightly volatile in the presence of aqueous vapor. Turns turmeric paper brown, and blue litmus port-wine color. Gives green color to the flame of alcohol.
BROMIC ACID.	BrO^5	White.	White.	○	White.	The bromates are decomposed by heat into bromides and oxygen. Sulphuric acid disengages bromine.
CARBONIC ACID.	CO_2	White.	White.	White.	White.	The carbonates are readily decomposed by acids, carbonic acid gas being given off with effervescence, which, when passed into lime water, gives a white precipitate.
CHLORIC ACID.	ClO^5	○	○	○	○	All the chlorates are soluble in water. At a red heat they are converted into chlorides, oxygen being given off.
HYDRIODIC ACID.	HI	○	Pale-yellow.	○	Bright yellow.	The iodides evolve iodine when heated with nitric or sulphuric acid. With chlorine water and starch, they give a dark-purple precipitate.
HYDROBROMIC ACID.	HBr	○	Yellowish.	○	White.	The bromides, when heated with nitric acid, evolve bromine.
HYDROCHLORIC ACID.	HCl	○	White.	○	White.	The chlorides, when heated with peroxide of lead, or of manganese, evolve chlorine.
HYDROCYANIC ACID.	H_2C_2N	○	White.	○	White.	With a mixture of protosalt and persalt of iron, the alkaline cyanides give a precipitate of Prussian blue.
HYDROFLUORIC ACID.	HF	White.	White.	White.	White.	The fluorides, when moistened with sulphuric acid, give off fumes which corrode glass.
HYDROSELENIC ACID.	HSe	○	Black.	○	Black.	The selenides, when heated in the outer frame of the blowpipe, evolve the odor of selenium, resembling that of putrid horse radish.
HYDROSULPHURIC ACID.	HS	○	Black.	○	Black.	Most of the sulphides, when treated with an acid, evolve hydrosulphuric acid, which smells like rotten eggs.
HYPOSULPHUROUS ACID.	S_2O_2	White.	White; becoming brown.	○	White.	The hyposulphites are decomposed by hydrochloric acid; sulphur is precipitated, and sulphurous acid set free.
HYPOSULPHURIC ACID.	S^2O^5	○	○	○	○	The hyposulphates are decomposed without deposition of sulphur, when boiled with hydrochloric acid; sulphurous and sulphuric acids are formed.
IODIC ACID.	IO^5	White.	White.	White.	White;	The iodates are decomposed by heat into iodides and oxygen.
NITRIC ACID.	NO^5	○	○	○	○	When mixed with sulphuric and hydrochloric acids, the nitrates dissolve gold leaf. With copper filings and sulphuric acid, orange fumes are given off.
PERCHLORIC ACID.	ClO^7	○	○	○	○	The perchlorates are resolved by heat into chlorides and oxygen. They are not decomposed in the cold by hydrochloric or sulphuric acid; thus differing from the chlorides.
PHOSPHORIC ACID (Tribasic).	PO^3	White.	Pale Yellow.	White.	White.	The soluble phosphates give with salts of magnesia, when ammonia is present, a white crystalline precipitate.

PHOSPHOROUS ACID.	PO_2	White.	White, becoming brown.	White.	White, becoming brown.	White.	White.	The hydrated phosphites are decomposed when heated in a tube; hydrogen is given off, and phosphates are formed.
SELENIC ACID.	SeO_2	White.	White.	White.	White.	White.	White.	The seleniates are decomposed by boiling with hydrochloric acid; chlorine is evolved, together with selenious acid.
SELENIOUS ACID.	SeO_3	White.	White.	White.	White.	White.	White.	Metallic zinc or sulphurous acid causes the precipitation of selenium from acidified solutions of the selenites.
SILICIC ACID.	SiO_2	White.	Pale yellow.	White.	White.	White.	White.	When a soluble silicate is evaporated to dryness with hydrochloric acid it is decomposed, and the silica remains insoluble.
SULPHURIC ACID.	SO_2	White.	White crystalline.	White crystalline.	White crystalline.	White.	White.	Most of the sulphates when heated with charcoal are converted into sulphides, which, when moistened with hydrochloric acid, evolve hydrosulphuric acid.
SULPHUROUS ACID.	SO_3	White.	White.	White.	White.	White.	White.	The sulphites are decomposed by sulphuric acid, sulphurous acid being given off without the deposition of sulphur.

4. ORGANIC ACIDS.									
Acids (neutralized).	Symbol.	Chloride of Calcium (CaCl).	Perechloride of Iron (Fe ₂ Cl ₃).	Nitrate of Baryta (BaO, NO ₃).	Nitrate of Silver (AgO, NO ₃).	Acetate of Lead (PbO, C ₂ H ₃ O ₂).	Remarks.		
ACETIC ACID.	$HO, C_2H_3O_2$	○	○	○	White crystalline in concentrated solutions.	○	The acetates, when warmed with sulphuric acid, give off the smell of vinegar. Acetic acid boiled with an excess of protoxide of lead, forms the subacetate, which is alkaline to test-paper.		
BENZOIC ACID.	$HO, C_6H_5O_2$	○	Brownish-Yellow.	○	Crystalline in concentrated neutral solutions.	White in concentrated neutral solutions.	Solutions of the benzoates, when treated with sulphuric acid, give a crystalline precipitate of benzoic acid.		
CITRIC ACID.	$3HO, C_6H_7O_7$	White.	○	White.	White.	White.	With protomitate of mercury, a white precipitate, which becomes gray.		
FORMIC ACID.	HO, C_1HO_2	○	○	○	White; becoming black, especially when warmed.	○	The formiates, when warmed with sulphuric acid, do not blacken, and give off carbonic oxide gas.		
MALIC ACID.	$2HO, C_4H_5O_6$	White on the addition of alcohol.	○	White.	White; becoming Gray.	White precipitate that melts in boiling water.	Malate of lead dissolves in hot dilute acetic acid, and crystallizes on cooling in fine needles. Malic acid is decomposed by heat, into maleic and fumaric acids.		
OXALIC ACID.	HO, C_2O_3	White.	Yellowish-brown.	White crystalline.	White.	White.	Neither the acid nor the oxalates are blackened by strong sulphuric acid, but give off carbonic acid and carbonic oxide gases.		
SUCCINIC ACID.	$HO, C_4H_5O_3$	○	Reddish brown.	○	White on standing.	White.	A mixture of chloride of barium, ammonia, and alcohol, gives a white precipitate of succinate of baryta.		
TARTARIC ACID.	$2HO, C_4H_4O_6$	White.	○	White.	White.	White.	Added in excess to potash, gives a crystalline precipitate of the bitartrate.		

