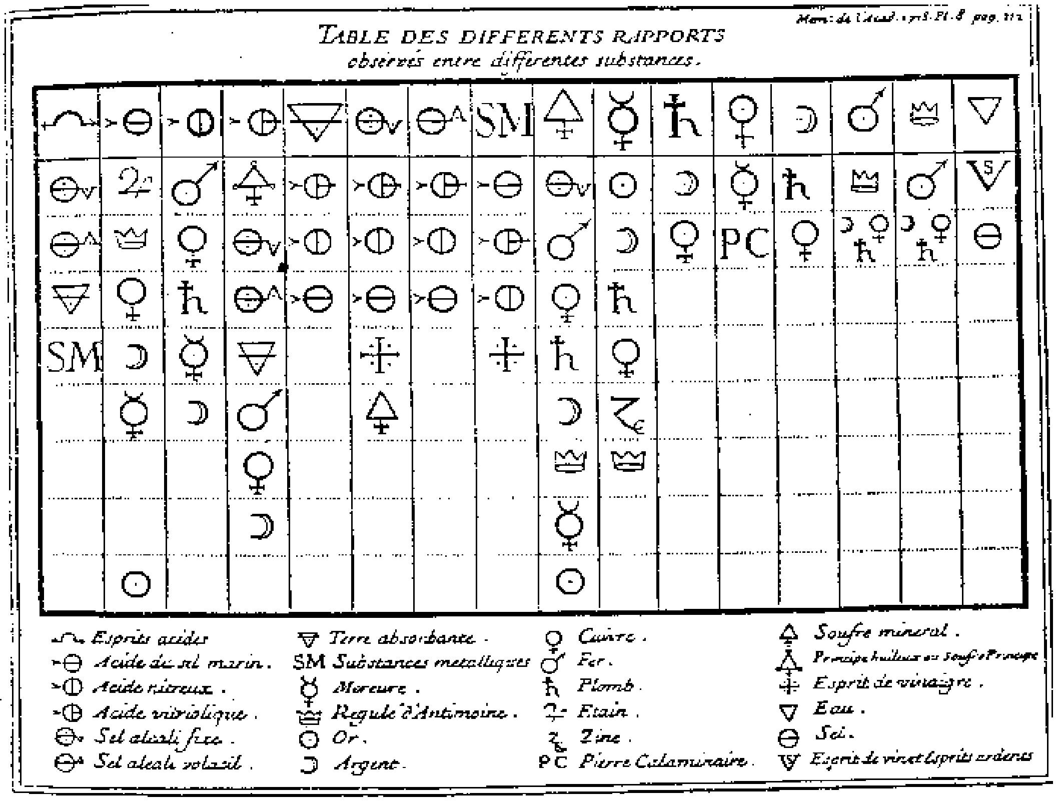
Dizionari e Nomenclatura
della
Chimica Antiquaria

-

&
Sistemi di Classificazione Periodica
degli
Elementi



Mem: de l'Acad. 1718. Pl. 8 pag. 212

TABLE DES DIFFERENTS RAPPORTS
observés entre differentes substances.

Esprits acides
Acide du sel marin.
Acide nitreux.
Acide vitriolique.
Sel alcali fixe.
Sel alcali volatil.

Terre absorbante.
SM Substances metalliques
☿ Mercure.
Regule d'Antimoine.
☉ Or.
☽ Argent.

♀ Cuivre.
♂ Fer.
♄ Plomb.
♃ Etain.
Zinc.
PC Pierre Calaminaire.

Soufre mineral.
Principe huileux ou Soufre Principe
Esprit de vinaigre.
Eau.
Sel.
Esprit de vin et Esprits ardents

◆

A Dictionary of the New Chymical Nomenclature

from *Method of Chymical Nomenclature* (Paris, 1787); translated by James St. John (London, 1788), pp. 105-176.

[p. 105]

A

New Names	Ancient Names
ACETATS	SALTS formed by the union of the acetic acid or radical vinegar, with different bases
Acetat aluminous, or Acetat of alumine	
Acetat ammoniacal, or Acetat of ammoniac [1]	
[p. 106] Acetat of arsenic	
Acetat of barytes	
Acetat of bismuth	
Acetat of cobalt	
Acetat of copper	
Acetat of gold	
Acetat of iron	
Acetat of lead	
Acetat of lime	
Acetat of magnesia	
Acetat of manganese	
Acetat of mercury	
Acetat of molybden	
Acetat of nickel	
Acetat of platina	
Acetat of potash	
[p. 107] Acetat of silver	
Acetat of soda	
Acetat of tin	
Acetat of tunstein	
Acetat of zink	
Acetites	Salts formed by the union of the acetous acid, or distilled vinegar, with different bases
Acetite aluminous	Acetated clay
Acetite ammoniacal	Mindererus's spirit
Acetite of antimony	
Acetite of arsenic	
Acetite of barytes	
Acetite of bismuth	
Acetite of cobalt	
Acetite of copper	Crystals of Venus
Acetite of gold	
Acetite of iron	
Acetite of lead	Sugar of lead Super-acetated lead
[p. 108] Acetite of lime	
Acetite of magnesia	Acetous salt of magnesia
Acetite of manganese	
Acetite of mercury	Foliated earth of mercury

Acetite of molybden	
Acetite of nickel	
Acetite of platina	
Acetite of potash	Foliated earth of tartar
Acetite of silver	
Acetite of soda	Mineral foliated earth
Acetite of tin	
Acetite of tunstein	
Acetite of zink	Acetous salt of zink
Acid acetic	Radical vinegar Spirit of Venus
Acid acetous	Acetous acid Distilled vinegar
Acid arsenic	Arsenical acid
Acid benzoic	Acid of Benjamin
[p. 109] Acid benzoic sublimated	Flowers of Benjamin
Acid boracic	Volatile narcotic salt of vitroil [sic; should be vitriol] Sedative salt, acid of borax
Acid bombic	Acid of silk worms
Acid carbonic	Gas Sylvestre, of Van Helmont Spiritus Sylvestris Fixed air, of Dr Black Aerial acid Atmospheric acid Mephitic acid Cretaceous acid Acid of charcoal
Acid citric	Lemon juice
Acid fluoric	Fluoric acid Acid of spar
Acid formic	Formic acid, acid of ants
Acid gallic	Astringent principle Gallic acid
Acid lactic	Sower whey, galactic acid
Acid lithic	Acid of bezoar Lithiasic acid
Acid malic	Acid of apples Mulusian acid
Acid molybdic	Acid of molybden Acid of wolfram
Acid muriatic	Acid of sea-salt Smoking spirit of salt Marine acid
[p. 110] Acid muriatic oxygenated	Dephlogisticated marine acid Aerated marine acid
Acid nitrous	Phlogisticated nitrous acid Smoking nitrous acid Smoking spirit of nitre
Acid nitric	White nitrous acid Degazated nitrous acid Dephlogisticated nitrous acid
Acid nitro-muriatic	Aqua regia Regaline acid
Acid oxalic	Acid of sorrel Saccharine acid Acid of sugar
Acid phosphorous	Volatile phosphoric acid
Acid phosphoric	Acid of phosphorus
Acid Prussic	Coloring matter of Prussian blue
Acid pyro-ligneous	Empyreumatic acid spirit of box
Acid pyro-mucous	Spirit of honey, of sugar, &c
Acid pyro-tartareous	Spirit of tartar
Acid saccho-lactic	Acid of the sugar of milk

Acid sebacic	Acid of fat
Acid succinic	Volatile salt of amber Acid of amber
[p. 111] Acid sulphureous	Sulphureous acid Volatile sulphureous acid Phlogisticated vitriolic acid Spirit of sulphur
Acid sulphuric	Acid of sulphur Vitriolic acid Oil of vitriol Spirit of vitriol
Acid tartareous	Acid of tartar
Acid tunstic	Acid of tungstein Acid of wolfram
Affinity	Affinity
Aggregation	Aggregation
Air atmospherical	Atmospherical air
Alkalies	Alkalies in general
Alcohol	Spirit of wine Ardent spirits
Alcohol of potash	Lily of Paracelsus Acrid tincture of tartar
Alcohol nitric	Dulcified spirit of nitre
Alcohols resinous	Spirituous tinctures
Alloy, or allay	Alloy of metals
Alumine	Earth of alum Basis of alum Pure argillous earth
[p. 112] Amalgam	Amalgam
Ammoniac	Volatile alkali caustic Fluor-volatile alkali Volatile spirit of sal ammoniac
Antimony	Regulus of antimony
Argile or clay, a mixture of alumine and silice	Clay or argillous earth
Aroma	Odoriferous principle of flowers
Arseniats	Arsenical salts
Arseniat acidulous of potash	Arsenical neutral salt, of Macquer
Arseniat of alumine	
Arseniat of ammoniac	Arsenical ammoniac
Arseniat of barytes	
Arseniat of bismuth	
Arseniat of cobalt	
Arseniat of copper	
Arseniat of gold	
Arseniat of iron	
Arseniat of lime	
[p. 113] Arseniat of magnesia	
Arseniat of manganese	
Arseniat of mercury	
Arseniat of molybden	
Arseniat of nickel	
Arseniat of platina	
Arseniat of potash	
Arseniat of silver	
Arseniat of soda	
Arseniat of tin	
Arseniat of tunstein	
Arseniat of zink	

B

New Names	Ancient Names
Barytes	Ponderous earth Barytes Basis of ponderous spar
Balsams	Buquet's balsams (resins united with a concrete acid salt)
Benzoin	Benzoin or Benjamin
[p. 114] Benzoats	Salts formed by the union of the benzoic acid with different bases. The salts of this genus have no appellations in the ancient nomenclature.
Benzoat of alumine	
Benzoat of ammoniac	
Benzoat of antimony	
Benzoat of arsenic	
Benzoat of barytes	
Benzoat of bismuth	
Benzoat of cobalt	
Benzoat of copper	
Benzoat of gold	
Benzoat of iron	
Benzoat of lead	
Benzoat of lime	
Benzoat of magnesia	
Benzoat of manganese	
[p. 115] Benzoat of mercury	
Benzoat of molybden	
Benzoat of nickel	
Benzoat of platina	
Benzoat of potash	
Benzoat of silver	
Benzoat of soda	
Benzoat of tin	
Benzoat of tunstein	
Benzoat of zink	
Bismuth	Bismuth
Bitumens	Bitumens
Bombiats	Salts formed by the union of the bombic acid with different bases. This genus of salt had no appellation in the ancient nomenclature.
Bombiat of alumine	
Bombiat of ammoniac	
[p. 116] Bombiat of antimony	
Bombiat of arsenic	
Bombiat of barytes	
Bombiat of bismuth	
Bombiat of cobalt	
Bombiat of copper	
Bombiat of gold	
Bombiat of lead	
Bombiat of iron	
Bombiat of lime	
Bombiat of magnesia	
Bombiat of manganese	
Bombiat of mercury	
Bombiat of molybden	
Bombiat of nickel	

Bombiat of platina	
Bombiat of potash	
[p. 117] Bombiat of silver	
Bombiat of soda	
Bombiat of tin	
Bombiat of tunstein	
Bombiat of zink	
Borat	Borax
Borat aluminous	Argillous borax
Borat ammoniacal	Ammoniacal borax Sedative sal ammoniac
Borat of antimony	
Borat of arsenic	
Borat of barytes	
Borat of bismuth	
Borat of cobalt	
Borat of copper	
Borat of gold	
Borat of iron	
Borat of lead	
[p. 118] Borat of lime	
Borat of magnesia	Magnesian borax
Borat of manganese	
Borat of mercury	Mercurial borax Mercurial sedative salt
Borat of molybden	
Borat of nickel	
Borat of platina	
Borat of potash	Vegetable borax
Borat of silver	
Borat of soda	Common borax saturated with boracic acid
Borat of tin	
Borat of tunstein	
Borat of zink	Borax of zink
Borax of soda, or Borat sursaturated with soda	Rough borax Tinckal Crysocolla Borax of commerce Sub-boraxated mineral alkali

[p. 119]

C

New Names	Ancient Names
Caloric	Latent heat Fixed heat Matter of heat
Camphor	Camphor
Camphorat	Salts [sic: plural --CJG]formed by the union of the camphoric acid with different bases. These salts were unknown to former chymists, and have no names in the ancient nomenclature.
Camphorat of alumine	
Camphorat of ammoniac	
Camphorat of antimony	
Camphorat of arsenic	
Camphorat of barytes	
Camphorat of bismuth	
Camphorat of cobalt	

Camphorat of copper	
Camphorat of gold	
[p. 120] Camphorat of iron	
Camphorat of lead	
Camphorat of lime	
Camphorat of magnesia	
Camphorat of manganese	
Camphorat of mercury	
Camphorat of molybden	
Camphorat of nickel	
Camphorat of platina	
Camphorat of potash	
Camphorat of silver	
Camphorat of soda	
Camphorat of tin	
Camphorat of tunstein	
Camphorat of zink	
Carbon	Pure charcoal
Carbonats	Salts formed by the union of the carbonic acid with bases
[p. 121] Carbonat of alumine	Cretaceous argil
Carbonat of ammoniac	Concrete volatile alkali Ammoniacal chalk
Carbonat of antimony	
Carbonat of arsenic	
Carbonat of barytes	
Carbonat of bismuth	
Carbonat of cobalt	
Carbonat of copper	
Carbonat of gold	
Carbonat of iron	Apperative saffron of mars Rust of iron Aerated iron Martial chalk Mephiticated iron
Carbonat of lead	Chalk of lead Spathic lead
Carbonat of lime	Chalk Lime-stone Aerated calcareous earth Calcareous spar Cream of lime Magnesian earth Magnesia alba, of the shops Bergman's aerated magnesia Cretaceous magnesia
[p. 122] Carbonat of magnesia	Magnesian chalk Kirwan's muriatic earth Count de Palma's, and Sentinelli's powder
Carbonat of manganese	
Carbonat of mercury	
Carbonat of molybden	
Carbonat of nickel	
Carbonat of platina	
Carbonat of potash	Salt of tartar Vegetable fixed alkali Salt of worm-wood Aerated vegetable fixed alkali Cretaceous tartar Mephiticated tartar Nitre fixed by itself Van Helmont's alkahest

Carbonat of silver	
Carbonat of soda	Natrum or natron Base of marine salt Marine or mineral alkali Crystals of soda Cretaceous soda Aerated soda Effervescing soda Mephiticated soda, &c
Carbonat of tin	
[p. 123] Carbonat of tunstein	
Carbonat of zink	Chalk of zink Aerated zink
Carburet of iron	Plumbago
Citrats	Salts formed by the union of the acid of lemons with different bases. This genus of salt had no name in the ancient nomenclature.
Citrat of alumine	
Citrat of ammoniac	
Citrat of antimony	
Citrat of arsenic	
Citrat of barytes	
Citrat of bismuth	
Citrat of cobalt	
Citrat of copper	
Citrat of gold	
Citrat of iron	
Citrat of lead	
[p. 124] Citrat of lime	
Citrat of magnesia	
Citrat of manganese	
Citrat of mercury	
Citrat of molybden	
Citrat of nickel	
Citrat of platina	
Citrat of potash	
Citrat of silver	
Citrat of soda	
Citrat of tin	
Citrat of tunstein	
Citrat of zink	
Cobalt	Regulus of cobalt Cobalt
Copper	Copper Venus

[p. 125]

D

New Names	Ancient Names
Diamond	Diamond

E

New Names	Ancient Names
Ether acetic	Acetous ether or aether
Ether muriatic	Marine ether
Ether nitric	Nitrous ether
Ether sulphuric	Vitriolic ether

Extract	Extract

F

New Names	Ancient Names
Fecula	Fecula of vegetables
Fluats	Salts formed by the fluoric acid, combined with different bases
Fluat of alumine	Argillous fluor Spathic argile
Fluat of ammoniac	Spathic sal ammoniac Ammoniacal fluor
Fluat of antimony	
Fluat of arsenic	
[p. 126] Fluat of barytes	Ponderous fluor Barytic fluor
Fluat of bismuth	
Fluat of cobalt	
Fluat of copper	
Fluat of gold	
Fluat of iron	
Fluat of lead	
Fluat of lime	Fluor spar Vitreous spar Cubic spar Phosphoric spar Spathic fluor
Fluat of magnesia	Fluorated magnesia Spathic magnesia Magnesian fluor
Fluat of manganese	
Fluat of mercury	
Fluat of molybden	
Fluat of nickel	
Fluat of platina	
Fluat of potash	Tartareous fluor Spathic tartar
[p. 127] Fluat of silver	
Fluat of soda	Fluor of soda Spathic soda
Fluat of tin	
Fluat of tunstein	
Fluat of zink	
Formiats	Salts produced by the union of the formic acid with different bases. This genus of salt was without a name in the ancient nomenclature.
Formiat of alumine	
Formiat of ammoniac	
Formiat of antimony	
Formiat of arsenic	
Formiat of barytes	
Formiat of bismuth	
Formiat of cobalt	
Formiat of copper	
Formiat of gold	
[p. 128] Formiat of iron	
Formiat of lead	
Formiat of lime	
Formiat of magnesia	
Formiat of manganese	

Formiat of mercury	
Formiat of molybden	
Formiat of nickel	
Formiat of platina	
Formiat of silver	
Formiat of soda	
Formiat of tin	
Formiat of tunstein	
Formiat of zink	