T A B L E

Showing the Behavior of the Metals with *Hydrosulphuric acid, Hydrosulphate of Ammonia, and Carbonate of Ammonia, employed successively.* (*Dr. Will.*)—(*The rarer metals are printed in italics.*)

Elements precipitated from their acid solutions by HYDROSULPHURIC ACID, as Sulphides.		Bodies precipitated by HYDROSULPHATE OF AMMONIA.			Bodies not precipitated by Hydrosulphuric Acid, or Ammonia.
Soluble in Hydrosulphate of Ammonia, and reprecipitated by Hydrochloric Acid.	Insoluble in Hydrosulphate of Ammonia.	As Sulphides.	As oxides.	As Salts.	
Antimony . . Orange.	Mercury	Nickel	Alumina	Baryta, Strontia, Lime.	In the presence of Muriate of Ammonia, on addition of CARBONATE OF AMMONIA, are precipitated. } not precipitated. } Baryta. } Strontia. } Lime. } Magnesia. } Soda. } Lithia. } Ammonia. }
Arsenic	Silver	Cobalt	<i>Glucina</i>	in combination with phosphoric, boracic, oxalic and some other acids. } Magnesia. } in combination with phosphoric acid. }	
Tin	Lead	Manganese { Flesh-colored	Chromium		
Gold	Bismuth	Iron	<i>Thorina</i>		
Platinum	Copper	Zinc	<i>Ytria</i>		
Iridium	<i>Caadmium</i>	Uranium { Brownish black.	<i>Cerium</i>		
Molybdenum . Brown.	Palladium		<i>Zirconia</i>		
	Rhodium		Titanium		
	Osmium		Tantalum		

R E A G E N T S .

The following is a list of the reagents, &c., usually employed in testing and analysis :—

Sulphuric acid, strong and dilute.	Carbonate of soda.
Hydrochloric acid.	Phosphate of soda.
Nitric acid.	Borax.
Nitrohydrochloric acid (aqua regia.)	Lime water.
Oxalic acid.	Sulphate of lime.
Acetic acid.	Chloride of calcium.
Tartaric acid.	Chloride of barium.
Hydrosulphuric acid (sulphuretted hydrogen.)	Nitrate of baryta.
Ammonia.	Perchloride of iron.
Hydrosulphate of ammonia.	Nitrate of cobalt.
Carbonate of ammonia.	Sulphate of copper.
Oxalate of ammonia.	Ammonio-sulphate of copper.
Phosphate of soda and ammonia (microcosmic salt.)	Acetate of lead.
Potash.	Subacetate of lead.
Carbonate of potash.	Nitrate of silver.
Nitrate of potash.	Ammonio-nitrate of silver.
Iodide of potassium.	Perchloride of mercury.
Chromate of potash.	Protochloride of tin.
Cyanide of potassium.	Perchloride of gold.
Ferrocyanide of potassium (yellow prussiate of potash.)	Bichloride of platinum.
Ferridcyanide of potassium (red prussiate of potash.)	Sulphate of indigo.
Antimoniate of potash.	Solution of starch.
	Black flux.
	Distilled water.
	Alcohol.
	Litmus and turmeric paper.

The following scheme exhibits the successive steps which are to be taken in order to separate the several inorganic substances from the solution in muriatic acid by the methods described.

Digest the soil in distilled water, dry at 250°, weigh, digest with dilute muriatic acid for 12 hours, and filter the solution. This solution should be decidedly sour, and may contain lime, magnesia, alumina, oxide of iron, oxide of manganese, potash, soda and phosphoric acid.

1. Add caustic ammonia in excess.
2. Oxide of iron alumina, and phosphoric acid are precipitated. Digest in acetic acid.
3. Phosphates of alumina and iron remain undissolved. Fuse with carbonate of soda, and wash with distilled water.
4. Alumina and oxide of iron are dissolved. Neutralize by nitric acid, and add main; dissolve in muriatic acid, and add silver will fall; or by muriatic acid and add chlorine (6).
5. Phosphoric acid is dissolved. Neutralize by nitric acid, and add main; dissolve in muriatic acid, and add silver will fall; or by muriatic acid and add chlorine (6).
6. Solution contains alumina and oxide of iron; add ammonia, and digest the precipitate in a solution of caustic potash.
7. Oxide of iron remains; wash and weigh.
8. Add muriatic acid till the solution is sour; then ammonia in excess.-- Alumina falls; wash and weigh.
9. To the clear solution add oxalate of ammonia, and cover it from the air.
10. Oxalate of lime falls, wash, heat to redness to convert it into carbonate, and weigh.
11. Add hydrosulphuret of ammonia.
12. If manganese is present it falls as sulphuret; dissolve in muriatic acid, precipitate by carbonate of soda, wash, heat to redness in the air, and weigh.
13. Render sour by muriatic acid, boil, filter, evaporate to dryness, and heat to incipient redness to drive off all the ammoniacal salts. Redissolve in a little water, mix with a little pure red oxide of mercury, evaporate again to dryness, heat to redness, and treat with water.
14. Caustic magnesia remains; wash, heat to redness, and weigh.
15. The solution contains the chlorides of potassium and sodium, if present. Evaporate to dryness, weigh, re-dissolve in water, and add bichloride of platinum, to separate the potash.
16. Wash the precipitate with weak alcohol, dry by a gentle heat, and weigh.
17. The chloride of sodium remains in solution, and its weight is found by deducting from the weight of the mixed chlorides (15) that of the chloride of potassium (16).

ASSAY NOTE, No.

TESTS FOR THE METAL.

Carbonate of soda, - - -	
Ammonia, - - -	
Potash, - - -	
Red Prussiate of Potash, - -	
Sulphuretted Hydrogen, - -	
METAL INDICATED, - -	

TESTS FOR THE ACID.

Chloride of barium, - - -	
Nitrate of Silver, - - -	
Nitrate of Lead, - - -	
Chloride of Calcium, - - -	
ACID INDICATED, - -	

DIRECTIONS.—Against the word No. _____, write the number that is marked upon the envelope of the salt, or upon the bottled solution which is presented to you for analysis. Fill up the blank spaces opposite the names of the tests as follows:—If you get no precipitate, insert a cypher, 0. If you get a precipitate, write P, and add the color of the precipitate, thus: *P white* or *P brown*. If the precipitate dissolves in an excess of the test, add S after the color, as *P white S*, *P brown S*. When the metal and the acid are indicated, write their names in the spaces provided for that purpose. Sign your name below.

.....*Analyst.*

Date,

INDICATING PRECIPITANTS FOR METALS IN SALTS.

Solutions to be neutral.				Solutions to be Acid.	METALS Indicated.
Carbonate of Soda.	Ammonia.	Potash.	Red Prussiate of Potash.	Sulphuretted Hydrogen Gas.	
None. None. None.					1 Potassium. 2 Sodium. 3 Ammonium.
	None. None. None.				4 Barium. 5 Strontium. 6 Calcium.
		White White White White White All 5 are insoluble in excess.	Brown. Blue. None.	Yellow. Black.	7 Manganese. 8 Iron, protosalts. 9 Magnesium. 10 Cadmium. 11 Bismuth.
		White White White White White All 6 are soluble in excess.	Yellow-red. White.	None. Black. Yellow. Orange.	12 Zinc. 13 Tin, protosalts. 14 Aluminum. 15 Lead. 16 Tin, persalts. 17 Antimony.
		Black, See Gold, No. 25.	Red-brown.		18 Mercury, its Protosalts.
		Blue, If boiled, red. Blue, If boiled, black.			19 Cobalt. 20 Copper.
		Green. Green. Green.	Yellow-green. None. Light-blue.		21 Nickel. 22 Chromium. 23 Iron, persalts and protosalts mixed.
		Yellow. Yellow, Sometimes slight, and black.	Yellow-red, But none from the Perchloride. None.		24 Mercury, its persalts. 25 Gold.
		Brown. Brown.	None. Brown.		26 Iron, persalts. 27 Silver.

INDICATING PRECIPITANTS FOR ACIDS IN SALTS.

Nitrate of Barytes, or Chloride of Barium.	Nitrate of Silver.	Nitrate of Lead.	Chloride of Calcium.	SALTS Indicated.
None. None. None. None. None. None.	None. None. White. Black.	 Yellow. White.		1 Nitrates. 2 Chlorates. 3 Chlorides. 4 Iodides. 5 Arsenites. 6 Sulphurets.
White } White } White } White } White }	All 5 soluble in Nitric acid, without Effervescence.	None. Yellow. Brown.	 White, Sol. in water. White, Insol. in water.	7 Fluorides. 8 Phosphates. 9 Arseniates. 10 Borates. 11 Oxalates.
White {	Soluble in Acids, with effervescence.			12 Carbonates.
White {	Insoluble in Acids.			13 Sulphates.
Yellow				14 Chromates.

Before proceeding farther, I request you to compare these Tables with your Assay Notes, and to draw conclusions, from the results of your experiments, in regard to the nature of the substance which you have had to examine.

EXPLANATION

OF THE

TABLE OF DECIMAL EQUIVALENTS.

The first column contains the common English names of certain compounds. The second and fourth columns exhibit the atomic constitution of these compounds, expressed in symbols. The third and fifth columns show how much by weight of each constituent, is contained in 1 part by weight of the compound named in column first.

EXAMPLES :

1 Part (that is 1 Grain, or 1 Pound) of Alumina contains
 0.53295 of Aluminum.
 0.46705 of Oxygen.

Total, 1.00000.

1 Part of Sulphate of Barytes, contains
 0.65628 of Barytes.
 0.34372 of anhydrous Sulphuric Acid.

Total, 1.00000.

Or it contains

0.58768 of Barium.
 0.13797 of Sulphur.
 0.27435 of Oxygen.

Total, 1.00000.

EXAMPLES OF THE USE OF THIS TABLE.

RULE:—*To find the weight of any Constituent in a given weight of a Compound.*—Multiply the given weight of the compound, by the decimal equivalent of the particular constituent. The product is the weight of that constituent.

Example.—Suppose you have 25.45 grains of precipitated sulphate of barytes, and wish to know how much dry sulphuric acid it contains. To find this, you have only to multiply 25.45 by the decimal equivalent of the dry sulphuric acid contain in 1 part of sulphate of barytes. According to the Table this is .34372. See article, “Barytes, Sulphate,” page 23. The product is the weight of the dry sulphuric acid, expressed in grains.

$$25.45 \times .34372 = 8.7476740 \text{ grains.}$$

Proof of the correctness of this calculation.—The atomic weight of sulphate of barytes is 1458.045, and that of dry sulphuric acid is 501.165. Then by proportion :—

$$1458.045 : 501.165 :: 25.45 : x = 8.7477.$$

RULE:—*To find how much by weight of any compound can be produced from a given weight of one of its constituents.*—Multiply the weight of the given constituent by 1.00000, and divide the product by the decimal equivalent of the given constituent,

The product of the division is the required weight of the compound.

Example.—Given, $55\frac{1}{2}$ grains of Iron; required, the quantity of Peroxide of Iron, Fe^2O^3 , which it will produce.

The decimal equivalent of Iron, quoted at the article “Iron, Peroxide,” page 25, is .69338. The calculation is therefore,

$$55.5 \times 1 = \text{Fe}^2\text{O}^3$$

.69338

55.50000*

or, $\frac{55.50000}{.69338} = x = 80.043$ grains.

.69338

Proof.—The atomic weight of Peroxide of Iron, Fe^2O^3 , is 978.41, and that of two atoms of Iron, Fe^2 , is 678.41. Then by proportion we find:
 $678.41 : 978.41 :: 55.50 : x = 80.043$ grains.

Calculations of this sort, performed with the atomic weights, are *twice as long* as those performed with the decimal equivalents, the numbers expressing the latter being so prepared as to reduce the whole operation to a simple multiplication or division.

DECIMAL EQUIVALENTS.

Alumina,	Al^2	53295	O^3	46705
Aluminum, Chloride,	Al^2	20496	Cl^2	79504
Ammonia,	N	82544	H^3	17456
Ammonia, Muriate,	} N^2H^6	32030	H^2Cl^2	67970
Ammonium, Chloride,		} N^2H^3	33894	Cl^2
Antimony, Terchloride,	Sb^2		54845	Cl^6
—Pentachloride,	Sb^2	42155	Cl^{10}	57845
—Oxide,	Sb^2	84317	O^3	15683
—Sulphuret,	Sb^2	72771	S^2	27229
Antimonic Acid,	Sb^2	76336	O^5	23664
Antimonious Acid,	Sb^2	80128	O^4	19872
Arsenic, Terchloride,	As^2	41449	Cl^6	58551
—Pentachloride,	As^2	29812	Cl^{10}	70188
—Sulphuret,	As^2	70029	S^2	29971
Arsenic, Sulphuret,	As^2	60903	S^3	39097
— — — — —	As^2	48311	S^6	51689
Arsenic Acid,	As^2	65280	O^5	34720
Arsenious Acid,	As^2	75808	O^3	24192
Arseniuretted Hydrogen,	As^2	96170	H^6	03830
Barium, Chloride,	Ba	65938	Cl^2	34062
— Sulphuret,	Ba	80987	S	19013
Barytes,	Ba	89549	O	10451
— Carbonate,	BaO	77586	CO^2	22414
— — — — —	Ba	69478	C	06198
— Chromate,	BaO	59482	CrO^3	40518
— Nitrate,	BaO	58564	N^2O^5	41436
— Phosphate,	2BaO	68201	P^2O^5	31799

* As many cyphers are added to the decimal fractions of the given quantity, as make up five figures after the point.