G

New Names	Ancient Names
Gas	Gas Elastic fluid Aeriform fluid
[p. 129] Gas, acetous acid	Acetous acid gas
Gas ammoniacal	Alkaline gas, of Dr. Priestley Alkaline air Volatile alkali gas
Gas azotic	Vitiated air Impure air Phlogisticated air Phlogisticated gas Atmospherical mophets
Gas, carbonic acid	Fixed air, of Dr. Black Hale's solid air Cretaceous acid gas Mephitic gas
Gas, carbonated hydrogen	Inflammable gas with charcoal
Gas, fluoric acid	Spathic acid gas of Dr. Priestley Fluoric acid gas
Gas hydrogen	Inflammable air Inflammable gas Kirwan's phlogiston
Gas hydrogen of marshes	Mophetized inflammable gas Inflammable air of marshes
Gas muriatic acid	Marine air or gas of Dr. Priestley Muriatic acid gas
Gas nitrous	Nitrous gas, of Hales and Dr. Priestley
Gas, nitrous acid	Nitrous acid gas
Oxygen gas	Vital air Pure air Dephlogisticated air, of Dr. Priestley
[p. 130] Gas, oxygenated muriatic acid	Aerated muriated acid gas Dephlogisticated marine acid, of Scheele
Gas Prussic acid	Gas of Prussian blue
Gas, phosphorized hydrogen	Phosphoric gas, of Mr. Gengembre
Gas, sulphurated hydrogen	Hepatic gas, of Bergman Sulphur-caline air
Gas, sulphureous acid	Sulphureous acid gas Vitriolic acid air, of Dr. Priestley
Gluten	Glutenous matter of flower
Gold	Gold

I

New Names	Ancient Names
Iron	Iron Mars

L

New Names	Ancient Names
Lactats	Salts formed by the union of the acid of flour whey or lactic acid, with different bases. These salts were unknown before Scheele, and without names until the present time. Their properties have as yet been very little examined.
[p. 131] Lactat of alumine	
Lactat of ammoniac	
Lactat of antimony	
Lactat of arsenic	
Lactat of barytes	
Lactat of bismuth	
Lactat of cobalt	
Lactat of copper	
Lactat of gold	
Lactat of iron	
Lactat of lead	
Lactat of lime	
Lactat of magnesia	
Lactat of manganese	
Lactat of mercury	
Lactat of molybden	
Lactat of nickel	
[p. 132] Lactat of platina	
Lactat of potash	
Lactat of silver	
Lactat of soda	
Lactat of tin	
Lactat of tunstein	
Lactat of zink	
Lead	Lead Saturn
Light	Light
Lime or calcareous earth	Calcareous earth Quick-lime
Lithiats	Salts formed by the combination of the lithic acid, or acid of the stone sometimes generated in the human bladder, with different bases. This genus of salts had no name in the ancient nomenclature, because it was not known before the time of Scheele.
Lithiat of alumine	
Lithiat of ammoniac	
[p. 133] Lithiat of antimony	
Lithiat of arsenic	
Lithiat of barytes	
Lithiat of bismuth	
Lithiat of cobalt	
Lithiat of copper	
Lithiat of gold	
Lithiat of iron	
Lithiat of lead	
Lithiat of lime	
Lithiat of magnesia	
Lithiat of manganese	
Lithiat of mercury	
Lithiat of molybden	
Lithiat of nickel	
Lithiat of platina	
Lithiat of potash	

[p. 134] Lithiat of silver	
Lithiat of soda	
Lithiat of tin	
Lithiat of tunstein	
Lithiat of zink	

M

New Names	Ancient Names
Malats	Salts formed by the union of the malic acid, or acid of apples with different bases. This genus of salts has been without a name in the ancient nomenclature.
Malat of alumine	
Malat of ammoniac	
Malat of antimony	
Malat of arsenic	
Malat of barytes	
Malat of bismuth	
Malat of cobalt	
[p. 135] Malat of copper	
Malat of gold	
Malat of lead	
Malat of lime	
Malat of iron	
Malat of magnesia	
Malat of manganese	
Malat of mercury	
Malat of molybden	
Malat of nickel	
Malat of platina	
Malat of potash	
Malat of silver	
Malat of soda	
Malat of tin	
Malat of tunstein	
Malat of zink	
[p. 136] Manganese	Regulus of manganese
Mercury	Mercury Quick-silver
Molybdats	Salts formed by the union of the molybdic acid with different bases. This genus of salts was without a name in the ancient nomenclature.
Molybdat of alumine	
Molybdat of ammoniac	
Molybdat of antimony	
Molybdat of arsenic	
Molybdat of barytes	
Molybdat of bismuth	
Molybdat of cobalt	
Molybdat of copper	
Molybdat of gold	
Molybdat of iron	
Molybdat of lead	
Molybdat of lime	
[p. 137] Molybdat of magnesia	
Molybdat of manganese	

Molybdat of mercury	
Molybdat of molybden	
Molybdat of nickel	
Molybdat of platina	
Molybdat of potash	
Molybdat of silver	
Molybdat of soda	
Molybdat of tin	
Molybdat of tunstein	
Molybdat of zink	
Molybden	Regulus of molybden
Mucus	Mucilage
Muriats	Salts formed by the union of the muriatic acid with different bases
Muriat of alumine	Marine alum Argillous marine salt
Muriat of ammoniac	Sal ammoniac Salmiac
Muriat of antimony	Muriated antimony
[p. 138] Muriat of arsenic	
Muriat of arsenic, sublimated	Butter of arsenic
Muriat of barytes	Barytic marine salt
Muriat of bismuth	Muriated bismuth
Muriat of bismuth sublimated	Butter of bismuth
Muriat of cobalt	Sympathetic ink
Muriat of copper	Muriated copper
Muriat of copper, sublimated ammoniacal	Cupreous ammoniacal flowers
Muriat of gold	Regaline salt of gold Muriated gold
Muriat of iron	Muriated iron Marine salt of iron
Muriat of lead	Muriated lead Plumbum corneum
Muriat of iron sublimated ammoniacal	Martial ammoniacal flowers
Muriat of lime	Mother ley of sea-salt Calcareous marine salt Fixed sal ammoniac
Muriat of magnesia	Marine salt having magnesia for basis
Muriat of manganese	Muriated manganese
[p. 139] Muriat of mercury, corrosive	Corrosive sublimate Super-muriated mercury
Muriat of mercury, mild	Mercurius dulcis Sub-muriated mercury
Muriat of mercury sublimated mild	Sweet mercury sublimate Aquila alba
Muriat of mercury and ammoniac	Salt of alembroth
Muriat of mercury by precipitation	Salt of wisdom White precipitated muriated mercury
Muriat of molybden	
Muriat of nickel	
Muriat of platina	Muriated platina Regaline salt of platina
Muriat of potash	Sylvius's febrifuge salt Regenerated sea-salt
Muriat of silver	Luna cornea
Muriat of soda	Sea-salt
Muriat of soda, fossile	Salined fossile alkali
Muriat of tin	Salt of Jupiter
Muriat of tin, concrete	Solid butter of tin, of Mr. Beaume
[p. 140]	Libavius's smoking liquor

Muriat of tin, smoking	
Muriat of tin sublimated	Butter of tin
Muriat of tunstein	
Muriat of zink	Marine salt of zink Muriated zink
Muriat of zink sublimated	Butter of zink
Muriats oxygenated	(New combinations of the oxygenated muriatic acid with potash and soda, discovered by Mr. Bertholet.)
Muriat of potash, oxygenated	
Muriat of soda, oxygenated	

N

New Names	Ancient Names
Nitrats	Salts formed by the union of the nitric acid with different bases
Nitrat of alumine	Nitrous alum Argilaceous earth
Nitrat of ammoniac	Nitrous sal ammoniac Ammoniacal nitre
Nitrat of antimony	
Nitrat of arsenic	Nitre of arsenic
Nitrat of barytes	Nitrated barytes Nitre of heavy earth
[p. 141] Nitrat of bismuth	Nitre of bismuth
Nitrat of cobalt	Nitre of cobalt
Nitrat of copper	Nitre of copper
Nitrat of gold	
Nitrat of iron	Nitre of iron Martial nitre
Nitrat of lead	Nitre of lead Nitre of saturn
Nitrat of lime	Calcareous nitre Mother ley of nitre
Nitrat of magnesia	Nitre of magnesia Magnesian nitre
Nitrat of manganese	Nitre of manganese Nitrated manganese
Nitrat of mercury	Nitre of mercury Mercurial nitre
Nitrat of mercury in dissolution	Solution of mercury
Nitrat of molybden	
Nitrat of nickel	Nitrated nickel Nitre of nickel
Nitrat of platina	
Nitrat of potash, or nitre	Nitre, salt-petre Sal prunel Nitrated vegetable alkali
Nitrat of silver	Nitre of silver Lunar crystals
[p. 142] Nitrat of silver, molten	Lunar caustic
Nitrat of soda	Cubic nitre Rhomboidal nitre
Nitrat of tin	Nitre of tin Stanno-nitrous salt
Nitrat of tunstein	
Nitrat of zink	Nitre of zink
Nitrites	Salts formed by the combination of *nitrous* acid[2] with different bases. This genus of salt had no name in the ancient nomenclature, and was not known before the late discoveries.
Nitrite of alumine	
Nitrite of ammoniac	

Nitrite of antimony	
Nitrite of arsenic	
Nitrite of barytes	
Nitrite of bismuth	
Nitrite of cobalt	
[p. 143] Nitrite of copper	
Nitrite of gold	
Nitrite of iron	
Nitrite of lead	
Nitrite of lime	
Nitrite of magnesia	
Nitrite of manganese	
Nitrite of mercury	
Nitrite of molybden	
Nitrite of nickel	
Nitrite of platina	
Nitrite of potash	
Nitrite of silver	
Nitrite of soda	
Nitrite of tin	
Nitrite of tunstein	
Nitrite of zink	

[p. 144]

O

New Names	Ancient Names
Oxalats	Salts formed by the combination of the oxalic acid with different bases. The greater number of these salts have not been named in the old nomenclature.
Oxalat acidulous of ammoniac	
Oxalat acidulous of potash	Common salt of sorrel
Oxalat acidulous of soda	
Oxalat of alumine	
Oxalat of ammoniac	
Oxalat of antimony	
Oxalat of arsenic	
Oxalat of barytes	
Oxalat of bismuth	
Oxalat of cobalt	
Oxalat of copper	
Oxalat of gold	
[p. 145] Oxalat of iron	
Oxalat of lead	
Oxalat of lime	
Oxalat of magnesia	
Oxalat of manganese	
Oxalat of mercury	
Oxalat of molybden	
Oxalat of nickel	
Oxalat of platina	
Oxalat of potash	
Oxalat of silver	
Oxalat of soda	
Oxalat of tin	
Oxalat of tunstein	

Oxalat of zink	
Oxyd arsenical of potash	Liver of arsenic
Oxyd white of arsenic	White arsenic Calx of arsenic
[p. 146] Oxyd of antimony by the muriatic acid and nitric acid	Mineral bezoar
Oxyd of antimony, white, by nitre	Diaphoretic antimony Cerusse of antimony Kerkringius's pearly matter
Oxyd of antimony white sublimated	Snow of antimony Flowers of antimony Argentine flowers of regulus of antimony
Oxyd of antimony by the muriatic acid	Powder of algaroth
Oxyd of antimony sulphurated	Liver of antimony
Oxyd of antimony sulphurated semi-vitreous	Crocus metallorum
Oxyd of antimony sulphurated orange-colored	Dealcalised sulphur-caline antimony Golden sulphur of antimony Precipitated sulphur of antimony
Oxyd of antimony, red sulphurated	Kermes mineral Sulphur-caline antimony
Oxyd of antimony sulphurated vitreous	Glass of antimony
[p. 147] Oxyd of antimony, brown vitreous sulphurated	
Oxyd of arsenic, white sublimated	Flowers of arsenic
Oxyd of arsenic, yellow sulphurated	Orpiment
Oxyd of arsenic, red sulphurated	Red arsenic Realgar
Oxyd of bismuth, white, by the nitric acid	Magistery of bismuth Spanish white
Oxyd of bismuth sublimated	Flowers of bismuth
Oxyd of cobalt, grey, with silice	
Oxyd of cobalt, vitreous	Azure Smalt
Oxyd of copper, green	Verdigris Rust of copper
Oxyd of gold, ammoniacal	Aurum fulminans
Oxyd of gold by tin	Precipitate of gold by tin Cassius's purple
[p. 148] Oxyds of iron	Saffrons of mars
Oxyd of iron, brown	Astringent saffron of mars
Oxyd of iron, yellow	Ochre
Oxyd of iron, black	AEthiops of iron
Oxyd of iron, red	Colcothar of vitriol
Oxyds of lead	Calces of lead
Oxyd of lead, white, by the acetous acid	White lead
Oxyd of lead, semi-vitreous; or litharge	Litharge
Oxyd of lead, yellow	Massicot
Oxyd of lead, red; or minium	Minium Red lead
Oxyd of manganese, white	White calx of manganese
Oxyd of manganese, black	Black magnesia
Oxyd of mercury, yellow; by the nitric acid	Nitrous turbith
Oxyd of mercury, yellow; by the sulphuric acid	Turbith mineral Yellow precipitate
[p. 149] Oxyd of mercury, blackish	AEthiops *per se*
Oxyd of mercury, red; by the nitric acid	Red precipitate
Oxyd of mercury, red; by fire	Mercurius precipitatus *per se*
Oxyd of mercury, sulphurated black	AEthiops mineral
Oxyd of mercury, sulphurated red	Cinnabar

Oxyd of tin, grey	
Oxyd of tin, sublimated	Flowers of tin
Oxyd of zink sublimated	Flowers of zink Pompholix
Oxyds metallic	Calces of metals
Oxyds, sublimated metallic	Metallic flowers
Oxygen	Oxygen Basis of vital air Acidifying principle Empyreal principle Sorbile principle

[p. 150]

P

New Names	Ancient Names
Phosphats	Salts formed by the union of the phosphoric acid with different bases
Phosphat of alumine	
Phosphat of ammoniac	Phosphorical ammoniac Ammoniacal phosphate
Phosphat of antimony	
Phosphat of arsenic	
Phosphat of barytes	
Phosphat of bismuth	
Phosphat of cobalt	
Phosphat of copper	
Phosphat of gold	
Phosphat of iron	Syderite Marsh iron ore
Phosphat of lead	
Phosphat of lime	Earth of bones Animal earth
Phosphat of magnesia	Phosphate of magnesia
Phosphat of manganese	
[p. 151] Phosphat of mercury	Rosy precipitate of mercury
Phosphat of molybden	
Phosphat of nickel	
Phosphat of platina	
Phosphat of potash	
Phosphat of silver	
Phosphat of soda	
Phosphat of soda and ammoniac	Native salt of urine Fusible salts of urine
Phosphat sursaturated with soda	Wonderful pearly salt
Phosphat of tin	
Phosphat of tunstein	
Phosphat of zink	
Phosphites	Salts formed by the combination of the phosphorous acid with different bases
Phosphite of alumine	
Phosphite of ammoniac	
[p. 152] Phosphite of antimony	
Phosphite of arsenic	
Phosphite of barytes	
Phosphite of bismuth	
Phosphite of cobalt	
Phosphite of copper	
Phosphite of gold	

Phosphite of iron	
Phosphite of lead	
Phosphite of lime	
Phosphite of magnesia	
Phosphite of manganese	
Phosphite of mercury	
Phosphite of molybden	
Phosphite of nickel	
Phosphite of platina	
Phosphite of potash	
[p. 153] Phosphite of silver	
Phosphite of soda	
Phosphite of tin	
Phosphite of tunstein	
Phosphite of zink	
Phosphorus	Phosphorus of Kunkel
Phosphuret	Combination of phosphorus not oxygenated, with different bases
Phosphuret of copper	
Phosphuret of iron	Syderum, of Bergman Syderotete of Mr. de Morveau Regulus of syderite
Pyro-lignites	Salts formed by the union of the pyro-lignic acid with different bases. These salts had no names in the ancient nomenclature.
Pyrolignite of alumine	
Pyrolignite of ammoniac	
Pyrolignite of antimony	
Pyrolignite of arsenic	
[p. 154] Pyrolignite of barytes	
Pyrolignite of bismuth	
Pyrolignite of cobalt	
Pyrolignite of copper	
Pyrolignite of gold	
Pyrolignite of iron	
Pyrolignite of lead	
Pyrolignite of lime	
Pyrolignite of magnesia	
Pyrolignite of manganese	
Pyrolignite of mercury	
Pyrolignite of molybden	
Pyrolignite of nickel	
Pyrolignite of platina	
Pyrolignite of potash	
Pyrolignite of silver	
Pyrolignite of soda	
[p. 155] Pyrolignite of tin	
Pyrolignite of tunstein	
Pyrolignite of zink	
Pyromucites	Salts formed by the union of the pyro-mucic acid with different bases. This genus of salts had no name in the old nomenclature.
Pyromucite of alumine	
Pyromucite of ammoniac	
Pyromucite of antimony	
Pyromucite of arsenic	
Pyromucite of barytes	

Pyromucite of bismuth	
Pyromucite of cobalt	
Pyromucite of copper	
Pyromucite of gold	
Pyromucite of iron	
Pyromucite of lead	
[p. 156] Pyromucite of lime	
Pyromucite of magnesia	
Pyromucite of manganese	
Pyromucite of mercury	
Pyromucite of molybden	
Pyromucite of nickel	
Pyromucite of platina	
Pyromucite of potash	
Pyromucite of silver	
Pyromucite of soda	
Pyromucite of tin	
Pyromucite of tunstein	
Pyromucite of zink	
Pyrotartrites	Salts formed by the union of the pyrotartareous acid with different bases
Pyrotartrite of alumine	
Pyrotartrite of ammoniac	
[p. 157] Pyrotartrite of antimony	
Pyrotartrite of arsenic	
Pyrotartrite of barytes	
Pyrotartrite of bismuth	
Pyrotartrite of cobalt	
Pyrotartrite of copper	
Pyrotartrite of gold	
Pyrotartrite of iron	
Pyrotartrite of lead	
Pyrotartrite of lime	
Pyrotartrite of magnesia	
Pyrotartrite of manganese	
Pyrotartrite of mercury	
Pyrotartrite of molybden	
Pyrotartrite of nickel	
Pyrotartrite of platina	
Pyrotartrite of potash	
[p. 158] Pyrotartrite of silver	
Pyrotartrite of soda	
Pyrotartrite of tin	
Pyrotartrite of tunstein	
Pyrotartrite of zink	
Platina	Juan blanca Platina White gold Platina del pinto
Potash	Caustic vegetable fixed alkali
Potash molten	Common caustic, Potential cautery Infernal or septic stone
Potash, siliciated; in liquidity	
Prussiats	Salts formed by the union of the prussic acid, or coloring matter of Prussian blue, with different bases. This genus of salts had no name in the old nomenclature.
Prussiat of alumine	