Barytes, Seleniate,	BaO	.54633	SeO ³	.45367
— Sulphate,	BaO	65628	SO ³	34372
= Ba 58768	S	13797	O ⁴	27435
Bismuth, Chloride,	Bi	66707	Cl ²	33293
— Oxide,	Bi	89867	O	10133
— Sulphuret,	Bi	81512	S	18488
Boracic Acid,	B	31190	O ³	68810
Boron, Chloride,	B	09289	Cl ⁶	90711
— Fluoride,	B	16239	F ⁶	83761
Bromine, Chloride,	Br ²	30812	Cl ¹⁰	69188
Bromic Acid,	Br ²	66177	O ⁵	33823
Cadmium, Chloride,	Cd	61151	Cl ²	38849
— Oxide,	Cd	87449	O	12551
— Sulphuret,	Cd	77597	S	22403
Calcium, Chloride,	Ca	36644	Cl ²	63356
— Oxide,	Ca	71911	O	28089
— Fluoride,	Ca	52268	F ²	47732
— Sulphuret,	Ca	55999	S	44001
Carbon, Chloride,	C	25670	Cl	74330
— —	C	14725	Cl ²	85275
— —	C	10324	Cl ⁵	89676
— Oxide,	C	43323	O	56677
— Sulphuret,	C	15965	S ²	84035
Carbonic Acid,	C	27651	O ²	72349
Chloric Acid,	Cl ²	46958	O ⁵	53042
Chromium, Oxide,	Cr ²	70109	O ³	29891
— Chloride,	Cr ²	34635	Cl ⁶	65365
— Perchloride,	Cr	20944	Cl ⁶	79056
— Sulphuret,	Cr ²	53831	S ³	46169
Chromic Acid,	Cr	53975	O ³	46025
Cobalt, Chloride	Co	45462	Cl ²	54538
— Protoxide,	Co	78678	O	21322
— Peroxide,	Co ²	71098	O ³	28902
Copper, Protochloride,	Cu	64130	Cl	35870
— Perchloride,	Cu	47199	Cl ²	52801
— Protoxide,	Cu ²	88782	O	11218
— Peroxide,	Cu	79826	O	20174
— Protoiodide,	Cu	33396	I	66604
— Protosulphuret,	Cu ²	79733	S	20267
— Persulphuret,	Cu	66296	S	33704
Cyanogen, Cy ² ,	N ²	53662	C ²	46338
Glucina,	G ²	68846	O ³	31154
Gold, Protochloride,	Au ²	84886	Cl ²	15114
— Perchloride,	Au ²	65182	Cl ⁶	34818
— Sulphuret,	Au ²	80466	S ³	19534
Hydriodic Acid,	H ²	00785	I ²	99215
Hydrobromic Acid,	H ²	01260	Br ²	98740
Hydrochloric Acid,	H ²	02742	Cl ²	97258
Hydrocyanic Acid,	H ²	03645	Cy ²	96355
Hydrofluoric Acid,	H ²	05067	F ²	94933
Hydrogen, Carburetted,	H ⁴	24616	C	75384

Hydrogen, Carburetted,		H ⁴	14036	C ²	85964
— Phosphuretted,		H ⁶	08712	P ²	91288
— Arseniuretted,		H ⁶	03830	As ²	96170
— Peroxide,		H ²	05873	O ²	94127
Hydrosulphuric Acid,	}	H ²	05841	S	94159
Hydrogen, Sulphuretted,					
Hydroselenic Acid,		H ²	02461	Se	97539
Hydrotelluric Acid,		H ²	01524	Te	98476
Iodic Acid,		I ²	75942	O ⁵	24058
Iodine, Chloride,		I ²	41627	Cl ¹⁰	58373
Iron, Protochloride,		Fe	43385	Cl ²	56615
— Perchloride,		Fe ²	33813	Cl ³	66187
— Protoxide,		Fe	77232	O	22768
— Peroxide,		Fe ²	69338	O ³	30662
— Sulphuret,		Fe	62773	S	37227
— —		Fe ²	52923	S ³	47077
— Sulphuret, <i>Pyrites</i> ,		Fe	45744	S ²	54256
Lead, Chloride,		Pb	74519	Cl ²	25481
— Protoxide,		Pb	92829	O	07171
— Peroxide,		Pb	86618	O ²	13382
— Chromate,		PbO	68147	CrO ³	31853
— Nitrate,		PbO	67317	N ² O ⁵	32683
— Phosphate,		2PbO	75761	P ² O ⁵	24239
— Sulphate,		PbO	73563	SO ³	26437
— — = Pb	68287	S	10612	O ⁴	21101
— Sulphuret,		Pb	86550	S	13450
Lime,		Ca	71911	O	28089
— Hydrate,		CaO	75991	H ² O	24009
— — = Ca	54646	O	42686	H ²	02668
— Carbonate,		CaO	56292	CO ²	43708
— — = Ca	40478	C	12086	O ³	47436
— Phosphate,		2CaO	44382	P ² O ⁵	55618
— — = Ca ²	31916	P ²	24453	O ⁷	43631
— Sulphate,		CaO	41532	SO ³	58468
— — = Ca	29866	S	23469	O ⁴	46665
Lithia,		L	44850	O	55150
Lithium, Chloride,		L	15520	Cl ²	84480
Magnesia,		Mg	61293	O	38707
— Phosphate,		2MgO	36671	P ² O ⁵	63329
— Sulphate,		MgO	34015	SO ³	65985
Magnesium, Chloride,		Mg	26348	Cl ²	73652
— Sulphuret,		Mg	44046	S	55954
Manganese, Protochloride,		Mn	43865	Cl ²	56135
— Sesquichloride,		Mn	34252	Cl ³	65748
— Superchloride,		Mn	20665	Cl ⁶	79335
— Protoxide,		Mn	77573	O	22427
— Deutoxide,		Mn ²	69752	O ³	30248
— Peroxide,		Mn	63363	O ²	36637
— Sulphate,		MnO	47082	SO ³	52918
— Sulphuret,		Mn	63228	S	36772
Manganic Acid,		Mn	53553	O ³	46447
Mercury, Protochloride,		Hg ²	85117	Cl ²	14883
— Perchloride,		Hg	74091	Cl ²	25909