Prussiat of ammoniac	
Prussiat of antimony	
[p. 159] Prussiat of silver [sic; should be arsenic--CJG] Prussiat of barytes	
Prussiat of bismuth	
Prussiat of cobalt	
Prussiat of copper	
Prussiat of gold	
Prussiat of iron	Prussian blue Berlin blue
Prussiat of lead	
Prussiat of lime	Calcareous prussiate Lime-water of Prussian blue
Prussiat of magnesia	
Prussiat of manganese	
Prussiat of mercury	
Prussiat of molybden	
Prussiat of nickel	
Prussiat of platina	
Prussiat of potash	Liquor saturated with the coloring matter of Prussian blue
[p. 160] Prussiat of potash, saturated ferruginous	Prussian alkali
Prussiat of potash ferruginous not saturated	Phlogisticated alkali
Prussiat of silver	
Prussiat of soda	
Prussiat of tin	
Prussiat of tunstein	
Prussiat of zink	
Pyrophore of Homburg	Pyrophore of Homburg

R

New Names	Ancient Names
Resins	Resins

S

New Names	Ancient Names
Saccholats	Salts formed by the combination of the saccho-lactic acid with different bases. This genus of salts had no name in the ancient nomenclature.
Saccholat of alumine	
Saccholat of ammoniac	
[p. 161] Saccholat of antimony	
Saccholat of arsenic	
Saccholat of barytes	
Saccholat of bismuth	
Saccholat of cobalt	
Saccholat of copper	
Saccholat of gold	
Saccholat of iron	
Saccholat of lead	
Saccholat of lime	
Saccholat of magnesia	
Saccholat of manganese	

Saccholat of mercury	
Saccholat of molybden	
Saccholat of nickel	
Saccholat of platina	
Saccholat of potash	
[p. 162] Saccholat of silver	
Saccholat of soda	
Saccholat of tin	
Saccholat of tunstein	
Saccholat of zink	
Saponuls	Combinations of the volatile or essential oils with different bases
Saponuls acid	Combinations of the volatile or essential oils with the different acids
Saponuls metallic	Soaps composed of the essential oils united to metallic substances
Saponul of alumine	Soap made of essential oil united to the basis of alum
Saponul ammoniacal	Soap made of essential oil united to the volatile alkali
Saponul of barytes	Soap made of essential oil united to barytes
Saponul of lime	Soap made of essential oil united to lime
Saponul of potash	Soap made of essential oil united to vegetable fixed alkali, or *Starkey's soap*
Saponul of sodae	Soap made of essential oil united to mineral fixed alkali
[p. 163] Sebats	Salts formed by the combination of the acid of fat with different bases. These salts had no names in the ancient nomenclature.
Sebat of alumine	
Sebat of ammoniac	
Sebat of antimony	
Sebat of arsenic	
Sebat of barytes	
Sebat of bismuth	
Sebat of cobalt	
Sebat of copper	
Sebat of gold	
Sebat of iron	
Sebat of lead	
Sebat of lime	
Sebat of magnesia	
Sebat of manganese	
[p. 164] Sebat of mercury	
Sebat of molybden	
Sebat of nickel	
Sebat of platina	
Sebat of potash	
Sebat of silver	
Sebat of soda	
Sebat of tin	
Sebat of tunstein	
Sebat of zink	
Silice, or siliceous earth	Siliceous earth
Soda	Caustic soda Marine alkali Mineral alkali
Soaps	Combinations of unctuous, or fixed oils, with different bases
Soaps acid	Combinations of unctuous, or fixed oils, with different acids
Soaps metallic	Combinations of unctuous, or fixed oils, with metallic substances
[p. 165] Soap of alumine	Soap composed of unctuous oil united to the basis of alum
Soap of ammoniac, or ammoniacal	Soap composed of unctuous oil united to volatile alkali

Soap of barytes	Soap composed of unctuous oil united to barytes
Soap of lime	Soap composed of unctuous oil united to lime
Soap of magnesia	Soap composed of unctuous oil united to magnesia
Soap of potash	Soap composed of unctuous oil united to vegetable fixed alkali
Soap of soda	Soap composed of unctuous oil united to mineral fixed alkali
Succinats	Salts formed by the combination of the acid of amber or succinic acid with different bases
Succinat of alumine	
Succinat of ammoniac	
Succinat of antimony	
Succinat of arsenic	
Succinat of barytes	
Succinat of bismuth	
[p. 166] Succinat of cobalt	
Succinat of copper	
Succinat of gold	
Succinat of iron	
Succinat of lead	
Succinat of lime	
Succinat of magnesia	
Succinat of manganese	
Succinat of mercury	
Succinat of molybden	
Succinat of nickel	
Succinat of platina	
Succinat of potash	
Succinat of silver	
Succinat of soda	
Succinat of tin	
Succinat of tunstein	
[p. 167] Succinat of zink	
Succinum, or amber	Yellow amber
Sugar	Sugar
Sugar crystallized	Sugar candied
Sugar of milk	Sugar of milk Salt of milk
Sulphats	Salts formed by the combination of the sulphuric acid with different bases
Sulphat of alumine	Alum Super-vitriolated clay
Sulphat of ammoniac	Glauber's secret ammoniacal salt Ammoniacal vitriol
Sulphat of antimony	Vitriol of antimony
Sulphat of arsenic	Vitriol of arsenic
Sulphat of barytes	Ponderous spar Baroselenite
Sulphat of bismuth	Vitriol of bismuth
Sulphat of cobalt	Vitriol of cobalt
Sulphat of copper	Roman vitriol. Blue stone. Super-vitriolated copper
Sulphat of iron	Green copperas Salt of steel Super-vitriolated iron
Sulphat of gold	
[p. 168] Sulphat of lead	Vitriol of lead
Sulphat of lime	Vitriolated lime Selenite Gypsum

	Plaster of Paris
Sulphat of magnesia	Vitriolated magnesia Bitter purging salt Sedlitz salt Epsom salt Seydschutz salt
Sulphat of manganese	Vitriol of manganese
Sulphat of mercury	Super-vitriolated mercury Vitriol of mercury
Sulphat of molybden	
Sulphat of nickel	
Sulphat of platina	
Sulphat of potash	Vitriolated vegetable alkali Sal enixum de duobus Vitriolated tartar Arcanum duplicatum Glaser's sal polychrest Vitriol of potash
Sulphat of silver	Vitriol of silver
Sulphat of soda	Glauber's salt Vitriol of soda
Sulphat of tin	Vitriol of tin
Sulphat of tunstein	
[p. 169] Sulphat of zink	White vitriol or copperas Vitriol of zink Vitriol of Goslar
Sulphites	Salts formed by the combination of the sulphureous acid with different bases
Sulphite of alumine	
Sulphite of ammoniac	
Sulphite of antimony	
Sulphite of arsenic	
Sulphite of barytes	
Sulphite of bismuth	
Sulphite of cobalt	
Sulphite of copper	
Sulphite of gold	
Sulphite of iron	
Sulphite of lead	
Sulphite of lime	
Sulphite of magnesia	
Sulphite of manganese	
[p. 170] Sulphite of mercury	
Sulphite of molybden	
Sulphite of nickel	
Sulphite of platina	
Sulphite of potash	Stahl's sulphureous salt
Sulphite of silver	
Sulphite of soda	
Sulphite of tin	
Sulphite of tunstein	
Sulphite of zink	
Sulphur	Sulphur
Sulphur sublimated	Flowers of sulphur
Sulphurets alkaline	Alkaline livers of sulphur Alkaline hepars. Sulphur-calies
Sulphurets earthy	Earthy livers of sulphur Earthy hepars
Sulphurets	Combinations of sulphur with the metals
Sulphuret of alumine	

Sulphuret of ammoniac	Boyle's smoking liquor Volatile alkaline liver of sulphur
[p. 171] Sulphuret of antimony	Antimony
Sulphuret of antimony, native	Ore of antimony
Sulphuret of barytes	Liver of sulphur of barytes
Sulphuret of bismuth	
Sulphuret of cobalt	
Sulphuret of copper	Pyrites of copper
Sulphuret of gold	
Sulphuret of iron	Martial pyrites
Sulphuret of fixed oil	Balsom of sulphur
Sulphuret of volatile oil	Balsom of sulphur
Sulphuret of lead	
Sulphuret of magnesia	Magnesian liver of sulphur
Sulphuret of manganese	
Sulphuret of mercury	
Sulphuret of molybden	
Sulphuret of nickel	
Sulphuret of platina	
[p. 172] Sulphuret of potash	Liver of sulphur having for basis the vegetable alkali
Sulphuret of potash antimoniated	Antimoniated liver of sulphur
Sulphuret of silver	Blanckmal
Sulphuret of soda	Liver of sulphur having for basis the mineral alkali
Sulphuret of soda antimoniated	Antimoniated liver of sulphur
Sulphuret of tin	
Sulphuret of tunstein	
Sulphuret of zink	Blende or factitious galena

T

New Names	Ancient Names
Tartar	Crude tartar
Tartrites	Salts formed by the combination of the tartareous acid with different bases
Tartrite acidulous of potash	Tartar. Supertartarised vegetable alkali Cream of tartar Crystals of tartar
Tartrite of alumine	
Tartrite of ammoniac	Ammoniacal tartar
[p. 173] Tartrite of antimony	
Tartrite of arsenic	
Tartrite of barytes	
Tartrite of bismuth	
Tartrite of cobalt	
Tartrite of copper	
Tartrite of gold	
Tartrite of iron	
Tartrite of lime	Calcareous tartar
Tartrite of lead	Saturnine tartar
Tartrite of magnesia	
Tartrite of manganese	
Tartrite of mercury	
Tartrite of molybden	
Tartrite of nickel	
Tartrite of platina	

[p. 174] Tartrite of potash	Tartarised tartar Soluble tartar Vegetable salt
Tartrite of potash antimoniated	Emetic tartar Antimoniated tartar
Tartrite of potash, ferruginous	Chalybiated tartar Soluble martial tartar
Tartrite of potash surcompounded with antimony	Tartarised tartar containing antimony
Tartrite of silver	
Tartrite of soda	Rochelle salt Seignette's polychrest salt Tartarised soda
Tartrite of tin	
Tartrite of tunstein	
Tartrite of zink	
Tin	Tin Jupiter
Tunstats	Salts formed by the combination of the tunstic acid, with different bases. These salts had no name in the ancient nomenclature.
Tunstat of alumine	
Tunstat of ammoniac	
Tunstat of antimony	
[p. 175] Tunstat of arsenic	
Tunstat of barytes	
Tunstat of bismuth	
Tunstat of cobalt	
Tunstat of copper	
Tunstat of gold	
Tunstat of iron	
Tunstat of lead	
Tunstat of lime	
Tunstat of magnesia	
Tunstat of manganese	
Tunstat of mercury	
Tunstat of molybden	
Tunstat of nickel	
Tunstat of platina	
Tunstat of potash	
Tunstat of silver	
[p. 176] Tunstat of soda	
Tunstat of tin	
Tunstat of tunstein	
Tunstat of zink	

W

New Names	Ancient Names
Water	Water
Water, lime	Lime water
Water distilled	Distilled water
Waters impregnated with the carbonic acid	Acidulated waters Gazeous waters
Waters sulphurated	Hepatic waters

Z

New Names	Ancient Names

Zink	Zink

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[1] These two manners of expressing the basis of a neutral salt will not again be repeated; but the one or the other shall without distinction be used. These first examples are sufficient to shew that either the substantive of the adjective may be used with equal propriety.
The same observation agrees also with the Latin nomenclature. [original note]

[2] That is to say, by an acid of nitre containing less oxygen than that which we have denominated *nitric* acid, and which form the *nitrats*. [original note]

Transcriber's note

The *Method of Chymical Nomenclature* contains several memoirs describing and tables illustrating the new nomenclature of the "Chemical Revolution". The selection presented here featured the largest of those tables, a list in alphabetical order (roughly) by terms of the (translated) new nomenclature. The dictionary included new nomenclature terms in both the vernacular (originally French, but English in this translation) *and* in Latin; however, this selection omits the Latin.

This dictionary was laid out to facilitate looking up a term in the new nomenclature and having it defined in terms of an older name. Now it is the "new" nomenclature that is familiar and the "ancient" nomenclature that is strange, and therefore more likely to be looked upthis can be done using the search or find command on your browser.

Finally, note that the "new" nomenclature is similar, but not identical, to the familiar modern binary ionic nomenclature in which -ic and -ous denote higher and lower oxidation states of cations, and -ate and -ite higher and lower degrees of oxidation of anions. In English, in the modern binary nomenclature, the cation precedes the anion; in this version, the opposite order holds. The orthography of the translator, St. John, is preserved in this selection: -at rather than the modern -ate (*e.g.*, in "acetat"). Finally, note that the *Method of Chymical Nomenclature* represents an important advance, but it was not always correct; see, for example, acetate ("acetat") and acetite, and acetic and acetous acid. --CJG

Jöns Jacob Berzelius (1779-1848)

Essay on the Cause of Chemical Proportions, and on Some Circumstances Relating to Them: Together with a Short and Easy Method of Expressing Them.

Annals of Philosophy **2**, 443-454 (1813), **3**, 51-2, 93-106, 244-255, 353-364 (1814) [from Henry M. Leicester & Herbert S. Klickstein, eds., *A Source Book in Chemistry, 1400-1900* (Cambridge, MA: Harvard, 1952)][1]

III. On the Chemical Signs, and the Method of Employing them to Express Chemical Proportions.

When we endeavour to express chemical proportions, we find the necessity for chemical signs. Chemistry has always possessed them, though hitherto they have been of very little utility. They owed their origin, no doubt, to the mysterious relation supposed by the alchymists, to exist between the metals and the planets, and to the desire which they had of expressing themselves in a manner incomprehensible to the public. The fellow-laborers in the antiphlogistic revolution published new signs founded on a reasonable principle, the object of which was that the signs, like the new names, should be definitions of the composition of the substances, and that they should be more easily written than the names of the substances themselves. But, though we must acknowledge that these signs were very well contrived, and very ingenious, they were of no use; because it is easier to write an abbreviated word than to draw a figure, which has but little analogy with letters, and which, to be legible, must be made of a larger size than our ordinary writing. In proposing new chemical signs, I shall endeavour to avoid the inconveniences which rendered the old ones of little utility. I must observe here that the object of the new signs is not that, like the old ones, they should be employed to label vessels in the laboratory: they are destined solely to facilitate the expression of chemical proportions, and to enable us to indicate, without long periphrases, the relative number of volumes of the different constituents contained in each compound body. By determining the weight of the elementary volumes, these figures will enable us to express the numeric result of an analysis as simply, and in a manner as easily remembered, as the algebraic formulas in mechanical philosophy.

The chemical signs ought to be letters, for the greater facility of writing, and not to disfigure a printed book. Though this last circumstance may not appear of any great importance, it ought to be avoided whenever it can be done. I shall take, therefore, for the chemical sign, the *initial letter of the Latin name of each elementary substance:* but as several have the same initial letter, I shall distinguish them in the following manner:-- 1. In the class which I call *metalloids*, I shall employ the initial letter only, even when this letter is common to the metalloid and some metal. 2. In the class of metals, I shall distinguish those that have the same initials with another metal, or a metalloid, by writing the first two letters of the word. 3. If the first two letters be common to two metals, I shall, in that case, add to the initial letter the first consonant which they have not in common: for example, S = sulphur, Si = silicium, St = stibium (antimony)[2], Sn = stannum (tin), C = carbonicum, Co = cobaltum (cobalt), Cu = cuprum (copper), O = oxygen, Os = osmium, &c.

The chemical sign expresses always one volume of the substance. When it is necessary to indicate several volumes, it is done by adding the number of volumes: for example, the *oxidum cuprosum* (protoxide of copper) is composed of a volume of oxygen and a volume of metal; therefore its sign is $Cu + O$. The *oxidum cupricum* (peroxide of copper) is composed of 1 volume of metal and 2 volumes of oxygen; therefore its sign is $Cu + 2O$. In like manner, the sign for sulphuric acid is $S + 3O$; for carbonic acid, $C + 2O$; for water $2H + O$, &c.

When we express a compound volume of the first order, we throw away the +, and place the number of volumes above the letter[3]: for example, $CuO + SO^3$ = sulphate of copper, $CuO^2 + 2SO^3$ = persulphate of copper. These formulas have the advantage, that if we take away the oxygen, we see at once the ratio between the combustible radicals. As to the volumes of the second order, it is but rarely of any advantage to express them by formulas as one volume; but if we wish to express them in that way, we may do it by using the parenthesis, as is done in algebraic formulas: for example, alum is composed of 3 volumes of sulphate of aluminia and 1 volume of sulphate of potash. Its symbol is $3(AlO^2 + 2SO^3) + (Po^2 + 2SO^3)$. As to the organic volumes it is at present very uncertain how far figures can be successfully employed to express their composition. We shall have occasion only in the following pages to express the volume of ammonia. It is $6H + N + O$ or H^6NO.

Comparative Table of the Specific Weights of Elementary Bodies[4]

Names	Symbols	Weight in form of gas	Ditto at a minimum	Ditto at a maximum	Sp. gr. in a solid form
Oxygen	O	100.00	...	...	...
Sulphur	S	201.00	200.00	210.00	1.998
Phosphorus	P	167.512	167.3	...	1.714
Muriatic radicle	M	139.56	...	157.7	...
Fluoric radicle	F	60.	...	...	...
Boron	B	73.273	...	...	...
Carbon	C	75.1	73.6	75.9	3.5
Nitric radicle	N	79.54	75.51	...	...
Hydrogen	H	6.636	...	7.63	...
Arsenic	As	839.9	...	852.2	8.81
Molybdenum	Mo	601.56	...	...	8.6
Chromium	Ch	708.045	...	...	5.9 ?
Tungsten	Tn	2424.24	...	...	17.22
Antimony	Sb	1612.96	...	...	6.7
Tellurium	Te	806.48	...	819.	6.115
Columbium	Cl	...	...	...	...
Titanium	Ti	1801.	...	...	...
Zirconium	Zr	...	...	...	...
Silicium	Si	216.66	...	...	...
Osmium	Os	...	...	...	...