— Protoxide,	Hg ²	.96200	O	.03800
— Peroxide,	Hg	92678	O	07322
— Cyanide,	Hg	79325	Cy ²	20675
Mercury, Sulphuret,	Hg	86287	S	13713
Molybdc Acid,	Mo	66612	O ³	33388
Nickel, Chloride,	Ni	45508	Cl ²	54492
— Oxide,	Ni	78709	O	21291
Nitrogen, Chloride,	N ²	11763	Cl ⁶	88237
Nitric Acid, <i>dry</i> ,	N ²	26149	O ⁵	73851
— Hydrate, sp. gr. 1.521	N ² O ⁵	85753	Aq	14247
= N ² 22423	H ²	01581	O ⁶	75996
Nitrous Acid,	N ²	37112	O ³	62888
Nitric Oxide,	N	46955	O	53045
Nitrous Oxide,	N ²	63904	O	36096
Oxalic Acid, <i>dry</i> ,	C ²	33757	O ³	66243
Osmic Acid,	Os	75672	O ⁴	24328
Phosphorous, Protochloride,	P ²	22805	Cl ⁶	77195
— Perchloride,	P ²	15057	Cl ¹⁰	84943
Phosphoric Acid,	P ²	43966	O ⁵	56034
Phosphorous Acid,	P ²	56667	O ³	43333
Hypophosphorous Acid,	P ²	79688	O	20312
Platinum, Protochloride,	Pt	73587	Cl ²	26413
— Perchloride,	Pt	58212	Cl ⁴	41788
— Potassium-Chloride, {	Pt	40420	Cl ⁴	29015
	KCl ²	30563		
— Ammonium-Chloride, {	Pt	44232	H ² Cl ⁶	48076
	N ² H ⁶	07692		
Potassium, Chloride,	K	52534	Cl ²	47466
— Iodide,	K	23674	I ²	76326
— Sulphuret,	K	70891	S	29109
Potash,	K	83048	O	16952
— Hydrate, K 69749	O ²	28474	H ²	01777
— Carbonate,	KO	68092	CO ²	31908
= K 56549	C	08823	O ³	34628
— Chlorate,	KO	38492	Cl ² O ⁵	61508
= K 31967	Cl ²	28883	O ⁶	39150
— Nitrate,	KO	46562	N ² O ⁵	53438
= K 38669	N ²	13973	O ⁶	47358
— Sulphate,	KO	54067	SO ³	45933
= K 44902	S	18437	O ⁴	36661
Selenic Acid,	Se	62244	O ³	37756
Silica,	Si	48050	O ³	51950
Silicon, Chloride,	Si	17284	Cl ⁶	82716
— Fluoride,	Si	28347	F ⁶	71653
— Sulphuret,	Si	31497	S ³	68503
Silver, Bromide,	Ag	58011	Br ²	41989
— Chloride,	Ag	75330	Cl ²	24670
— Cyanide,	Ag	80380	Cy ²	19620
— Iodide,	Ag	46132	I ²	53868
Silver, Nitrate,	AgO	68194	N ² O ⁵	31806
— Oxide,	Ag	93111	O	06889
— Phosphate,	2AgO	76490	P ² O ⁵	23510
— Sulphuret,	Ag	87045	S	12955

Soda,		Na	74418	O	25582
— Hydrate,	Na	57789	O ²	39732	H ² 02479
— Carbonate,			NaO	58576	CO ² 41424
	Na	43591	C	11454	O ³ 44955
Carbonate, <i>cryst.</i> ,			{ NaO, } { CO ² }	37237	Aq ¹⁰ 62763
— Sulphate, <i>anhydrous</i> ,			NaO	43819	SO ³ 56181
= Na	32609		S	22551	O ⁴ 44840
— Sulphate, <i>cryst.</i> ,			{ NaO, } { SO ³ }	44231	Aq ¹⁰ 55769
Sodium, Chloride,		Na	39656	Cl ²	60344
— Fluoride,		Na	55441	F ²	44559
— Fluo-Silicide,		Na ³	24709	Si ² F ¹⁸	75291
— Sulphuret,		Na	59118	S	40882
Strontian,		Sr	84551	O	15449
— Carbonate,		SrO	70074	CO ²	29926
— Nitrate,		SrO	48877	N ² O ⁵	51123
— Sulphate,		SrO	56360	SO ³	43640
Strontium, Chloride,		Sr	55285	Cl ²	44715
Sulphuretted, Hydrogen,		H ²	05841	S	94159
Sulphurous Acid,		S	50145	O ²	49855
Hyposulphurous Acid,		S ²	66796	O ²	33204
Sulphuric Acid, <i>anhydrous</i> ,		S	40139	O ³	59861
— Hydrate, sp. gr. 1.85			SO ³	81670	Aq 18330
= S	33782		O ⁴	65184	H ² 02034
Hyposulphuric Acid,			S ²	44588	O ⁵ 55412
Sulphur, Chloride,	SCI	S	47614	Cl	52386
— —	SCI ⁴	S	18516	Cl ⁴	81484
— —	SCI ⁶	S	13156	Cl ⁶	86844
Telluric Acid,		Te	72780	O ₃	27220
Tellurium, Sulphuret,		Te	66596	S ²	33404
Tantallic Acid,		Ta ²	88494	O ³	11506
Tantalum, Chloride,		Ta ²	63471	Cl ⁶	36529
— Oxide,		Ta	92024	O	07976
Tin, Protochloride,		Sn	62422	Cl ²	37578
— Perchloride,		Sn	45372	Cl ⁴	54628
— Protoxide,		Sn	88028	O	11972
— Peroxide,		Sn	78616	O ²	21384
— Sulphuret,		Sn	64634	S ²	35366
Titanic Acid,		Ti	60293	O ²	39707
Titanium, Chloride,		Ti	25542	Cl ⁴	74458
Tungstic Acid,		W	79773	O ³	20227
Uranium, Protoxide,		U	96443	O	03557
— Peroxide,		U ²	94758	O ³	05242
Vanadium, Suboxide,		V	89538	O	10462
— Oxide,		V	81058	O ²	18942
Vanadic Acid,		V	74045	O ³	25955
Water,		H ²	11111	O	88889
Yttria,		Y	80073	O	19927
Zinc, Chloride,		Zn	47670	Cl ²	52330
— Oxide,		Zn	80128	O	19872
— Sulphuret,		Zn	66716	S	33284
Zirconia,		Zr ²	73695	O ³	26305
— Sulphate,		ZnO	50103	SO ³	49897

A CHEMICAL READY-RECKONER.

Many of the calculations which the chemist finds it necessary to make, fall under what is commonly termed the *rule of three* (the rule of proportion). Calculations of that sort can be executed rapidly but roughly, for ordinary operations, by means of a pair of compasses and the diagram given in the margin.

This diagram contains GUNTER'S *line of logometric numbers*. The compasses employed must open easily and have very fine points. If you open the compasses so wide that one leg points to 10, and the other to 20, upon this scale, you will find that wherever you apply the compasses thus opened to the degrees marked upon the scale, the numbers situated at their two points will always bear the relation of 10 : 20. Hence you can readily perform such calculations as the following:—

10	:	20	::	50	:	100
15	:	30	::	45	:	90
13.5	:	27	::	19.5	:	39
11.25	:	22.5	::	17.75	:	35.5

With any other opening of the compasses, you come to similar results: at equal intervals of space, the numbers on the scale are always proportional.

Now, although such calculations cannot be made with great accuracy, and are not much to be depended upon when each term consists of more than three figures; yet the results are sufficiently correct for many common laboratory experiments, for checking the results of direct arithmetical calculations, and for verifying the calculations contained in argumentative discourses. I shall mention a few problems in which this method of calculation can be brought into use, in company with portions of the foregoing Tables of Atomic Weights and Decimal equivalents.

PROBLEM 1. *How much Sodium is contained in 27½ grains of Chloride of Sodium?*—1 grain of Chloride of Sodium contains .39656 grain of Sodium. See Table, page 27. Hence the problem to be solved is this:—

$$100 : 39.66 :: 27.5 : x.$$

Place one leg of the compasses upon 100 at the bottom of the scale, and the other upon 39½ or a little beyond 39½, namely, as near to $39\frac{6}{100}$ as you can guess. Then remove one leg of the compasses from 100 to 27½; upon which the other leg will fall upon $10\frac{9}{100}$, which is the number of grains of Sodium contained in 27½ grains of NaCl².