Iridium	I	...	...	...	...
Rhodium	Rh	1490.31	...	...	11.
Platinum	Pt	1206.7	...	...	21.65
Gold	Au	2483.8	...	...	19.361
Palladium	Pa	1407.56	...	...	11.871
Silver	Ag	2688.17	...	2718.31	10.51
Mercury	Hg	2531.6	2503.13	2536.1	13.56
Copper	Cu	806.48	800.	...	8.722
Nickel	Ni	733.8	...	...	8.666
Cobalt	Co	732.61	...	...	8.7
Bismuth	Bi	1774.	...	...	9.88
Lead	Pb	2597.4	...	2620.2	11.445
Tin	Sn	1470.59	...	...	7.299
Iron	Fe	693.64	...	...	7.788
Zinc	Zn	806.45	...	...	7.215
Manganese	Ma	711.575	...	...	8.013
Uranium	U	...	...	...	...
Cerium	Ce	1148.8	...	...	...
Yttrium	Y	881.66	876.42	...	...
Glucinum	Gl	...	...	...	...
Aluminum	Al	228.025	...	342.	...
Magnesium	Ms	315.46	301.63	321.93	...
Strontium	Sr	1418.14	...	...	...
Barytium	Ba	1709.1	...	...	...
Calcium	Ca	510.2	...	...	...
Sodium	So	579.32	...	...	0.9348
Potassium	Po	978.0	...	...	0.8

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[1][The excerpt includes all of the brief section III from this long paper, and the table from its ends. --CJG]

[2][The abbreviations employed in this lengthy paper are not entirely consistent throughout. These include antimony (St or Sb), columbium (now known as niobium, Cb or Cl), lead (P or Pb), manganese (Mn or Ma), mercury (Hy or Hg), rhodium (R or Rh), tin (Sn or St), and tungsten (W or Tn). The symbols and/or names of several other elements differ from present usage. These include chromium (Ch rather than Cr), glucinum (Gl rather than beryllium, Be), magnesium (Ms rather than Mg), muriatic radicle (M rather than chlorine, Cl), potassium (Po rather than K for *Kalium*), and sodium (So rather than Na for *natrium*). --CJG]

[3][When he said above, he meant directly above, not above and to the right, as I have rendered the formulas here. --CJG]

[4][The table appears to be arranged in order of polarity from electronegative to electropositive as Berzelius used the terms in his dualistic theory of bonding. --CJG]

Glossary
of
Archaic Chemical Terms

Introduction

This glossary makes no claims for completeness or originality. I began to compile the following list mainly of terms I came across in the course of reading and posting the papers listed in the classic papers section of this site. I have expanded it to include formulas and structures for some common acid-base indicators and vitamins, as well as some other interesting non-systematic chemical terms.

I intended it mainly for my own use or as a teaching tool. As a result, it lacks the polish and the painstaking acknowledgement of sources of a scholarly work. I hope it is, nonetheless, useful. It will continue to grow as I add more papers and better cross-reference the ones I have already posted.

I have tried to cross-reference entries. Terms in parentheses () are usually linked cross-references within the glossary. Names in brackets [] are scientists in whose work the term *appears* (perhaps in translation), not necessarily (and usually not) those who *coined* the term. Many of these names have links to papers posted at this site. Use your browser's search function to find the glossed term in such a paper. The notation *et al.* means that there are additional papers *at this site* that contain the term.

Finally a partial list of sources follows:

- James Bryant Conant, ed., *Harvard Case Histories in Experimental Science*, vol. 1 (Cambridge, MA: Harvard, 1957)
- W. E. Flood, *The Dictionary of Chemical Names* (New York: Philosophical Library, 1963)
- Julius Grant, *Hackh's Chemical Dictionary*, 3rd ed. (Philadelphia: Blakiston, 1944)
- *Oxford English Dictionary* (Oxford: Oxford, 1971)
- Frederick Soddy, "Radioactivity", *Chemical Society Annual Reports* **10**, 262-88 (1913)

Thanks to Peter Morris of the Science Museum, London, for comments and entries.

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acid of ...

- ... **air**: carbon dioxide, CO_2, which forms carbonic acid in aqueous solution
- ... **amber**: succinic acid, $HOOCCH_2CH_2COOH$
- ... **ants**: formic acid
- ... **apples**: malic acid
- ... **lemon**: citric acid
- ... **milk**: lactic acid
- ... **salt**: hydrochloric acid, HCl (***acidum salis***, marine acid, muriatic acid, spirit of salt). [Scheele]
- ... **sugar**: oxalic acid, $(COOH)_2$.

actinium ... See table of isotopes.

- ... **C**: an isotope of bismuth produced in actinium decay, namely ^{211}Bi (half-life = 2 min) [Soddy]
- ... **D**: an isotope of thallium produced in actinium decay, namely ^{207}Tl (half-life = 5 min). [Soddy 1 & 2]
- ... **emanation** (**actinon**, see emanation): an isotope of radon produced in actinium decay, namely ^{219}Rn (half life = 4 s).

ad siccum: to dryness, as in evaporation to dryness. [Scheele]

aether: ether.

air: formerly a general term for any gas (elastic fluid). [Black, Cavendish, Priestley]

- **alkaline air**: ammonia gas, NH_3; see spirit of hartshorn, volatile alkali. [Priestley]
- **dephlogisticated air**: oxygen, O_2 [Cavendish, Ingenhousz, Lavoisier 1 & 2, Priestley 1 & 2, Watt]; also known as **pure air**, [Lavoisier, Priestley, Watt] or **vital air** [Lavoisier]. See phlogiston.
- **fire air**: oxygen
- **fixed air**: carbon dioxide, CO_2 (carbonic acid). [Black, Cavendish, Priestley *et al.*]. (***aer fixus***) Scheele]
- **fluoro acid air**: silicon tetrafluoride, SiF_4 [Priestley].
- **hepatic air**: hydrogen sulfide, H_2S (sulphuretted hydrogen)
- **inflammable air**: hydrogen, H_2. [Cavendish, Franklin, Priestley, Watt *et al.*]

- **mephitic air**: nitrogen, N_2 (azote, **phlogisticated air**), or carbon dioxide, CO_2 (carbonic acid, **fixed air**, **mephitic acid**) [Lavoisier]
- **nitrous air**: nitric oxide, NO (nitrous gas) [Cavendish, Lavoisier, Priestley 1 & 2]
- **phlogisticated air**: nitrogen, N_2 (azote) [Cavendish, Lavoisier, Priestley 1 & 2, Watt]
- **phlogisticated nitrous air**: nitrous oxide, N_2O (laughing gas); see **nitrous air**. [Priestley]
- **pure air**: **dephlogisticated air**.
- **vital air**: **dephlogisticated air**.
- **vitriolic acid air**: sulfur dioxide (SO_2). [Priestley] See vitriolic acid.

alabamine (**Ab**): a name proposed for element 85 (astatine) in a report of detection of the element whose validity was ultimately not recognized.

alcohol sulphuris: carbon disulfide, CS_2; not an alcohol at all, but a volatile liquid that contains sulfur.

alembroth, salt of: a double chloride of mercury and ammonium, $Hg_2(NH_4)_2Cl_4 \cdot H_2O$; see white precipitate [Lavoisier]

algaroth, powder of: antimony oxychloride, SbOCl, an emetic named after its inventor, a Vittorio Algarotti. [Lavoisier]

alizarin: 1,2-dihydroxyanthraquinone, $C_{14}H_8O_4$, a red dye long extracted from *Rubia tinctorium* (madder), synthetically prepared from anthracene in the 19th century. Click here for structures.

- ... **black**: naphtharazine, 5,8-dihydroxy-1,4-naphthoquinone, $C_{10}H_6O_4$, a black dye
- ... **blue** (**anthracene blue**): a dihydroxyanthraquinone quinoline, $C_{17}H_9O_4$
- ... **bordeaux** (... **brown**): 1,2,3-trihydroxyanthraquinone, $C_{14}H_8O_5$, a dye derived from anthraquinone
- ... **red**: alizarin sodium sulfonate, $NaC_{14}H_7O_7S$, the sodium salt of the sulfonic acid of **alizarin**; an acid-base indicator that changes from red to yellow as the pH is raised through 5.5
- ... **yellow**: sodium *p*-nitraniline salicylate, $C_{13}H_{10}NO_5$, an acid-base indicator that changes from yellow to purple as the pH is raised through 11.1

alkahest: a term invented by Paracelsus to denote a universal solvent. [Boyle]

alkali: a basic substance. **Caustic alkalis** were usually hydroxides, while **mild alkalis** were carbonates. (See alkaline air, fossil alkali, marine alkali, mineral alkali, vegetable alkali, volatile alkali.)

alum: originally potassium aluminum sulfate, $KAl(SO_4)_2 \cdot 12H_2O$; more recently the term also includes salts in which sodium or ammonium substitute for potassium. [Black, Lavoisier]

amyl: derives from *amylum*, starch. Some terms (amylase, amylose, amylo-pectin) are still directly related to starch. The following terms come from starch-derived amyl alcohols:

- **amyl**: a pentyl radical or substituent, C_5H_{11}-.
- **amylene**: pentene, C_5H_{10}, usually 1-pentene or 2-pentene; isoamylene is one of the isomers of 2-methyl-2-butene.
- **amyl hydrate**: an **amyl** (*i.e.*, pentyl) alcohol

aniline purple: mauvein, $C_{27}H_{24}N_4$, the first aniline dye, 1856 (Perkin's mauve).

antimony ...

- ... **black**: antimony(III) sulfide, Sb_2S_3, a grey-black powder.
- ... **bloom** (also ... **white**): antimony(III) oxide, Sb_2O_3
- ... **butter**: See butter.
- ... **glance**: stibnite, a native antimony(III) sulfide. (See glance.)
- ... **flowers** (also ... **red**, ... **vermillion**): antimony(III) oxysulfide, $Sb_2O_3 \cdot Sb_2S_3$, containing some $SbOS_2$. See other flowers.

apothecary measures: weight and fluid (volume) measurements used in preparing medicines. They included ...

- **dram (drachm)**: unit of weight equal to 3.888 g. [Black]
- **fluid dram**: unit of volume equal to 3.55 mL (60 **minims**). [Scheele]
- **minim**: unit of volume equal to 0.0616 mL
- **pound (libra) Troy**: unit of weight equal to 373.2 g
- **scruple**: unit of weight equal to 1.296 g. [Black]

aqua: literally water (Latin). In addition to terms denoting a condition or source or water (such as ***aqua tepida***, warm water, or ***aqua nivialis***, water from snow), some *aqua* terms denote aqueous solutions:

- ***aqua fortis***: nitric acid, HNO_3, literally "strong water". See nitrous acid, spirit of nitre. [Bacon, Black, Scheele]
- ***aqua regia*** or ***aqua regis***: literally "water of the king", a mixture of concentrated nitric and hydrochloric acids capable of dissolving the "royal metal" gold. [Bacon, Scheele]
- ***aqua vitae***: literally, "water of life"; concentrated aqueous ethanol, C_2H_5OH, typically prepared by distilling wine [Arnald of Villanova] (spirit of wine)

argentum: Latin for silver, hence the symbol Ag; ***argentum vivum***, literally "living silver", is native mercury [Pliny]

Arnaudon's green: chromium(III) phosphate, $CrPO_4$, a green pigment; also **Plessy's green**.

arsenic

- **butter of** ...: See butter
- **flowers of** ...: See flowers
- **red** ...: arsenic(II) sulfide, As_2S_2 (realgar, red orpiment).
- **white** ...: arsenic(III) oxide, As_2O_3.
- **yellow** ...: orpiment.

atom: does not necessarily correspond to the modern picture of the ultimate particle of an element. Dalton, for example, meant something more along the lines of "ultimate particle of a substance"; to him the smallest unit of a chemical compound was a **compound atom** (**molecule** in modern terminology), while the smallest particle of a chemical element was a **simple atom** (now just atom, although several of Dalton's simple atoms turned out to be molecules of elements, such as O_2). (See molecule.)

aurum: Latin for gold, hence the symbol Au; ***aurum fulminans*** (**fulminating gold**): gold hydrazide, $AuHNNH_2$, an olive-green powder that can explode on concussion [Black, Scheele]

azote or **azotic air**: nitrogen, named because it did not support respiration and was therefore "lifeless", N_2 (phlogisticated air; see also mephitic air). [Dalton 1 & 2, Lavoisier, Prout, T. Thomson]

baker's salt: ammonium carbonate, $(NH_4)_2CO_3$.

barilla: impure sodium carbonate extracted from soap-wort. [Rey]

barium white: barium sulfate, $BaSO_4$.

baryta and **barytes**: were both used for the earth from which barium was eventually isolated, namely barium oxide, BaO. [Dalton, Lavoisier, Ramsay, *et al*.]. **Barytes** can also refer to **barite**, a barium sulfate ($BaSO_4$) mineral also known as **heavy spar**. **Baryta** can also refer to barium hydroxide (caustic baryta) or its hydrate. **Barytium** is an older name for barium [Prout].

benzine: ligroin or petroleum ether [Rayleigh]; sometimes benzene, C_6H_6

Bezoar (or **Bezoar stone** or ***Bezoardicum minerale***): a counter-poison or antidote, especially a stony calculus from an animalÕs stomach. [Mayow]

bitter salt: magnesium sulfate, $MgSO_4{\cdot}7H_2O$ (Epsom salts)

bittern: waste solution of magnesium salts and bromides from the preparation of salt from sea-water by evaporation

black ash: impure sodium carbonate mixed with unburnt carbon (hence "black") and incombustible mineral residue

bleaching powder: formed by passing chlorine gas over dry calcium hydroxide, hence also called **chlorinated lime**. When dry the substance is mainly calcium oxychloride, $CaOCl_2$; after absorbing moisture, it becomes a mixture of calcium chloride and hypochlorite, $CaCl_2$ and $Ca(OCl)_2$

blue stone: a native crystalline copper sulfate, $CuSO_4{\cdot}5H_2O$.

bone ash: an impure calcium phosphate

bone black: an impure animal charcoal prepared from bones and blood

brevium: an isotope of protactinium produced in uranium decay, namely ^{234}Pa (half-life = 1.6 min) [Fajans 1913]

brimstone: sulfur, S. [Boyle]

bromcresol...

- ... **green**: $C_{21}H_{14}Br_4O_5S$, an acid-base indicator that changes from yellow to blue as the pH is raised through 5
- ... **purple**: $C_{21}H_{16}Br_2O_5S$, an acid-base indicator that changes from yellow to purple as the pH is raised through 6

bromphenol...

- ... **blue**: tetrabromophenolsulphonphthalein, $C_{19}H_{10}Br_4O_5S$, an acid-base indicator that changes color from yellow to blue as the pH rises through 3.8
- ... **red**: dibromophenolsulphonphthalein, $C_{19}H_{12}Br_2O_5S$, an acid-base indicator that changes color from yellow to red as the pH rises through 6.5

bromthymol blue: dibromothymolsulfonphthalein, $C_{27}H_{38}Br_2O_5S$, an acid-base indicator that changes from yellow to blue as the pH rises through 6.8.

brunswick green: a basic copper oxychloride, $CuOCl \cdot Cu(OH)_2$, or a green copper carbonate.

butter: In addition to its still current meanings of a low-melting vegetable fat or a high milk-fat foodstuff, a butter could be a soft substance such as an inorganic chloride. **Butter of antimony** was antimony trichloride, $SbCl_3$; **butter of arsenic** was arsenic(III) chloride, $AsCl_3$; **butter of tin** was a hydrate of tin tetrachloride $SnCl_4 \cdot 5H_2O$; and **butter of zinc** was zinc chloride, $ZnCl_2$. [Lavoisier]

Cadet's fuming liquid (**Cadet's liquid**): heavy brown liquid first prepared by the French chemist Louis Claude Cadet de Gassicourt. Cadet's liquid is highly toxic, smells strongly of garlic, and spontaneously bursts into flame when exposed to air. It is mainly cacodyl oxide, $((CH_3)_2As)_2O$, with other cacodyl compounds such as dicacodyl, $((CH_3)_2As)_2)$. Berzelius coined the name kakodyl (later changed to cacodyl) for the dimethylarsinyl radical, $(CH_3)_2As$, from the Greek *kakodes* (evil-smelling) and *hyle* (matter).

cadmia (***cadmia fornacea*** or ***fornacum***): an older name for the common zinc ore **calamine** (*q.v.*); also applied to a sublimed zinc oxide and to a cobalt ore. (The element now called cadmium is often found associated with zinc.) [Agricola]

calamine: Two ores of zinc were known by this name: zinc carbonate ($ZnCO_3$, also known as **Smithsonite**) and hydrous zinc silicate ($Zn_2SiO_4 \cdot H_2O$). They were distinguished by Smithson in 1802, but the term continued to be applied to both ores. The silicate was sometimes distinguished as **siliceous** or **electric calamine**. **calamine**

calcareous earth: calcium oxide, CaO (lime, quicklime). [Black, Lavoisier]

- **caustic ...**: calcium hydroxide, $Ca(OH)_2$ (slaked lime)
- **mild** ...: calcium carbonate, $CaCO_3$ (chalk, carbonate of lime).

calces: See calx.

calcination: formation of a calx, *i.e.*, oxidation of a metal, often by roasting. [Bacon, Black; Lavoisier 1, 2, & 3; Rey]

calomel: mercury(I) chloride, Hg_2Cl_2.

caloric: a postulated elastic fluid associated with heat. [Avogadro, Davy, Dalton, Lavoisier, *et al.*]

calx (plural **calces**): a metal oxide (earth), the result of roasting a metal or mineral. [Lavoisier 1, Rey, Stahl] Sometimes used for a particular **calx**, namely lime.

carbolic acid: phenol, C_6H_5OH.

carbonic acid: formerly, carbon dioxide, CO_2 (fixed air) [Dalton; but also Arrhenius, Maxwell, Mendeleev, Rutherford, J. J. Thomson *et al.*]

carbonic oxide: carbon monoxide, CO [Dalton, Gay-Lussac, Maxwell, Ramsay, T. Thomson *et al.*]

carburetted hydrogen: methane, CH_4 [Dalton 1 & 2, Prout]

Caro's acid: permonosulfuric acid (i.e., peroxymonosulfuric acid), H_2SO_5, first prepared by Heinrich Caro in 1898.

Cassel yellow: lead oxychloride, $PbCl_2 \cdot 2PbO$ (**mineral yellow**).

cassiopeium: Auer von Welsbach's name for lutetium, Lu.

cathode rays (sometimes **kathode** rays in 19th-century English translations): streams of electrons issuing from the cathode of an evacuated tube. They were identified as what are now called electrons late in the 19th century. [Perrin, Rutherford, J. J. Thomson 1 & 2]

Celsius scale: temperature scale devised in the early 18th century by a certain Elvius from Sweden (1710), a Christian of Lyons (1743), and the botanist Linnaeus (1740), apparently independently. Temperatures on this scale are denoted by °C. The normal freezing point of water is 0°C and the normal boiling point of water is 100°C. The scale was named after Anders Celsius who proposed a similar scale in 1742, but designating the freezing point to be 100 and the boiling point to be 0. The scale is sometimes also called the **Centigrade scale**. (See Fahrenheit scale, Kelvin scale, Rankine scale, Réaumur scale.)

Centigrade scale: Celsius scale.

cerusa (or **ceruse** or **cerussa**): white lead.

chalk: calcium carbonate, $CaCO_3$ (carbonate of lime, mild calcareous earth). [Lavoisier; Priestley; T. Thomson]. **Acid of chalk** is carbon dioxide, CO_2 (carbonic acid, fixed air) [Lavoisier]

chamber crystals: nitrosyl sulfate, $NO{\cdot}HSO_4$, formed in lead chambers of sulfuric acid manufacture.

charcoal: either a charred carbonaceous material or its primary constituent, namely carbon. Lavoisier coined the term **carbone** (carbon) to distinguish the element from impure charred material; however, the distinction was not universally adopted right away--even in translation of Lavoisier's work. [Dalton 1 and 2]

chrome ...

- ... **green**: mixture of chromic oxide, Cr_2O_3, and cobalt oxide.
- ... **red**: basic lead chromate, $PbCrO_4{\cdot}PbO$.
- ... **yellow**: lead chromate, $PbCrO_4$ (Leipzig yellow, **paris yellow**).

chromic acid: chromium(VI) oxide, CrO_3, or its formal hydrate, H_2CrO_4

chymical: Sometimes the modern term **alchemical** is more accurate than **chemical**. Similarly **chymist** often means **alchemist**. [Boyle]

Cleve's acid and salts: named for the 19th-century Swedish chemist.

- ... **acid**: 4-amino-2-naphthalenesulfonic acid, $C_{10}H_9NO_3S$
- ... **salts**: two chloride salts of triammineplatinum complex ions, $[Pt(NH_3)_3Cl]Cl$ and $[Pt(NH_3)_3Cl_3]Cl$

cobalt

- **black** ...: a native, earthy cobalt
- ... **bloom**: see **red cobalt**
- ... **blue**: a pigment containing cobalt(II) oxide, CoO; zinc oxide, ZnO; and chalcedony, an amorphous quartz, SiO_2
- ... **green**: a green pigment, solid solution of cobalt(II) and zinc oxides, CoO and ZnO
- **red** ...: erythrite, a native cobalt arsenate, $Co_3(AsO_4)_2{\cdot}8H_2O$
- ... **violet**: cobalt(II) phosphate, $Co_3(PO_4)_2{\cdot}2H_2O$, a pigment in oil paints
- ... **yellow**: cobalt(III) potassium nitrite, $K_3Co(NO_2)_6{\cdot}xH_2O$

colcothar: iron(III) oxide, Fe_2O_3, by-product from sulfuric acid manufacture (**Paris red**) [Lavoisier]

columbium: older name for niobium, Nb.

congo ...

- ... **blue**: $C_{17}H_{12}N_3O_7S_2Na_2$, also known as **diamine blue**, **Niagara blue**, and **trypan blue**; a blue dye and antimalarial compound
- ... **red**: $C_{32}H_{22}N_6O_6S_2Na_2$, a red azo dye and acid-base indicator that changes from blue to red as the pH rises.
- ... **yellow**: an orange-yellow dye, $C_{24}H_{18}O_4N_5SNa$

copperas: see vitriol.

- **blue** ... = copper sulfate, $CuSO_4$
- **green** ... = a native iron(II) sulfate, $FeSO_4{\cdot}7H_2O$
- **white** ... = copiapite (native $Fe_4S_5O_{18}{\cdot}H_2O$)
- **yellow** ... = zinc sulfate, $ZnSO_4$.

corpuscle: generally (and still) a small particle; in the late 19th and early 20th centuries, a competing name for the electron. [J. J. Thomson 1 & 2]

corrosive sublimate of mercury: mercuric chloride, $HgCl_2$. [Scheele]

Coupier's blue: azodiphenyl, $C_{24}H_{18}N_2$, a blue dye.

creech: calcium sulfate, $CaSO_4$

cresol ...

- ... **purple**: *m*-cresolsulfonphthalein, $C_{21}H_{18}O_5S$, an acid-base indicator that changes from red to yellow as the pH rises through 2.
- ... **red**: *o*-cresolsulfonphthalein, $C_{21}H_{18}O_5S$, an acid-base indicator that changes from yellow to red as the pH rises through 8.

Crookes tube: a highly exhausted electrical discharge tube, named for William Crookes, who experimented with such tubes

crystal violet: hexamethyl-*p*-rosaniline hydrochloride, $C_{25}H_{30}N_3Cl$, an acid-base indicator that changes from green to blue as the pH passes through 1.0.

dephlogisticated marine acid: chlorine, Cl_2 (oxymuriatic acid). See marine acid. [Priestley, Scheele]

diuretic salt: potassium acetate, KC_2H_3O.

didymium: a mixture of praseodymium, Pr, and neodymium, Nd, believed to be an element until 1885. [Mendeleev, Newlands]

Dutch oil (**Dutch liquid**, **Oil of the Dutch chemists**): ethylene chloride, $C_2H_4Cl_2$, first prepared by the action of chlorine on ethylene (hence olefiant gas) in 1794 by four Dutch chemists Johann Rudolph Deimann, Adrien Paets van Troostwyck, Anthoni Lauwerenburgh and Nicolas Bondt. [Wurtzw]

earth: a metal oxide (calx); see calcareous earth, magnesian earth, siliceous earth. [Dalton, Priestley, Scheele, T. Thomson]

elastic fluid: usually a descriptive term for gas (air) [Black, Dalton, Gay-Lussac, Lavoisier, T. Thomson *et al.*]; however, certain elastic fluids were postulated which correspond to no material (caloric, ether, phlogiston).

electron

- **nuclear** ...: in some early models of the nucleus before the discovery of the neutron, electrons were posited to be part of the nucleus
- **positive** ...: sometimes a positron (the oppositely charged anti-particle of the electron); sometimes a positive ion (*i.e.*, an atom from which an electron was stripped)

emanation: a radioactive gas (radon) produced in the decay of other radioactive elements. Specifically, **thorium emanation** (also **thoron**) is ^{220}Rn (half life = 55 s) produced from the decay of thorium; **radium emanation** is ^{222}Rn (half life = 3.8 d) produced from the decay of radium; **actinium emanation** (also **actinon**) is ^{219}Rn (half life = 4 s). See niton and table of isotopes. [Rutherford 1 & 2, Soddy 1 & 2]

Epsom salts: magnesium sulfate, $MgSO_4 \cdot 7H_2O$; see bitter salt.

ether (physics; also **aether**, sometimes **luminiferous ether**): a hypothetical elastic fluid postulated to support the transmission of light. [Clausius, Röntgen, J. J. Thomson 1 & 2]

ether (chemistry): Originally the name of a volatile compound resulting from the action of an acid on alcohol. The current meaning is an organic compound whose formula is ROR', where R and R' are alkyl or aryl groups; especially **diethyl ether**, $C_2H_5OC_2H_5$. Some ethers in the older sense include:

- **acetic** ...: ethyl acetate, $C_2H_5O_2C_2H_3$
- **muriatic** ...: ethyl chloride, C_2H_5Cl
- **nitric** ...: ethyl nitrate, $C_2H_5NO_3$ (***aether nitri***) [Scheele].
- **nitrous** ...: ethyl nitrite, $C_2H_5NO_2$ (spirit of nitre)
- **sulfuric** ...: **diethyl ether** [Gay-Lussac]

Ethiops (or Aethiops) mineral: mercury(I) sulfide, Hg_2S, a black substance

ethyl ...

- **Ethyl gas** (or **Ethyl gasoline** or sometimes simply **Ethyl**): leaded gasoline, i.e., gasoline including tetraethyllead, $(C_2H_5)_4Pb$, as an additive
- ... **red**: according to Hackh's dictionary, $C_{23}H_{23}N_2$, a quinoline dye and acid-base indicator that changes from colorless to red as the pH rises through 5.4; current chemical catalogs say $C_{17}H_{19}N_3O_2$.

Everitt's salt: potassium ferrous ferrocyanide, $K_2Fe[Fe(CN)_6]$

Fahrenheit scale: temperature scale devised in 1717 by D. G. Fahrenheit and denoted by °F. The normal freezing point of water is 32°F and the normal boiling point of water is 212°F. (See Celsius scale, Kelvin scale, Rankine scale, Réaumur scale.)

ferrum: Latin for iron, hence the symbol Fe

flores martiales: ferriammonium chloride, NH_4FeCl_4. See flowers and Mars.

flowers: a chemical, often an oxide, obtained by sublimation. For example: **flowers of arsenic**, **tin**, and **zinc** [Lavoisier, Priestley] are the respective oxides, As_2O_3, SnO_2, ZnO (also called pompholix). **Flowers of antimony** is antimony oxysulfide, $Sb_2O_3 \cdot Sb_2S_3$ (also called antimony red); **flowers of sulphur**, though, is simply sublimed sulfur.

fluor and **fluor spar** (or **fluorspar**): Fluor was originally applied to readily fusible minerals, particularly those containing fluorine, espeically fluorite (calcium fluoride, CaF_2). Fluorspar for CaF_2 dates to the late 18th century; fluorite to the 1860s.

fossil alkali: sodium carbonate (common mineral alkali, marine alkali, soda)

funiculus: an invisible membrane postulated to hold up a column of mercury in the Torricellian experiment [Linus]

galena: native lead sulfide, PbS, or lead or silver ore, or the slag remaining after refining lead.

glacial: glass-like, crystallized. This usage persists in terms such as glacial acetic acid and glacial phosphoric acid.

glance: a mineral with a glassy appearance. Specific examples include:

- **antimony** ...: See antimony
- **bismuth** ...: bismuthinite, Bi_2S_3
- **iron** ...: hematite, Fe_2S_3
- **nickel** ...: Ni_2AsS, a native arsenic sulfide
- **silver** ...: see silver
- **tellurium** ...: nagyagite, a lead sulfotelluride that also contains gold and antimony

Glauber's salt: sodium sulfate, $Na_2SO_4 \cdot 10H_2O$, named for the iatrochemist Johann Glauber who prepared it; also ***sal mirabilis***.

glucinium or **glucinum**: beryllium, Be. [Berzelius, Marignac, Newlands, Ramsay]

grain : unit of mass. For late 18th-century French system, see *livre*. [Lavoisier, Priestley, Proust]

green salt: uranium(IV) fluoride, UF_4.

gros: Unit of mass in late 18th-century France; see *livre*. [Lavoisier 1 & 2]

hepar: This Latin word for liver referred to reddish-brown (*i.e.*, liver-colored) metal sulfides. (See sulphuret.) ***Hepar sulphuris*** (**liver of sulphur**) was a synonym either for *potassa sulphurata* (a mixture of various compounds of potassium and sulfur made by fusing potassium carbonate and sulfur) [Cavendish, Priestley, Stahl] or, in homeopathic contexts, for calcium sulfide, CaS.

Homberg's salt: boric acid, $B(OH)_3$.

hydrargyrum: Latin for mercury, hence the symbol Hg

igneous fluid: a postulated elastic fluid sometimes used synonymously with caloric (matter of heat), sometimes with phlogiston (matter of fire), and sometimes as a substance with the postulated properties of both. [Lavoisier 1 & 2]

illinium: another name proposed for promethium, element 61.

ionium: an isotope of thorium produced in uranium decay, namely ^{230}Th (half-life = 80 kyr). See table. [Boltwood 1907; Soddy 1, 2, & 3]

Jupiter: In astrological and alchemical thought, the seven heavenly bodies known to the ancients were associated with seven metals also known in antiquity. Jupiter was associated with tin. [Helmont]

kalium: Latin (and German) for potassium, hence the symbol K.

kelp: ashes of seaweed from which carbonates or iodine were extracted

Kelvin scale: an absolute temperature scale (*i.e.*, one in which absolute zero is assigned the value zero) named after William Thomson, first (and last) Baron Kelvin of Largs, who first proposed an absolute temperature scale. One Kelvin (denoted simply K or sometimes in older sources °K) is the same size as a **Celsius** degree, so the normal freezing point of water is 273.15 K and the normal boiling point is 373.15 K. (See Celsius scale, Fahrenheit scale, Rankine scale, Réaumur scale.) [Kelvin]

King's yellow: a native yellow arsenic(III) sulfide, As_2S_3 (**yellow arsenic**, orpiment)

Kurrol's salt: a potassium phosphate, $(KPO_3)_4$, with ion-exchange properties

lapis: Latin for stone; also an alchemical term for non-volatile solids

- ... ***causticus***: fused sodium or potassium hydroxide
- ... ***imperialis***: silver nitrate, $AgNO_3$
- ... ***lunaris***: fused silver nitrate

laughing gas: nitrous oxide, N_2O (phlogisticated nitrous air).

lead

- **black** ...: graphite, an allotrope of carbon
- **red** ...: minium, **Paris red**.
- **white** ...: basic lead carbonate, $2PbCO_3 \cdot Pb(OH)_2$ (**ceruse**)

Libavius, fuming liquor of (***spiritus fumans Libavii***): tin tetrachloride, $SnCl_4$, which fumes because it is hydrolyzed by moisture in the air to stannic oxide. First prepared at the beginning of the seventeenth century by the German chemist Andreas Libavius. When mixed with one-third of its weight of water, it forms a hydrate formerly called butter of tin.

ligne: Unit of length in late 18th-century France; see *pied*. [Lavoisier]

lime: calcium oxide, CaO (**burnt lime**, calcareous earth, **quicklime**) [Dalton, Lavoisier, Priestley, Ramsay, *et al.*]

- **carbonate** of ...: calcium carbonate, $CaCO_3$ (mild calcareous earth, chalk)
- **chlorinated** ...: see bleaching powder.
- **milk** of ...: a suspension of calcium hydroxide. See other milks.
- **quicklime**: calcium oxide, CaO. [Bacon, Black, Lavoisier, Priestley]
- **slaked** ...: calcium hydroxide, $Ca(OH)_2$ (**hydrated lime**, caustic calcareous earth).
- **lime-water**: a saturated aqueous solution of calcium hydroxide (***liquor calcis***) [Black, Dalton, Lavoisier, Ramsay *et al.*]

litharge: a yellow lead(II) oxide, PbO. [Marignac, Priestley]

livre: Unit of mass in the late 18th-century France: 1 *livre* (Paris pound) = 16 ***onces***; 1 *once* (Paris ounce) = 8 ***gros***; 1 *gros* = 72 **grains**. In modern units, the *livre* is equivalent to 489 grams or about 1.08 pounds in the "English" system still commonly used in the United States. [Lavoisier, Proust]

lunar caustic: fused silver nitrate, $AgNO_3$; see moon.

lye: potassium hydroxide solution, KOH

magnesia ...:

- ... **alba**: (literally "white magnesia") was a hydrated magnesium carbonate, also known as mild **magnesian earth**. [Black] $4MgCO_3 \cdot Mg(OH)_2 \cdot 5H_2O$ was **magnesia alba levis**, and $MgCO_3 \cdot Mg(OH)_2 \cdot 4H_2O$ was **magnesia alba ponderosa**.
- ... **nigra**: (literally "black magnesia") was the mineral pyrolusite, natural manganese dioxide, MnO_2, sometimes also called simply magnesia or **manganese**. [Scheele] Eventually manganese became the name of the metal present in the mineral.

magnium: Humphry Davy's name for magnesium (Mg), the metal obtained from magnesia alba, proposed to avoid confusion with the metal found in magnesia nigra.

Magnus salt: tetrammineplatinum tetrachloroplatinate, $Pt(NH_3)_4PtCl_4$, named after Heinrich Gustav Magnus

malachite green: pulverized malachite, a basic copper carbonate mineral, $Cu_2(OH)_2CO_3$, used as a pigment; or a green triphenylmethane dye, $C_{23}H_{25}N_2Cl$, also known as **Victoria green** or **benzal green**, an acid-base indicator that changes from yellow to blue-green as the pH is raised through 1

manganese ...

- **black** ...: See magnesia nigra. .
- ... **green**: barium manganate, $BaMnO_4$
- **red** ...: rhodonite, $MnSiO_3$, a manganese silicate mineral, or rhodochrosite, a manganese carbonate mineral, $MnCO_3$

Marignac salt: potassium tin(II) sulfate, $K_2Sn(SO_4)_2$, named for Jean de Marignac, who is best known for atomic weight measurements

marine acid: hydrogen chloride solution, HCl (*acidum salis*, muriatic acid, spirit of salt). Gaseous HCl was **marine acid air**. [Cavendish, Lavoisier, Priestley, Scheele, *et al.*]

marine alkali: sodium carbonate (common mineral alkali, fossil alkali, soda)

Mariotte's law: better known today as Boyle's law, that the product of pressure and volume of a gas is constant; named for Edme Mariotte, who discovered it independently some time after Boyle

Mars: In astrological and alchemical thought, the seven heavenly bodies known to the ancients were associated with seven metals also known in antiquity. Mars was associated with iron.

marsh gas: methane, CH_4

martius yellow: the calcium salt of naphthalene yellow.

massicot: a yellow lead(II) oxide, PbO.

masurium (**Ma**): another name proposed for technetium, element 43.[Noddack 1925]

mercurius calcinatus per se: mercuric oxide, HgO, prepared by the calcination of mercury [Priestley, Watt]. The substance known as **precipitated mercury per se** [Lavoisier, Priestley] or **red precipitate** [Priestley] is the same substance; however, because of its different preparation (by mixing mercury with nitric acid, evaporating, and heating the residual mercuric nitrate), the identity was not at first realized.