Proof.— $.39656 \times 27.5 = 10.905400.$

PROBLEM 2. *How much Chloride of Silver is produced by 20½ grains of Silver?*—1 part of Chloride of Silver contains .7533 part of Silver. Table, page 26. Hence the problem is this:—

$$75.33 : 100 :: 20.5 : x.$$

Place the two legs of the compasses upon 100 and 75½. Then remove one leg from 75½ up to 20½, upon which the other leg falls upon $27\frac{1}{4}$ = grains of Chloride of Silver, produced by 20½ grains of Silver.

Proof. $\frac{100 \times 20.5}{75.33} = 27.213.$

ON THE ANALYSIS OF SOILS.

The following directions are from a paper issued from the "*Museum of Economic Geology*."*

In selecting specimens, care must be taken to obtain a fair average sample, and to insure the true subsoil or subjacent hard rock, clay, sand, &c. Specimens of the latter should be obtained as near as possible beneath the spot whence the soil may have been selected, for it sometimes happens that the soil of a field varies in places from resting on different kinds of subsoil.

The quantity of soil taken as a specimen should weigh about a pound, which should be tied up in a canvass bag and labeled.

With respect to specimens of subsoils, if of marl, sand, or clay, portions weighing about a pound should be tied up in a canvass bag, labeled to correspond with the respective soils above them. If the subjacent rocks be hard, a piece also weighing about a pound, and fresh broken from the body of the rock, as nearly as possible beneath the surface whence any specimen of soil may have been selected should suffice, and should be wrapped in strong brown paper, labeled to correspond with the soil above it.

I. Dry the specimen at 212° Fahr., powder, sift through a lawn sieve, rub in a mortar, again dry at 212°, and put into a stoppered bottle.

II. Spread 500 grains on a sheet of writing paper, and expose to the air for twelve hours; note the increase of weight; from seven to ten grains is a favorable indication.

III. Determine the amount of carbonic acid in 100 grains, by treating it in a counterpoised bottle with hydrochloric acid with the usual precautions.

IV. Determine the amount of organic matter in 200 grains, by heating to redness in a platinum crucible, with occasional stirring; weigh the residue, and divide it into two equal parts: introduce one into a counterpoised bottle containing hydrochloric acid, and estimate the disengaged carbonic acid; if this be less than that obtained before calcination, the difference must be added to the weight of the calcined product under operation, and this deducted from the weight before calcination will indicate the amount of organic matter.

V. The other half of the residue left after calcination is now to be boiled in a flask with about an ounce of hydrochloric acid. By this means all the ingredients except the silica and part of the alumina will be dissolved, some of them being decomposed. The insoluble part is to be separated by filtration, washed until no longer acid, and dried. The solution, together with the washings of the insoluble powder, is to be marked A, and put aside for further examination. The powder is to be finely pulverized and mixed with four times its weight of dried carbonate of soda; the mixture is then to be heated in a platinum crucible until it fuses into a glass. The crucible and its contents being placed, while warm, in a Wedgewood dish containing distilled water, about an ounce of hydrochloric acid is to be added and heat applied. More acid and water may be added if necessary, until nothing more is dissolved. This being done, the solution and insoluble part are to be evaporated to dryness, in order to aggregate the silica

* Pharm. Journal, vol. iv.

held in suspension; and care must be taken, during this operation, that no hard lumps are left in the solution, as the silica sometimes forms a coating over such particles through which the acid will not act. The residue, after the evaporation, is to be heated with water mixed with about half an ounce of hydrochloric acid, the solution is to be filtered and the insoluble part washed. The latter is the silica, which must be carefully heated to redness, and weighed while warm.* To the solution from which the silica has been separated ammonia is to be added; the *alumina* is hereby precipitated, which is washed, ignited, and weighed with the same precautions as the silica.

VI. The solution A is now to be examined. For this purpose add ammonia in excess, and afterwards strong acetic acid in considerable excess, and boil the mixture; *phosphate of peroxide of iron* and *phosphate of alumina* (if present) will be precipitated. Collect and wash the precipitate, and label the solution C. Treat the precipitate with solution of caustic potassa, which will redissolve the *phosphate of alumina*, and leave the *phosphate of iron*; separate, wash, dry, and weigh the latter; add ammonia to the potash solution to throw down the phosphate of alumina, which is, in like manner, to be collected and weighed.

It must not be inferred that the phosphates of iron and alumina obtained in this manner existed as such in the soil; the phosphoric acid may have been, at least in part, in combination with lime and magnesia, while the iron may have been in the state of peroxide, and the alumina uncombined; but, on dissolving these ingredients in the hydrochloric acid, the phosphate of lime or magnesia would be decomposed, and phosphate of iron and alumina formed. As this decomposition would always take place under the circumstances indicated, it next becomes a question whether the equivalent proportions of peroxide of iron, or alumina, or of phosphoric acid existed in excess. To determine this point, divide the solution C into two parts; to one add a few drops of solution of perchloride of iron, which, if any earthy phosphates still remain undecomposed, will occasion a precipitate of phosphate of iron, in which case it may be concluded that the whole of the iron originally in the solution has been obtained in the state of phosphate of iron. Continue the addition of perchloride of iron as long as a precipitate is formed, and treat this precipitate the same as that first obtained from solution A. If, on the other hand, no precipitate be formed from the perchloride of iron, it will be necessary to try whether there be more iron or alumina in the solution. In this case, add to the other half of the solution C liquid ammonia, so as to render it slightly alkaline; then add hydrosulphuret of ammonia, which will throw down peroxide of iron, oxide of manganese and alumina, if present; collect and wash this precipitate, and label the solution D. Dissolve the precipitate in hydrochloric acid and boil the solution, add caustic potassa in excess, which will throw down peroxide of iron and oxide of manganese, but will retain alumina in solution; the two former being thus separated, add hydrochloric acid to the filtered solution in slight excess, and finally precipitate the alumina by ammonia.

VII. The quantity of manganese contained in soils is usually so small as to render its separation from the iron unnecessary. Its presence may be

* Or rather the crucible should be allowed to cool underneath a receiver close to a vessel containing sulphuric acid, and weighed with the cover on.

indicated by the black color which the iron precipitate assumes on being exposed to the air, or by the smell of chlorine, which is afforded on adding a few drops of hydrochloric acid to the precipitate. If thought desirable to separate the two oxides, dissolve them in hydrochloric acid and add *precipitated carbonate of lime*, which will throw down the oxide of iron. Separate the precipitate, and add to the filtrate ammonia and oxalate of ammonia, by which the lime is removed; then add *caustic soda*. Collect, dry, and weigh the precipitate, which may be estimated as oxide of manganese.

VIII. The solution D may still contain lime, magnesia, and salts of potassa and soda. Boil, to drive off any sulphuretted hydrogen which it may contain, then add oxalate of ammonia as long as a precipitate of oxalate of lime is formed. Collect, dry, and weigh this precipitate, and label the solution E; if the precipitate be dried at 212° , it will contain one atom of water.

IX. Add hydrochloric acid to the solution E; evaporate to dryness, and heat to dull redness. Redissolve in water, and add *red oxide of mercury*; treat the residue with water, pure magnesia (if present) will remain, which is to be collected and weighed.