Mercury: In astrological and alchemical thought, the seven heavenly bodies known to the ancients were associated with seven metals also known in antiquity. Mercury was associated with mercury (quicksilver, *hydrargyrum*).

mesothorium: There were two mesothoriums produced in thorium decay. Mesothorium I is an isotope of radium, namely ^{228}Ra (half-life = 5.8 y); mesothorium II is an isotope of actinium, namely ^{228}Ac (half-life = 6 hr). See table. [Hahn, Soddy 1 & 2]

metanil yellow: the sodium salt of 4'-analine azobenzenesulfonic acid, $C_{12}H_{10}N_3O_3SNa$, an acid-base indicator that changes from red to yellow as the pH is raised through 1.8

methyl ...:

- ... **green**: $C_{25}H_{30}N_3Cl$, a triphyenylmethane dye and acid-base indicator that changes from yellow through blue-green to colorless as the pH is raised
- ... **orange**: sodium *p*-dimethylaminobenzenesulfonate, $C_{14}H_{14}O_3N_3SNa$, an acid-base indicator that changes from red to yellow as the pH is raised through 3.8
- ... **red**: *o*-dimethylaminoazobenzenecarboxylic acid, $C_{15}H_{15}O_2N_3$, an acid-base indicator that changes from yellow to reddish purple as the pH is raised through 4.5

methylene blue: 3,9-bisdimethylaminophenazothionium chloride trihydrate, $C_{16}H_{18}N_3SCl \cdot 3H_2O$, a thiazine dye and redox indicator.

microcosmic salt: an acid sodium ammonium phosphate, $NaNH_4HPO_4 \cdot 4H_2O$, found in blood and natural waters.

milk: mineral "milks" or **magmas** are aqueous suspensions

- ... of **barium**: an aqueous suspension of barium hydroxide, $Ba(OH)_2$
- ... of **bismuth**: an aqueous suspension of basic bismuth nitrates, $Bi(OH)_2NO_3$ and/or $BiOH(NO_3)_2$
- ... of **lime**: an aqueous suspension of calcium hydroxide, $Ca(OH)_2$. See lime.

- ... of **magnesia**: an aqueous suspension of magnesium hydroxide, $Mg(OH)_2$, especially a 7% suspension used as an antacid. See magnesia.
- ... of **sulfur**: precipitated sulfur

Millon's base: $(HOHg)_2NH_2OH$, formed from a solution of mercuric oxide in ammonium chloride; named for A. N. E. Millon.

mineral alkali, common: hydrated sodium carbonate (fossil alkali, marine alkali, soda)

mineral dye: an inorganic pigment. Examples include mineral ...

- ... **blue**: a blue copper or tungsten ore, or a mixture of ferriferrocyanide, $Fe_4[Fe(CN)_6]_3$, with calcium or barium sulfate
- ... **green**: copper(II) carbonate
- ... **purple**: a reddish iron oxide pigment
- ... **white**: a natural hydrated calcium sulfate
- ... **yellow**: lead oxychloride, $PbCl_2{\cdot}2PbO$ (**Cassel yellow**)

minium: red lead oxide, Pb_3O_4 [Lavoisier, Priestley] (**red lead [Priestley], Paris red**). Minium once referred to cinnabar (mercuric sulfide, HgS) as well, but now is used only for its cheif adulterant, red lead oxide.

Mohr salt: ferrous ammonium sulfate, $(NH_4)_2Fe(SO_4)_2{\cdot}6H_2O$, named for Karl Friedrich Mohr.

molecule: does not necessarily correspond to the modern conception of two or more atoms chemically bound together. Avogadro, for example, meant something like "ultimate particle of a substance"; his **elementary molecule** corresponds to a modern **atom** and his **composite molecule** to a modern molecule. (See atom.)

Monsel salt: an iron sub-sulfate, $Fe_4(SO_4)_5O$.

Monthier blue: a blue pigment, $FeNH_4[Fe(CN)_6]$.

Moon (***Luna***): In astrological and alchemical thought, the seven heavenly bodies known to the ancients were associated with seven metals also known in antiquity. The moon was associated with silver (*argentum*). See *lapis lunaris*, lunar caustic.

mosaic gold: a tin(IV) sulfide, SnS_2 pigment.

muriate: chloride; see muriatic acid. [Avogadro, Gay-Lussac, Thenard, T. Thomson]

muriatic acid: hydrochloric acid, HCl (*acidum salis*, marine acid, spirit of salt); **muriatic gas** is gaseous HCl. [Black, Gay-Lussac, Prout, Scheele, Thenard, *et al.*]

mustard gas: a di(chloroethyl)sulfide, $(ClCH_2CH_2)_2S$, used as a chemical weapon in World War I

naphthalene yellow: a dinitro 1-naphthol, $C_{10}H_5(NO_2)_2OH$.

Naples yellow: lead antimoniate, $Pb_3(SbO_4)_2$, used as a yellow pigment.

natrium: Latin for sodium, hence the symbol Na.

neutral red: dimethyldiaminotoluphenazine hydrochloride, also known as toluylene red; an acid-base indicator that changes from blue to magenta as the pH is raised through 7.5 and then to orange-yellow as pH is raised through 8.

nile blue: $C_{20}H_{19}ON_3$, an analine dye and acid-base indicator that changes from yellow through blue to magenta as the pH is raised

niton: the element radon, Rn, or one of its isotopes, ^{222}Rn (half life = 3.8 d). See emanation and table of isotopes.

nitre or **niter**: potassium nitrate, KNO_3 (saltpeter). Black gunpowder was made from nitre, charcoal, and sulfur. [Cavendish, Mayow, Priestley, Rayleigh, Watt, *et al.*].

- **Chile** ...: sodium nitrate, $NaNO_3$..
- **Norwegian** ...: calcium nitrate, $Ca(NO_3)_2$
- **rough** ...: magnesium chloride, $MgCl_2$
- **spirit** of ...: See spirit.

nitric acid: formerly, nitrogen dioxide, NO_2 [Avogadro, Dalton, Gay-Lussac, Lavoisier *et al.*] or nitrogen pentoxide, N_2O_5 [Prout]

nitrous acid: formerly, nitric acid, HNO_3 (*aqua fortis*, spirit of nitre) [Lavoisier], or nitrous acid, HNO_2, or a mixture of these acids; or one or more of the nitrogen oxides N_2O_3, NO_2, N_2O_4, N_2O_5 [Avogadro, Dalton].

nitrous gas: specifically nitric oxide, NO (nitrous air) [Avogadro, Dalton, Gay-Lussac, T. Thomson, *et al.*]; or a mixture of nitrogen oxides such as that produced by the action of nitric acid on a metal in the presence of air

Nordhausen acid (also **oleum**): fuming sulphuric acid, *i.e.* a solution of sulfur trioxide, SO_3, in concentrated (about 98%) sulfuric acid.

ocher or **ochre**: Ochers are inorganic pigments, mostly oxide minerals. Unmodified, ocher usually refers to an iron oxide. Specific ochers include: {Hackh}

- **antimony** ...: stibiconite, an antimony mineral, $Sb_2O_3(OH)_2$
- **bismuth** ...: bismite, $Bi_2O_3 \cdot 3H_2O$
- **brown** ...: bogore or bog iron ore, $2Fe_2O_3 \cdot 3H_2O$
- **molybdic** ...: molybdite, yellow molybdenum(VI) oxide, MoO_3
- **nickel** ...: annabergite, $Ni_3As_2O_2 \cdot 8H_2O$, a green mineral (**nickel bloom**)
- **plumbic** ...: brown lead(IV) oxide, PbO_2
- **red** ...: hematite, Fe_2O_3
- **telluric** ...: yellow tellurium(IV) oxide, TeO_2
- **tungstic** ...: yellow tungsten(VI) oxide, WO_3
- **uranic** ...: uraconite, a yellow uranium(III) oxide, U_2O_3
- **yellow** ...: a mixture of powdered iron oxide and clay

oil of ...: Click here for structures.

- ... **ants**: furfural, $C_5H_4O_2$
- ... **apples**: n-pentyl pentanoate, $C_4H_9COC_5H_{11}$ (amyl valerate)
- ... **bananas**: n-pentyl acetate, $CH_3COC_5H_{11}$ (**oil of pears**)
- ... **cognac**: ethyl hexyl ether, $C_6H_{13}OC_2H_5$, (enanthic ether)
- ... **garlic**: allyl sulfide, $(C_3H_5)_2S$
- ... **glonoin**: nitrogylcerin, $C_3H_5N_3O_9$
- ... **mirbane**: nitrobenzene, $C_6H_5NO_2$
- **artificial ... mustard**: allyl isothiocyanate, C_3H_5NCS
- ... **pears**: n-pentyl acetate (**oil of bananas**)
- ... **pineapple**: ethyl butyrate, $C_3H_7COOC_2H_5$
- ... **vitriol** or **... sulfur *per campanum***: vitriolic acid

olefiant gas: ethene, C_2H_4 [Dalton, Prout, Thenard, T. Thomson, *et al.*]. See Dutch oil.

oleum: Latin for oil. Also, fuming sulfuric acid (Nordhausen acid)

once: Unit of mass in late 18th-century France; see *livre*. [Lavoisier]

orpiment: arsenic(III) sulfide, As_2S_3 (**yellow arsenic**, **King's yellow**). **Red orpiment** is arsenic(II) sulfide, As_2S_2, also known as realgar or **red arsenic**.

oxymuriatic acid (also **oxygenated muriatic acid**): chlorine, Cl_2 (dephlogisticated marine acid); named on the belief that it was a compound of oxygen and HCl (muriatic acid). [Avogadro, Berzelius, Davy, Thenard]

Paris ...

- ...**blue**: ferric ferrocyanide, $Fe_4[Fe(CN)_6]_3$
- ... $_{\text{green}}$: copper(II) acetoarsenite, $Cu(C_2H_3O_2)_2 \cdot 3Cu(AsO_2)_2$.
- **plaster of** ...: hemihydrated calcium sulfate, $2CaSO_4 \cdot H_2O$.
- ... **red**: colcothar or minium
- ... **yellow**: (chrome yellow, Leipzig yellow)

patent yellow: lead oxychloride, $PbO \cdot PbCl_2$.

pearl ash: impure calcined potassium carbonate, K_2CO_3

Péligot's salt: potassium chlorochromate, $KCrO_3Cl$, named for Eugène Péligot.

Perkin's mauve or **violet**: see aniline purple

phenol red: phenolsulfonphthalein, $C_{19}H_{14}O_5S$, an acid-base indicator that changes from yellow to red as the pH passes through 8

phlogiston: a hypothetical elastic fluid which was seen as a metalizing and combustible principle. Metals were seen as the result of combining calces with phlogiston; smelting expelled the phlogiston. In combustion, phlogiston leaves the combustible body to combine with air or saturate air. The theory of phlogiston is associated with Stahl. [Cavendish, Priestley, Scheele, Watt *et al.*]

phosphuretted hydrogen: phosphine, PH_3 [Dalton]

pied: Unit of length in late 18th-century France: 1 *pied* (Paris foot) = 12 ***pouces***; 1 *pouce* (Paris inch) = 12 ***lignes***. In modern units, the *pied* is equivalent to 0.325 meters or about 1.07 feet in the "English" system still commonly used in the United States. [Lavoisier]

pinte: volume unit in late 18th-century France, equal to 2.01508 English pints, 58.145 cubic inches, or 0.953 liters. [Lavoisier]

Plimmer's salt: sodium antimony tartrate, $Na(SbO)C_4H_4O_6$.

plumbago: a lead ore, including lead oxide (litharge) or lead sulfide (galena); or graphite (black lead). [Lavoisier, Priestley, Thenard]

Plessy's green: chromium(III) phosphate, $CrPO_4$, a green pigment; also **Arnaudon's green**.

plumbum: Latin for lead, hence the symbol Pb

pompholix: crude zinc oxide, ZnO (flowers of zinc). [Lavoisier]

potash: crude or purified potassium carbonate, K_2CO_3 (vegetable alkali, pearl ash) or crude sodium carbonate leached from the ashes of plant material; or potassium hydroxide, KOH (lye), or even potassium oxide, K_2O. [Dalton, Rayleigh, T. Thomson *et al.*]

pouce: Unit of length in late 18th-century France; see *pied*.

precipitate

- **black precipitate**: $Hg_2O\cdot Hg_2NH_2NO_3$, also known as Hahnemann's mercury, a black powder used as an antisyphilitic
- **precipitated mercury per se** or **precipitate per se**: See *mercurius calcinatus per se*.
- **red precipitate**: see *mercurius calcinatus per se*.
- **white precipitate**: $HgNH_2Cl$ (sal alembroth, ***sal sapientiae***); an insoluble white powder used in medicine as an antiparasitic
- **yellow precipitate**: yellow mercury(II) oxide, HgO

Prussian blue: complex salts used in inks and dyes resulting from the oxidation of the white precipitate of a solution of iron(II) sulfate, $FeSO_4$, and potassium ferrocyanide, $K_4Fe(CN)_6$.

prussiate: a cyanide, CN^-, ferricyanide, $Fe(CN)_6^{3-}$, or ferrocyanide, $Fe(CN)_6^{4-}$.

- **red prussiate**: potassium ferricyanide, $K_3Fe(CN)_6$
- **yellow prussiate**: potassium ferrocyanide, $K_4Fe(CN)_6\cdot 3H_2O$.

prussic acid: hydrocyanic acid, HCN [Berthollet, Gay-Lussac, Prout]

pyrite or **pyrites**: originally any "fire-stone" from which sparks could be struck; eventually an iron sulfide or iron-copper sulfide. [T. Thomson]

pyroligneous acid: distillate from wood, containing acetic acid, methanol, and acetone

quicksilver: liquid mercury metal. [Boyle, Cavendish, Priestley, Torricelli]

racemic acid: *meso*-tartaric acid, the optically inactive geometric isomer of tartaric acid, HOOC-CHOH-CHOH-COOH.

radio- See table.

- **-actinium**: a radioactive isotope of thorium produced in actinium decay, namely ^{227}Th (half life = 19 d). [Soddy 1 & 2]
- **-elements**: For occurrences before 1913 (*i.e.*, before the concept of isotopy), **radioisotopes** is often a more appropriate modern term. [Soddy 1, 2, 3]
- **-lead**: a radioactive isotope of lead produced in uranium decay, namely ^{210}Pb (half life = 21 y). Also **radium D**.

- **-tellurium**: An isotope of polonium produced in uranium decay, namely ^{210}Po (half life = 140 d). [Markwald] Also called **radium F**.
- **-thorium**: an isotope of thorium produced in thorium decay, namely ^{228}Th (half-life = 1.9 y). [Hahn & Ramsay, Soddy 1 & 2].

radium ... See table.

- ... **A**: an isotope of polonium produced in uranium decay, namely ^{218}Po (half-life = 3 min). [Rutherford & Royds]
- ... **C** There were three isotopes whose designation included radium C, all of which occur in uranium decay. Simple radium C is an isotope of bismuth, namely ^{214}Bi (half-life = 20 min). [Rutherford 1, 2, & 3] **Radium C'** is an isotope of polonium, namely ^{214}Po; it is the major decay product of radium C. **Radium C_2** is an isotope of thallium, namely ^{210}Tl (half-life = 1.3 min); it is a minor decay product of radium C. [Soddy]
- ... **D**: radiolead. [Soddy 1 & 2]
- ... **E**: ^{210}Bi, first made synthetically in 1936 by John Jacob Livingood by bombarding natural bismuth (^{209}Bi) with deuterons.
- ... **F**: radiotellurium.
- ... **G**: The isotope of lead which is the end-product of uranium/radium decay, namely ^{206}Pb.

Rankine scale: absolute temperature scale (*i.e.*, one in which absolute zero is assigned the value zero) named after the 19th-century Scottish engineer William Rankine and denoted by °R. One Rankine degree is the same size as a Fahrenheit degree, so the normal boiling point of water is 460°R and the normal boiling point is 672°R. (See Celsius scale, Fahrenheit scale, Kelvin scale.)

realgar: a native red or orange arsenic(II) sulfide, As_2S_2 (red orpiment, red arsenic, **ruby arsenic, ruby sulfur**)

Réaumur scale: temperature scale devised in 1731 by R. A. F. Réaumur and denoted by °R. The normal freezing point of water is 0°R and the normal boiling point of water is 80°R. (See Celsius scale, Fahrenheit scale, Kelvin scale.) [Lavoisier]

regulus: A metal was formerly called the regulus of the ore from which it was reduced; "**regulus**" (without further specification) meant **regulus of antimony** (*i.e.*, antimony in modern nomenclature). [Lavoisier]

Reinecke's ...

- ... **acid**: tetrathiocyanodiammonochromic acid, $HCr(NH_3)_2(SCN)_4$
- ... **salt**: an ammonium salt of Reinecke's acid, $NH_4[Cr(NH_3)_2(SCN)_4]{\cdot}H_2O$

retort: a container with a long tubular neck used by chemists and alchemists for distillation and the like. [Black, Cavendish, Lavoisier, Scheele]

reverberatory furnace: a furnace constructed so that a sample placed within it is heated from above as well as from the fire beneath it. For example, the furnace may have a top which reflects heat on the sample from the fire below it. [Black, Lavoisier]

rochelle salt: potassium sodium tartrate, $KNaC_4H_4O_6{\cdot}4H_2O$, named for the French seaport La Rochelle, where the compound was prepared; also known as **Seignette's salt**, after the apothecary who first prepared it.

Röntgen rays: X-rays, named after their discoverer, Wilhelm Röntgen.

ruby: Ruby itself is a red corundum, Al_2O_3

- ... **arsenic**: realgar
- ... **blende**: a red sphalerite, zinc sulfide, ZnS
- ... **copper**: cuprite, copper(I) oxide, Cu_2O
- ... **silver**: see silver
- ... **sulfur**: realgar

saccharum saturni: sugar of lead; see also Saturn

sal ...