X. The *chlorides of potassium and sodium*, as well as the sulphate of lime, have yet to be determined. Boil 200 grains of the dried specimen in ten ounces of distilled water; filter the solution and wash the insoluble part; divide the solution into two equal parts; to one add nitric acid, and then *chloride of barium* as long as any precipitate occurs. Collect, wash, and dry this precipitate, which is sulphate of baryta, obtained from the decomposition of sulphate of lime. To the other half of the solution add nitric acid, and then *nitrate of silver* as long as any precipitate occurs, which treat as in the former case. This will be chloride of silver, obtained from the decomposition of the *chlorides of potassium and sodium*.

The above process, though it has no pretensions perhaps to great accuracy, is sufficiently exact for most practical purposes. When a complete analysis is to be made, *Dr. Ure* adopts the following method.* A known weight (about 100 grains) of the soil is introduced into a large glass flask with a thin concave bottom, capable of holding at least a quart of water, and over it is poured a sufficient quantity of dilute hydrochloric acid. The flask is placed on the ring of a retort-stand and exposed to a gentle heat, while the beak of a large glass funnel, having its mouth covered with a porcelain basin filled with distilled water, is inserted into its neck. By this arrangement, a continuous ebullition may be maintained in the mixture of soil and acid, without loss of acid or nuisance from its fumes, because the vapors are condensed whenever they reach the cold basin above the funnel; and in this way a boiling heat may be kept up till every constituent of the soil, except the silica, becomes dissolved. The funnel and porcelain basin should be properly supported on the rings of the retort-stand. *Dr. Ure* maintains the action for *six or eight hours*, at the end of which time he throws the contents of the matrass on a filter, and supersaturates the filtered liquor with ammonia. The silica which remains on the filter having been washed, is dried and weighed.

The *alumina, oxide of iron and phosphate of lime* thrown down by the ammonia being washed on the filter, and dried to a cheesy consistence, are

* Pharm. Journ., June, 1845.

removed with a bone spatula into a silver basin, and digested with heat in a solution of pure potassa, whereby the alumina is dissolved; the alkaline solution is passed through a filter and saturated with hydrochloric acid; ammonia is then added, pure white *alumina* falls, which is collected on a filter, washed, ignited and weighed.

The *iron* and *phosphate of lime* on the filter may be dried, gently ignited and weighed, or otherwise directly separated from each other without that step, by the action of dilute alcohol, acidulated with sulphuric acid at a gentle heat. Thus the oxide of iron will be dissolved, and its solution may be passed through a filter, while the *sulphate of lime* will remain undissolved, and may be dried, ignited and weighed; *five* parts of it correspond with *four* of phosphate. The *iron* is obtained in the state of sesquioxide by precipitation with ammonia.

The first filtered liquor, with excess of ammonia, contains the *carbonate of lime* and the *magnesia*. The former is separated by solution of oxalate of ammonia, and digestion, at a gentle heat, for a few hours; it is then filtered, washed, dried and gently ignited, by which it is converted into carbonate, in which form it is weighed. The *magnesia* in the filtrate is precipitated with phosphate of soda.

For some refractory soils in which the alumina exists as a double or triple silicate, it becomes necessary to fuse about fifty grains of the sample in fine powder, mixed with four times its weight of dry carbonate of soda, the mixture being put into a platinum crucible, and into a cavity in the centre fifty grains of hydrate of potassa being laid. The crucible is slowly raised to a red white heat, when its contents fuse into a homogenous liquid, of a gray or brown color, according to the metals present in it. *Manganese* gives a purple tint, and *iron* a red brown. The fused matter should be poured out into a shallow platinum basin, and, as soon as it is cold, it should be pulverized, dissolved in dilute hydrochloric acid, the solution evaporated to dryness, the dry mass again digested with hot water acidulated with hydrochloric acid, and the whole thrown down upon a filter. Pure *silica* remains, which is washed, dried, ignited and weighed. The filtered liquor, which contains the remaining constituents of the soil, is treated as already described.

Besides these systematic investigations, *Dr. Ure* directs researches to be made for certain peculiar substances, and especially for the so-called *neutro-saline* constituents, in the following manner. One hundred grains of the soil are triturated with twenty times their weight of distilled water, placed in a beaker till the clayey matter subsides, and the clear liquor is then decanted into a filter. A little of the filtered solution should be tested with nitrate of baryta, and also with oxalate of ammonia. If precipitates are afforded, the presence of *sulphate of lime* is indicated, and the following steps must be taken to eliminate it entirely:—Two hundred grains of the soil are triturated with a quart of distilled water, holding in solution fifty grains of sal ammoniac. The mixture should be allowed to clarify itself by subsidence, when the supernatant clear liquor should be evaporated down to two ounce measures, and then mixed with an equal bulk of *strong whisky* (11 per cent. over proof). The whole of the sulphate of lime will then be separated from the fluid, and, after being drained on a filter, may be dried, ignited, and weighed.

For determining the *alkaline salts*, the water filtered from the one hundred grains of soil should be evaporated down to one-fifth of its bulk, and

then treated, 1st, with nitrate of baryta for the *sulphates*; 2d, with nitrate of silver for the *chlorides*; 3d, with oxalate of ammonia for the *nitrate of lime* or *chloride of calcium*, provided no sulphate of lime is indicated by the first test; 4th, with litmus paper for the *alkaline* or *acid* reaction; 5th, with soda chloride of platinum for *potassa*, salts which are very valuable for the vigorous growth of many plants. The portions of the soil tested for potassa salts should, before being digested in water, be gently calcined, to ensure the expulsion of every particle of ammoniacal salt; otherwise the precipitate afforded by soda chloride of platinum would be fallacious.

Another peculiar research to which *Dr. Ure* directs especial attention, is that which determines the amount of ammonia in a soil, which may exist either ready formed, or in its elements, capable of affording a portion of that azotic food so indispensable to vigorous vegetation. The actual ammonia is easily obtained, by distilling the soil along with *milk of lime*; the distillate will contain all the volatile alkali, which may be estimated by a standard solution of sulphuric acid, according to *Péligot's* method, described page 468 "*Noad's Chemical Analysis.*" What *Dr. Ure* calls the *potential* ammonia, *slumbering*, so to speak, in its embryo elements, may be estimated by igniting 200 grains of the soil with its own weight of a mixture of hydrate of soda and quicklime.

Dr. Ure gives also the following simple method of testing for phosphoric acid in a soil:—Digest it for an hour or so, at a moderate heat, with dilute *nitric* acid (free from hydrochloric acid). Throw the mixture on a filter; to the filtered liquor add *potassa water* cautiously, till the instant that a precipitate begins to appear; then drop into it a weak solution of nitrate of silver. If any phosphoric salts be present, a yellowish precipitate will immediately fall, which is resolvable in an excess of nitric acid. Whatever is not thus dissolved is chloride of silver, and ought to be separated by filtration. On adding then weak potassa water cautiously to the filtered liquor, pure *phosphate of silver* will be obtained, without any alumina or iron, provided the liquor be still acidulous in a slight degree. The portion of soil should be fresh, not calcined, because the phosphates, when ignited, afford a white precipitate with nitrate of silver. The stronger the solution of the phosphoric compound is, the more characteristic is the yellow precipitate with silver; and then ammonia may be used to effect the partial separation of the excess of acid.

A solution of *sulphate of magnesia*, containing a little sal ammoniac, is probably the best test liquor for detecting phosphates in faintly acidulous, but still better in neutral, solutions.

The determination of phosphoric acid in soils is best effected by the following process, proposed originally by *Schulze*, and modified by *Liebig*. It is founded on the insolubility of phosphate of peroxide of iron and phosphate of alumina in *acetic* acid:—The hydrochloric solution of the soil is evaporated to dryness, nitric acid being added during the evaporation, the dry mass is treated with dilute hydrochloric acid, and the solution filtered off from the insoluble silica. To the acid solution ammonia is added, and then acetic acid; the mixture is boiled, filtered while hot, and the precipitate, which contains the whole of the phosphoric acid, in combination with iron and alumina, is collected on a filter, washed, dried, weighed, and digested with caustic potassa, which dissolves the latter. This is the pro-

cess as originally proposed by *Schulze*. According to *Liebig's* modification,* ammonia is added to the hydrochloric solution of the soil, till a precipitate begins to form; acetic acid is then added, and, finally, acetate of soda in excess; the mixture is boiled and filtered. The precipitate, having been washed with hot water, is dissolved in hydrochloric acid, ammonia added to alkaline reaction, and then hydrosulphuret of ammonia. The fluid is filtered off from the precipitated sulphuret of iron, and the latter is washed with water mixed with hydrosulphuret of ammonia. The filtrate is concentrated by evaporation, *sulphate of magnesia* added, and the mixture stirred; the formation of a crystalline precipitate indicates phosphoric acid; this precipitate consists of basic phosphate of magnesia and ammonia. It is collected on a filter, washed with water containing a little ammonia, dried, and ignited; the phosphoric acid is estimated as pyrophosphate of magnesia.

According to *Mr. Nesbit* † this process is inapplicable where phosphate of alumina is contained in the solution, the phosphoric acid being kept back in the precipitate formed by ammonia and hydrosulphuret of ammonia, and cannot be obtained in the filtrate.

Although the quantity of soluble saline matter extracted from a moderate quantity of any of our soils is rarely so great as to admit of a rigorous quantitative examination, it is, nevertheless, very desirable that a qualitative analysis of the aqueous extract should be made, in order to furnish information as to the ingredients which are supplied directly to the plant with the water which they imbibe from the soil. In some soils, those, for instance, of Egypt and India, and of other warm countries, soluble saline matter in the form of chlorides, sulphates, and nitrates, to the amount of 14 per cent., has been found. ‡ The qualitative examination will always inform the operator whether or not a quantitative analysis is required. The most convenient plan, therefore, is to digest a large quantity (from two to three pounds) of the soil with distilled water, and, having thrown it on a moist filter and thoroughly washed the insoluble matter, to divide the filtrate into two parts, using one part for the qualitative, and setting aside the other for the quantitative examination, should such be found necessary.

As the analysis of soils is a subject which is likely early to occupy the attention of the student in analytical chemistry, we have, with a view of assisting him in his labors, collected in a tabular form the different steps of the treatment of the hydrochloric solution. The substance of this Table is taken from the article on the analysis of soils, in *Johnstone's Agricultural Chemistry*, a work which we take the liberty of strongly recommending to the attention of the agricultural student.

* *Fresenius*—Quantitative Analysis, p. 516.

† Quarterly Journ. of the Chemical Society, No. 1, p. 45.

‡ See *Johnstone's Lectures on Agricultural Chemistry and Geology*, p. 43, Appendix.

ALPHABETICAL TABLE OF BEHAVIOUR UNDER BLOWPIPE EXAMINATION.

<i>Name of Substance.</i>	<i>Behaviour.</i>	<i>Name of Substance.</i>	<i>Behavior.</i>
1. ALUMINA.	Blue with nitrate of cobalt.	19. MERCURY, protoxide of.	Mixed with soda and heated in a tube the metal sublimes.
2. ANTIMONY, oxide of.	With soda in deoxidizing flame, reduced and gives off white fumes of oxide.	20. MERCURY, peroxide of.	As the protoxide.
3. BARYTA.	O O	21. MOLYBDENUM, oxide of.	With microcosmic salt in outer flame a green glass.
4. BISMUTH, oxide of.	With soda on charcoal reduced; brittle bead of metal.	22. NICKEL, oxide of.	With soda on charcoal, reduced to a magnetic powder. With borax and mic. salt in outer flame a red glass, becoming colorless on cooling.
5. CADMIUM, oxide of.	With soda on charcoal reduced, and metal volatilized, leaves a reddish-brown deposit.	23. OSMIUM, deutoxide of.	Osmium is characterized by forming, when heated in the air, a suboxide, which is volatile, and has a very disagreeable smell, causing much inconvenience to eyes and nose.
6. CALCIUM (Lime).	Radiates a brilliant light. Gives a red color to the flame.	24. PALLADIUM, protoxide of.	Reduced.
7. CHROMIUM, oxide of.	Emerald-green with fluxes.	25. PLATINUM, oxide	Reduced.
8. COBALT, oxide of.	Blue glass, with borax in both flames.	26. POTASH.	Violet flame.
9. COPPER, oxide of.	With soda on charcoal reduced. With borax and mic. salt in outer flame, green; in inner flame red.	27. RHODIUM, sesquioxide of.	Reduced.
10. GLUCINA.	With nitrate of cobalt, dark-gray or black.	28. SILVER, oxide of.	Reduced.
11. GOLD, teroxide of.	Reduced.	29. SODA.	Yellow flame.
12. IRIIDIUM, sesquioxide of.	Reduced.	30. STRONTIA.	Carmine flame.
13. IRON, protoxide of.	With the fluxes in the outer flame, brownish-yellow; in the inner flame, light-green.	31. TIN, protoxide of.	With soda in reducing flame a malleable bead of metallic tin.
14. IRON, peroxide of.	As the protoxide.	32. TIN, peroxide of.	Reduced with soda.
15. LEAD, oxide of.	With soda on charcoal reduced; yellow deposit also formed on charcoal.	33. URANIUM, sesquioxide of.	Yellow glass with borax.
16. LITHIA.	Gives red color to the flame.	34. VANADIUM, binoxide of.	With borax, yellow in the outer flame, in the inner brown, becoming green when cold.
17. MAGNESIA.	Light pink with nitrate of cobalt.	35. YTTRIA.	Nothing characteristic.
18. MANGANESE, protoxide of.	With soda a green bead. With borax in outer flame an amethyst bead, which loses its color in the reducing flame.	36. ZINC, oxide of.	With soda on charcoal, gives a white sublimate of oxide, which is yellow when hot. With nit. cobalt, green.
		37. ZIRCONIA.	Bright flame.