- ... ***acetosella***: see sorrel salt
- ... ***aeratus*** (or ***saleratus***, literally aerated salt): potassium hydrogen carbonate, $KHCO_3$.
- ... ***ammoniac***: ammonium chloride, NH_4Cl [Black, Fahrenheit, Scheele, Wurtz, *et al*.]; also **sal armoniack** [Helmont]
- ... ***commune***: common salt, *i.e.*, sodium chloride, NaCl [Scheele]; also ; also ***sal fossile, sal marinum***
- ... ***de duobus***: potassium sulfate, K_2SO_4 (vitriolate of tartar)
- ... ***enixum***: potassium hydrogen sulfate ($KHSO_4$)
- ... ***mirabilis***: Glauber's salt.
- ... ***nitrum*** or ... ***nitri***: nitre. [Mayow]

- ... ***sapientiae***: mercury(II) ammonium chloride, $HgNH_2Cl$; literally, "salt of the wise". (**white precipitate**)
- ... ***volatile***: ammonium carbonate, $(NH_4)_2CO_3$

salt ...

- ... **of hartshorn**: ammonium carbonate, $(NH_4)_2CO_3$; see also spirit of hartshorn
- **salt of lemon**: see sorrel salt
- **-peter** or **-petre**: potassium nitrate, KNO_3 (nitre). [Bacon, Helmont, T. Thomson]
- ... **of tin**: tin(II) chloride, $SnCl_2$
- ... **of wormwood**: potassium carbonate, K_2CO_3

Saturn: In astrological and alchemical thought, the seven heavenly bodies known to the ancients were associated with seven metals also known in antiquity. Saturn was associated with lead (*plumbum*)

Scheele's green: an acidic copper(II) arsenite, $CuHAsO_3$.

Schlippe's salt: sodium sulfantimonate, $Na_3SbS_4 \cdot 9H_2O$, named for Carl Friedrich von Schlippe.

Schšllkopf's acid: apparently, Schšllkopf had three. 1-naphthol-4,8-disulfonic acid, 1-naphthylamine-4,8-disulfonic acid, and 1-naphthylamine-8-sulfonic acid. (Click here for structures.)

Seignette's salt: see rochelle salt.

Seven planets, seven metals: In astrological and alchemical thought, the seven heavenly bodies known to the ancients were associated with seven metals also known in antiquity. The associations were:

Sun (*Sol*)	gold (*aurum*)
Mercury	mercury (quicksilver, *hydrargyrum*)
Venus	copper (*cuprum*)
Moon (*Luna*)	silver (*argentum*)
Mars	iron (*ferrum*)
Jupiter	tin (*stannum*)
Saturn	lead (*plumbum*)

siliceous earth: silicon dioxide, SiO_2. [Lavoisier, Scheele]

silver ...

- **black** ...: stephanite, a native silver antimony sulfide, $5Ag_2S \cdot Sb_2S$
- **fulminating** ...: silver nitride, Ag_3N, an explosive solid; distinct from silver fulminate, $Ag_2C_2N_2O_2$, which is also explosive
- ... **glance**: argentite, silver sulfide, Ag_2S. (See glance.)
- **horn** ...: a native silver chloride, AgCl (***argentum cornu***)
- **ruby** ...: proustite, Ag_3AsS_3

soda: sodium carbonate, Na_2CO_3 (**washing soda**), or sodium hydrogen carbonate, $NaHCO_3$ (**baking soda**) [Dalton, Lavoisier, Prout, Rayleigh]. **Caustic soda** was sodium hydroxide, NaOH. [Mendeleev]. See also fossil alkali, marine alkali, common mineral alkali.

sorrel salt: potassium hydrogen oxalate, KHC_2O_4 (***sal acetosella*, salt of lemon**)

Spanish white: bismuth oxychloride, BiOCl, or oxynitrate, $BiONO_3$

spirit (***spiritus***): an essence or extract that can be prepared from another substance as by distillation

- ... of **alum**: sulfuric acid, H_2SO_4
- **colonial** or **Columbian** ...: methanol, CH_3OH
- ... **of hartshorn**: ammonia, NH_3, or its aqueous solution (formerly prepared from animal horns or hooves); see also salt of hartshorn. See alkaline air, volatile alkali. [Black]
- ... **of nitre**: nitric acid, HNO_3 (*aqua fortis*, nitrous acid, **acid spirit of nitre**) [Cavendish, Fahrenheit, Mayow, Priestley] or ethyl nitrite, $C_2H_5NO_2$, also known as the **sweet spirit of nitre** or nitrous ether. See nitre.
- **pyroacetic** ...: acetone, $(CH_3)_2CO$
- **pyroligneous** or **pyroxylic** ...: methanol

- ... **of salt** (***spiritus salis***): hydrochloric acid, HCl (*acidum salis*, marine acid, muriatic acid). [Black, Scheele]
- ... **of vitriol** (***spiritus vitrioli***): vitriolic acid.
- ... **of wine** (***spiritus vini***): concentrated aqueous ethanol, C_2H_5OH, typically prepared by distilling wine; see *aqua vitae*. [Fahrenheit, Helmont, Mayow, Scheele, *et al*.]
- ... of **wood**: methanol

sugar of lead (***saccharum saturni***: lead acetate, $Pb(CH_3CO)_2{\cdot}3H_2O$

sulphuret: sulfide (hepar). [Berzelius, Dalton, T. Thomson]

sulphuretted hydrogen: hydrogen sulfide, H_2S (hepatic air). [Dalton, Gay-Lussac, Prout, T. Thomson *et al.*]

sulphuric acid: formerly, sulfur trioxide, SO_3. [Dalton, Gay-Lussac, Lavoisier, Prout, T. Thomson *et al.*]

sulphurous acid or **sulphurous gas**: formerly, sulfur dioxide, SO_2. [Avogadro, Gay-Lussac, Lavoisier, Prout, T. Thomson, *et al.*]

Sun (***Sol***): In astrological and alchemical thought, the seven heavenly bodies known to the ancients were associated with seven metals also known in antiquity. The sun was associated with gold (*aurum*).

sweet salt: sodium chlorite, $NaClO_2$.

tartar: (**tartar of wine**) potassium hydrogen tartrate, $KHC_4H_4O_6$ [Stahl]

- **cream of** ... (***cremor tartari***): **tartar** purified into small white crystals.
- ... **emetic**: potassium antimonyl tartrate, $KSbOC_4H_4O_6{\cdot}1/2H_2O$
- **oil of** ...: a saturated solution of potassium carbonate, K_2CO_3 [Lavoisier]
- **salt of** ...: solid potassium carbonate [Black, Cavendish, Rey, Stahl]
- **vitriolate of** ... (or **vitriolated**): potassium sulfate, K_2SO_4 [Priestley] (***sal de duobus***)

terra ...: earth

- ... **ponderosa** ("heavy earth"), barium oxide, BaO
- ... **ponderosa aerata** ("aerated heavy earth"), barium carbonate, $BaCO_3$

Thénard's blue: blue cobalt aluminate, $Co(AlO_2)_2$, named for Louis-Jacques Thénard.

thorium ... See table.

- ... **A**: an isotope of polonium produced in thorium decay, namely ^{216}Po (half-life = 0.15 s).[Soddy]
- ... **C**: The names of two radioisotopes, both produced in thorium decay, included thorium C. Simple thorium C was an isotope of bismuth, namely ^{212}Bi (half-life = 61 min); **thorium C'** was an isotope of polonium, namely ^{212}Po (half-life = 0.3 µs) [Rutherford, Soddy]
- ... **D**: an isotope of thallium produced in thorium decay, namely ^{208}Tl (half-life = 3 min). [Soddy 1 & 2]
- ... **X**: an isotope of radium produced in thorium decay, namely ^{224}Ra (half-life = 3.6 d). [Rutherford, Soddy]

thymol blue: thymolsulphonphthalein, $C_{27}H_{30}O_5S$, an acid-base indicator that changes from pink to yellow as the pH is raised through 2.2 and then to blue as the pH is raised through 8.8

trona: natural sodium carbonate/bicarbonate, $Na_2CO_3{\cdot}NaHCO_3{\cdot}2H_2O$

Turnbull's blue: ferroferricyanide, $Fe_3[Fe(CN)_6]_2$, also known as insoluble Prussian blue

turbith mineral (or **turpeth**): basic sulfate of mercury, $HgSO_4{\cdot}2HgO$. [Cavendish, Lavoisier, Priestley]

tyrian purple: 6,6'-dibromoindigotin, $C_{16}H_8N_2O_2Br_2$, an important dye of the ancient Mediterranean.

uranium ... See table.

- ... **I**: is simply the most abundant isotope of uranium, ^{238}U.
- ... **II**: an isotope of uranium produced in uranium decay, namely ^{234}U (half-life = $2.5x10_5$ y). [Soddy 1, 2, & 3]
- ... **X**: There were two uranium X produced in uranium decay. Uranium X_1 (simply uranium X before the discovery of uranium X_2) was an isotope of thorium, namely ^{234}Th (half-life = 24 d); uranium X_2 was an isotope of protactinium ^{234}Pa. [Crookes; Rutherford; Soddy 1, 2, & 3]

- ... **yellow**: sodium uranate, Na_2UO_4, a pigment used in glass and ceramics

vegetable alkali: usually crude or purified potassium carbonate, K_2CO_3 (pearl ash), sometimes specified as **mild vegetable alkali** or **fixed vegetable alkali**. **Caustic vegetable alkali** is potassium hydroxide. [Davy]

Venus: In astrological and alchemical thought, the seven heavenly bodies known to the ancients were associated with seven metals also known in antiquity. Venus was associated with copper (*cuprum*).

virginium (**Vi** or **Vm**): a name proposed for element 87 (francium) in a report of detection of the element whose validity was ultimately not recognized.

verdigris: basic copper acetate, used as a pigment from green to blue; **blue verdigris** is copper(II) acetate, $Cu(C_2H_3O_2)_2{\cdot}H_2O$.

vermilion: mercury(II) sulfide, HgS, a red pigment; also known as cinnabar. (See minium.)

vis viva: energy. The law of conservation of energy was originally phrased in terms of *vis viva* [Joule, Kelvin, Mayer]

vitamin (or sometimes **vitamine**, from "vital amine" [Funk]): an organic substance essential in small quantities to the normal health of an animal. Vitamins must typically be supplied to the animal through diet. The chemical names for some vitamins follow. For structures, see "Molecule of the Month" at Oxford University.

- ... **A**: retinol, $C_{20}H_{30}O$, a fat-soluble vitamin derived from carotenes
- ... **B**: a group of water-soluble, heat labile compounds that typically serve as co-enzymes. They include many examples that contain amine groups (as in "vital amine").
- ... **B$_1$**: thiamin (or thiamine), $C_{12}H_{17}N_4OSCl$
- ... **B$_2$**: riboflavin (or riboflavine), $C_{17}H_{20}N_4O_6$
- ... **B$_3$**: niacin (or nicotinic acid), $C_6H_5NO_2$
- ... **B$_6$**: pyridoxin (or pyridoxine), $C_8H_{11}NO_3$
- ... **B$_{12}$**: cyanocobalamin (or cyanocobalamine), $C_{63}H_{90}CoN_{14}O_{14}P$
- ... **Bc**: folic acid, $C_{19}H_{19}N_7O_6$
- ... **C**: ascorbic acid, $C_6H_8O_6$, a water-soluble vitamin found in many fruits and green vegetables
- ... **D**: This fat-soluble vitamin consists of steroid derivatives including ergocalciferol, $C_{28}H_{44}O$, and cholecalciferol, $C_{27}H_{44}O$.
- ... **E**: This vitamin occurs in four naturally occuring forms, called α-, β-, γ-, and δ-tocopherol. The α form, $C_{29}H_{50}O_2$, has the greatest activity; the β- and γ- forms have one fewer methyl group, and the δ- form two fewer.

vitriol: a sulfate, especially iron sulfate; see copperas).

- **vitriolic acid**: sulfuric acid, H_2SO_4 [Black, Cavendish, Lavoisier, Priestley], also known as **oil of sulfur *per campanum***, **oil of vitriol** [Black, Lavoisier, Scheele, Stahl], and **spirit of vitriol** (***spiritus vitrioli***) [Black, Scheele].
- **vitriolic acid air** (and sometimes vitriolic acid): sulfur dioxide, SO_2, also known as sulphurous acid or **sulphurous gas**.
- **blue vitriol**: copper sulfate, $CuSO_4{\cdot}5H_2O$, also **roman vitriol**
- **green vitriol**: iron(II) sulfate, $FeSO_4{\cdot}7H_2O$
- **red** or **rose vitriol**: cobalt(II) sulfate, $CoSO_4{\cdot}7H_2O$
- **uranvitriol**: a uranium sulfate
- **white vitriol** or **salt of vitriol**: zinc sulfate, $ZnSO_4{\cdot}7H_2O$ [Scheele]; also **salt of vitriol**

volatile alkali: aqueous ammonia, NH_3; see alkaline air, spirit of hartshorn. **Concrete volatile alkali** refers to ammonium carbonate, $(NH_4)_2CO_3$. [Black, Cavendish, Lavoisier, Scheele, *et al.*]

water glass (also **soluble glass**): a hydrated sodium silicate, $Na_2Si_4O_9{\cdot}xH_2O$, either an amorphous solid or in thick aqueous solution, used as a binder or adhesive.

wolfram: a name of Germanic origin originally applied to a native iron manganese tungstate and later to the element tungsten, hence the symbol W.

xylenol blue: 1,4-dimethyl-5-hydroxybenzenesulfonphthalein, an acid-base indicator that changes from red to yellow as the pH is raised through 2 and then to blue as the pH is raised through 8.8.

The Incompleat Chymist: Being an Essay on the Eighteenth-Century Chemist in His Laboratory, with a Dictionary of Obsolete Chemical Terms of the Period

Jon Eklund
Smithsonian Studies in History and Technology, Number 33
Smithsonian Institute Press
Washington, DC, 1975

You may wish to consult Carmen Giunta's Glossary of Archaic Chemical Terms for additional information.

Introduction to the Dictionary

Just as Samuel Johnson pointed out that no dictionary of a living language can be perfect, so it must be argued that no dictionary for a living historical discipline will initially be complete or free from errors. The purpose of our dictionary is to make it easier for students to become acquainted with an esoteric and often confused nomenclature in order to more clearly interpret the technical activities of eighteenth-century chemists. This first effort is not truly multilingual, though it includes Latin and French phrases that were common in British journals and treatises. Those who wish to determine French and German equivalents usually can do so by finding parallel sections in the French, English, and German editions of Macquer's original Dictionnaire de Chymie, though it is hoped that an expanded, multilingual edition may be prepared for publication sometime in the future. In any event, readers are encouraged to communicate additions and corrections to the present dictionary.

For a full discussion of the significance of chemical nomenclature in the history of chemistry, the reader is urged to consult Maurice Crosland's classic *Historical Studies in the Language of Chemistry.*

A

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Absorbent Earth
Chalk, marble, and clays. No specific formulas. Generally carbonates, silicates, and sulfates.
Acesunt
Any substance which is slightly acid, or turning sour.
Acetated Earths, Metals, Etc.
Acetates ($C_2H_3O_2^-$).
Acetous Acid
Impure acetic acid from vinegar.
Acetum
Referring to vinegar, or to a compound made from vinegar, as in "acetum radicatum."
Acid Air (Priestley)
Hydrogen chloride (HCl).
Acid From Ants
Formic acid ($HCOOH$).
Acid, Nitri Phlogistic
See Nitrous Air.
Acid of Amber
Succine acid ($C_4H_6O_4$).
Acid of Apples
Malic acid ($C_4H_6O_5$).
Acid of Arsenic
Arsenic acid (H_3AsO_4).
Acid of Barberry
Malic acid.
Acid of Benzoin
Benzoic acid (C_6H_5COOH).
Acid of Borax
Boric acid (H_3BO_3).
Acid of Burning Sulphur
Sulfurous acid (H_2SO_3).
Acid of Four Spar
Hydrofluoric acid (mixed usually with silicon fluoride) (HF; SiF_4).
Acid of Lemons
Citric acid ($C_6H_8O_7$).
Acid of Milk
Lactic acid ($C_3H_6O_3$).
Acid of Milk-Sugar
Mucic acid ($COOH(CHOH)_4COOH$).

Acid of Molybdaena
Molybdic acid (H_2MoO_4).

Acid of Nitre
Nitric acid (HNO_3).

Acid of Phosphorus
Phosphoric acid (H_3PO_4).

Acid of Salt
Hydrochloric acid (HCl).

Acid of Sea-Salt
Hydrochloric acid, alone, or in a compound (i.e., the Cl^- radical).

Acid of Sorrel
Oxalic acid (COOH COOH).

Acid of Sugar
Oxalic acid (COOH COOH).

Acid of Tamarinds
Tartaric acid ($C_4H_6O_6$).

Acid of Tartar
Tartaric acid.

Acid of Urine
Phosphoric acid (H_3PO_4)

Acid of Vinegar
Acetic acid (CH_3COOH).

Acid of Vitriol
Sulfuric acid (H_2SO_4)

Acidium Aereum
Carbon dioxide (CO_2).

Acidium Mephiticum
Carbon dioxide (CO_2).

Acidium Pingue
J.F. Meyer's hypothesized "fatty acid."

Acidium Sacchari
Oxalic acid (COOH COOH).

Acid Vitriolated Tartar
Potassium hydrogen sulphate ($KHSO_4$).

Adopters
Small, circular vessels with a necked opening and a spout opposite. Ther were connected between the distilling head and the receiver.

Aduration
A union or combination into one.

Aerated Alkali
Any alkali carbonate (e.g., K_2CO_3).

"Aerated" Compounds (Bergman)
Carbonates (CO_3^{2-}).

Aerated Lime
Calcium carbonate ($CaCO_3$).

Aerated Water
Water containing dissolved carbon dioxide.

Aer Hepaticus
Hydrogen sulfide (H_2S).

Aerial Acid
Carbon dioxide (CO_2).

Aerugo (Aeruca) (Rust of Copper)
See Verdigris.

Aer Urinosum
Ammonia (NH_3).

Aethiops Mercuriales
See Athiops Mineralis.

Aethiops Mineralis (Aethiops Mercuriales)
Black mercuric sulphide (H_2S).

Air
Generally, any substance in gaseous state.

Air (Priestley)
A gaseous substance which could not be liquified by cold.

Air, Dephlogisticated
Oxygen (O_2).

Air, Fixed
Carbon dioxide (CO_2).

Air, Hepatic
Hydrogen sulphide (H_2S).

Air, Inflammable
Hydrogen (H_2).

Air, Marine Acid
Hydrogen chloride (HCl).

Air, Mephitic

Carbon dioxide (CO_2).

Air, Phlogisticated

Nitrogen (N_2).

Air, Vital

Oxygen (O_2).

Air of Flour Spar

Hydrofluoric acid gas (usually with silicon fluoride) (HF).

Air of Vitriol

Sulphur dioxide (SO_2).

Alaunerde

Alumina (Al_2O_3).

Alcohol

Usually spirit of wine (CH_3CH_2OH) (sometimes *any* very fine powder).

Alembic

A type of distillation apparatus.

Alexipharmic

A remedy or preservative against poison.

Alicant Kelp

Crude sodium carbonate (Na_2CO_3).

Alk. Min. Vitriol

Sodium sulphate (Na_2SO_4).

Alkahest

Originally, the universal solvent (alchmeical term)

Alkahest Glauber

See Fixed vegetable alkali (K_2CO_3)

Alkahest of Reapour

See fixed vegetable alkali (K_2CO_3)

Alkahest of Van Helmot (Glauber's Alkahest)

concentrated potassium carbonate (K_2CO_3)

Alkalescent

Any substance which is slightly alkaline or turning alkaline

Alkali, Caustic

Hydroxides (OH^-)

Alkali, Common mineral

Sodium Carbonate ($Na_2CO_3 \cdot 10H_2O$)

Alkali, Concrete Volatile

Ammonium carbonate $(NH4)_2CO_3)$

Alkali, Fossil

Sodium Carbonate (Na_2CO_3)

Alkali, Marine

Sodium Carbonate (Na_2CO_3)

Alkali, Mild

Carbonates (CO_3^{2-})

Alkali, Vegetable, Fixed

Potassium Carbonate (K_2CO_3)

Alkali, Vegetable, Mild

Potassium Carbonate (K_2CO_3)

Alkali, Volatile

Ammonia (NH_3)

Alkali of Soda

Sodium carbonate (Na_2CO_3)

Alkali of Tartar

Potassium Carbonate (K_2CO_3)

Alkali of Wine Lees

Potassium cArbonate (K_2CO_3)

Alkali Veg. Saltium

Potassium chloride (KCl)

Alkali Veg. Vitriolat

Potassium sulphate (K_2SO_4)

Alkaline Air (Priestly)

Ammonia gas (NH_3)

Alkalized Nitre

See fixed nitre

Allay

Alloy

Allonge

See Adopters

Alterant

Anything which alters of changes the state of another

Aludels

A unit of a mutiple-head, earthenware distilling apparatus. Usually used for sublimations.

Alum

Mixed double salts of aluminum sulphate with potassium sodium or ammonium sulfate. (Potassium salt, when pure, was most commonly called "Alum."). ($Al_2(SO_4)_3 \cdot K_2SO_4 \cdot 24H_2O$); ($Al_2(SO_4)_3 \cdot (NH_4)_2SO_4 \cdot 24H_2O$); ($Al_2(SO_4)_3 \cdot Na_2SO4 \cdot 24H_2O$).

Alumen

Aluminum sulphate ($Al_2(SO_4)_3$.

Alumen Ustum (Burnt Alum)

alum dehydrated by heating

Amalgam

Any mercury alloy

Ammoniacal Nitre

Ammonium nitrate (NH_4NO_3)

Ammonium Fixatum (Fixed Ammoniac)

The residue on heating sal ammoniac with lime, i. e., calcium chloride ($CuCl_2$)

Ammonium Nitrosum

Ammonium nitrate (NH_4NO_3)

Animal Alkali

Ammonium carbonate [$(NH_4)_2CO_3$]

Anodyne

A medicine or drug which alleviates pain.

Antichlor

Hydrated sodium thiosulfate ($Na_2S_2O_3$)

Antimonial Caustic

Antimony trichloride ($SbCl_3$)

Antimonium Diaphoreticum

Misture of antimony oxide and potassium antimoniate (Sb_2O_3; $KSbO_3$)

Antimony

Antimony sulfide (Sb_2S_3) (pre-eighteenth century). Pure antimony was called "regulus of antimony."

Antizeumic

Opposed to fermentation

Aqua Fortis

Concentrated nitric acid (HNO_3)

Aqua Phaganeda or Phagadenica

A mixture of corrosive sublimate and limewater

Aqua Regia

Misture of HCl and HNO_3. Various proportions were used, depending on the material to be dissolved. Commonly, more nitric acid than hydrochloric was employed.

Aqua Secunda

Dilute nitric acid , often used for cleaning metals and minerals.

Ardent Spirit

Ethyl alcohol obtained after repeated distillations (CH_3CH_2OH)

Argillaceous Earth

Clay

Aromatic Oil

Any "oil" with a sweet or exotic odor. Often an essential oil.

Arsenic

Arsenic trioxide (As_2O_3)

Arsenical Sal Ammoniac

Ammonium arsenate $(NH_4)HAsO_4$.

Ash, Black

Impure sodium carbonate (Na_2CO_3).

Ash, Pearl

See Pearl Ash

Ash, Pot

See potash

Ashes of Tin

Stannic oxide (SnO_2)

Assay

A quantitative determination of the metal in an ore or alloy

Atramentum

Ferrous sulfate ($FeSO_4$)

Attrition

The action of rubbing one body against another; mutual friction.

Auripigmentum

Arsenic trisulfide (As_2S_3)

Aurum Fulminans

An explosive gold compound prepared from gold dissoled in "Aqua Regia" and a solution of ammonium carbonate. The exact formula is still in doubt.

Avolation

Evaporation,escape, act of "flying away."

Azote

nitrogen (N_2)

Azure

A blue pigment from cobalt

Azurite

Basic copper (cubric) carbonate ($2CuCO_3 \cdot Cu(OH)_2$

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Baking Soda
Sodium bicarbonate ($NaHCO_3$)
Balloons
Vessels used to receive condensation products in distillation.
Balneum Mariae
The water bath used for heating more delicate materials such as animal and vegetable mater.
Balsam
Light oily aromatic extracts from trees which cure into resins.
Barilla
Impure soda extracted from soap-wort (impure Na_2CO_3)
Barite, Baryte(s)
Barium sulfate ($BaSO_4$)
Baryta
Barium oxide (BaO)
Basis or Base
Any substance "A" which (1) is dissolved by substance "B"; (2) receives "B" and "fixes" it; (3) forms a compound of "B."
Bath Metal
A 4:1 alloy of copper and zinc, respectively.
Bay Salt
Sodium chloride (NaCl).
Beak
A tube, usually tapered, attached to a vessel to allow the exit of its contents.
Berlin Blue
Ferric ferrocyanide ($Fe_4[Fe(CN)_6]_3$.
Berlin Green
Ferric ferricyanide ($Fe[Fe(CN)_6]$.
Berthollet's Salt
Potassium chlorate ($KClO_3$).
Bezoardicum Minerale
See Bezoar Mineral.
Bezoar Mineral
Antimonic acid (H_3SbO_4).
Bismuth Corne
Bismuth oxychloride (BiOCl).
Bitter Cathartic Salt
Magnesium sulfate ($MgSO_4$).
Bitter Earth
Magnesium oxide or carbonate (MgO; $MgCO_3$).
Bittern
Liquor remaining after salt-boiling; a solution containing magnesium salts.
Bitter Salt
Magnesium sulphate ($MgSO_4 \cdot 7H_2O$).
Bitter Spar
"Dolomite" -Calcium and magnesium carbonate ($CaCO_3 \cdot MgCO_3$).
Bitumens
An amorphous grouping of resinous and petroleum products: crude oil, amber, asphaltum, coal.
Black Ash
Impure sodium carbonate (impure Na_2CO_3)
Black Copper
Copper sulfide (CuS).
Black Flux
A mixed product from the deflagration of charcoal, metal filings, nitre, and excess tartar.
Black Jack
See Blend.
Black Lead
Natural graphite of the sort used in pencils.
Black Wad
Manganese dioxide.
Blend
A mineral which looks very much like galena (PbS) and thus sometimes called "false galena." Now known as sphalerite. Primarily zinc sulfide (ZnS).
Blind Head
The top portion of a distilling apparatus which is not equipped with a beak or spout.
BLUE VITRIOL
Copper sulfate ($CuSO_4$)
BOLE (OR BOLAR EARTH)
Clays which adhere to the tongue when applied dry and which are colored yellow and red by a ferruginous (iron oxide) earth.
BORAX

Sodium tetraborate ($Na_2B_40_7 * 10H_2O$).

BRASS

An alloy of copper and zinc.

BRAUSTEIN

Manganese dioxide (MnO_2).

BRIMSTONE

Sulphur (S).

BRONZE

An alloy of copper and tin.

BUDDLING DISH

A flat pan or vat used in washing ores.

BURNING SPIRIT OF SATURN

Impure acetone (CH_3COCH_3).

BURNT ALUM

Exsiccated alum ($AIK (SO_4)_2$. Product of heating potassium alum.

BURNT LIME

See Quicklime.

BUTTER OF ANTIMONY

Deliquescent antimony trichloride ($SbCl_3$)

BUTTER OF ARSENIC

Arsenic trichloride ($AsCl_3$)

BUTTER OF TIN

Stannic chloride ($SnCl_4$)

BUTTER OF ZINC

Zinc chloride ($ZnCl_2$).

BUTYRUM ANTIMONII

See Butter of Antimony.

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CADMIA

A term used for various forms of several substances, including cobalt. Minerals containing carbonates of zinc and various compounds of iron, among other things, were often called cadmia or "calamine."

CALAMINE

In its purest form, zinc carbonate ($ZnCO_3$)'

CALAMY (CALAMINE)

Zinc carbonate ($ZnCO_3$), sometimes ($Zn_2SiO_4 * H_2O$).

CALCAREOUS EARTH

Usually chalk ($CaCO_3$). Also possible magnesia and/or alumina and/or barytes. Also lime.

CALCARIUM POTENTIALE

Potassium carbonate (K_2CO_3).

CALCIC LIVER OF SULFUR

Calcium sulfide (CaS).

CALCINATION

The action of fire on mineral substances in which the reactants (a) often lose a noticeable amount of weight, (b) acquire a white color, (c) become friable (easily crumbled or pulverized). Almost always, a very high heat is employed.

CALCINED METALS

Oxides.

CALCITE

Calcium carbonate ($CaCO_3$)

CALLUS

Any hard formation on the surface of a liquid or another solid.

CALOMEL

Mercurous chloride (Hg_2Cl_2)

CALX

Any powder obtained by strongly heating a substance in air. Almost always an oxide.

CALX ACETOSELL

Calcium oxalate (CaC_2O_4)

CALX AERATA

Calcium carbonate ($CaCO_3$)

CALX CITRATA

Calcium citrate ($Ca_3(C_6H_5C_7)_2$ 4 H_2O).

CALX MOLYBDAENATA

Calcium molybdate ($CaMoO_4$)

CALX OF ANTIMONY

Antimony trioxide (Sb_2O_3)

CALX OF GOLD

Not a true compound, but small discolored pieces of gold formed after exposure to relatively high heat.

CALX OF STONE

Calcium oxide (CaO).

CALX PLUMBI AERATA

See White Lead.

CALX SACCHARATA

Calcium oxalate (CaC_2O_4).

CALX. TARTARISATA

Calcium tartrate ($CaC_4H_4O_6$ $4H_2O$).

CALX VIVA

Quicklime (CaO).

CAMPHIRE (CAMPHORA, CANFORA, ETC.)

See Camphor.

CAMPHOR

An aromatic extract from the sap of certain trees found in Brazil and the Far East.

CAPUT MORTUM

Most commonly signifies any solid residue remaining after dry distillation. Sometimes used for ferric oxide (Fe_2O_3)

CARBONATE OF LIME

Calcium carbonate ($CaCO_3$).

CARBONIC ACID

Carbon dioxide (CO_2).

CARBONIC OXIDE

Carbon monoxide (CO).

CARBURETTED HYDROGEN GAS

Methane (CH_4)

CATHARTIC SALT OF GLAUBER

Sodium sulphate (Na_2SO_4).

CAUSTIC ALKALIS

Hydroxides ($-OH^-$).

CAUSTIC BARYTA

Barium hydroxide ($Ba(OH)_2$ $8H_2O$).

CAUSTIC CALCAREOUS EARTH

Calcium hydroxide ($Ca(OH)_2$).

CAUSTIC LEY (CAUSTIC LEES, ETC.)

See Caustic Lye.

CAUSTIC LYE:

Since "lye" had several meanings, this phrase was often used to refer specifically to the three strong mineral ($NaOH$, KOH, and NH_4OH) bases and usually meant potassium hydroxide (KOH).

CAUSTIC PONDEROUS EARTH

Hydrated barium hydroxide ($Ba(OH)_2 \cdot 8H_2O$).

CAUSTICUNi ANTIMONIALE

Probably antimony trichloride ($SbCl_3$)

CAWK

Barium sulphate ($BaSO_4$)

CEMENTATION

Any process by which a solid is caused to penetrate and combine with another substance.

Cendres Gravellees

Potassium carbonate (K_2CO_2).

Ceruse (Cerussa) (Cerusse)

See White Lead.

Cerusse Antimony

White antimony trioxide (Sb_2O_3).

Chalk

Calcium carbonate ($CaCO_3$).

Chalybeate (Water)

Any water which is impregnated or flavored with iron.

Chalybs cum Sulphure Preparatus

Ferrous sulfide (FeS).

Chalybs Tartar (Tartarified Iron)

A substance produced by the action of cream of tartar on iron filling. Probably ($FeC_4H_4O_6$).

Chymists Spirit

Any solution of ammonia (NH_4OH).

Cineres Clavellati

Potassium carbonate (K_2CO_3).

Cinnabar

Mercuric sulfide (HgS).

Cinnabar of Antimony

Mercuric sulphide (HgS), when produced by heating together mercuric chloride and crude antimony (antimony trisulfide).

Circulation

Cyclic distillation or refluxing.

Citrated Alkalies

Citrates.

Clays

Any stiff but malleable and sticky mineral solid.

Clyssus

Any vapors from the detonation of nitre with other substances which have been condensed and collected, as in clyssus of sulphur.

Coagulation

Reducing fluids to solid form.

Coagulum
A precipitate.

Cobalt
Cobalt ore. Pure cobalt was regulus of cobalt ($CoAsS$).

Cochineal
A scarlet dye made from the insect Coccus cacti, native to Mexico and Central America.

Coction
Any process in which heat was applied over a long period. This term usually implied less strenuous applications of heat than calcination, but it was used more broadly than decoction.

Cohobation
Repeated distillations, or any cyclic process in which a liquid is vaporized and condensed as, for example, in refluxing.

Colcothars
Any colorless sulfates (vitriols) in which the water of hydration was removed ($-SO_4$).

Colcothar
Ferric oxide (Fe_2O_3).

Colcothar Vitrioli
Red oxide of iron ($Fe_2O_3 \cdot FeO$) produced by heating green vitriol.

Collature
Filtration through a relatively coarse filter, e.g., a hair sieve, woolen cloth, etc.

Colophony
A resinous substance from distillation of light oil from turpentine.

Common Ammoniac
Ammonium Chloride (NH_4Cl).

Common Caustic
Potassium hydroxide or, less often, sodium hydroxide.

Common Magnesia
Magnesium carbonate ($MgCO_3$).

Common Mineral Alkali
Sodium carbonate (Na_2CO_3).

Common Nitre (Saltpeter)
Potassium nitrate (KNO_3).

Common Salt
Sodium chloride ($NaCl$).

Concentration
Any process in which the solute/solvent ratio is increased. Less often, this term was used to describe the separation of a substance A from a substance B joining it to a third substance, C.

Concreted
Solidified, congealed, coagulated, or (as verb) to unite, combine physically, as in solidity. Very rarely used for chemical combinations.

Concrete Volatile Alkali
Ammonium carbonate ($(NH_4)_2CO_3$).

Copperas
Originally blue vitriol. Later sometimes used for the entire class of vitriols (sulfates). Also sometimes ferrous sulfate ($FeSO_4 \cdot 7H_2O$).

Corneous (Horn) Lead
Lead chloride ($PbCl_2$).

Corning
Any process in which a whole or coarsely ground substance is granulated.

Cornu Cervi
Impure ammonium carbonate ($(NH_4)_2CO_3$).

Corrosive Sublimate
Mercuric chloride ($HgCl_2$).

Coruscate
To give off intermittent flashes of light, to sparkle.

Cream of Lime
Fine precipitate of calcium hydroxide ($Ca(OH)_2$) from water.

Cream of Tartar (Tartar)
Potassium hydrogen tartrate (KHC_4H_4O).

Creech
Calcium sulfate ($CaSO_4$).

Cremor
Any scum gathering at or near top of a liquid. Also, a thickening or change in color or consistency on top or within a liquid.

Creta Alba
Gypsum (calcium sulfate dihydrate) ($CaSO_4 \cdot 2H_2O$).

Crocus
Any solid of a saffron or reddish color, as in Crocus of Mars.

Crocus Martis
Ferric oxide (Fe_2O_3).

Crocus of Iron
Ferric oxide.

Crocus of Mars
Ferric oxide.

Crocus Saturni

Red lead (minium) (Pb_3O_4).

Crude Antimony

Natural antimony sulfide (Sb_2S_3).

Crude Flux

Nitre and tartar mixed in any proportion without detonation.

Crystalline Earths

Any solid which is (1) not attached in acids, (2) friable, (3) hard enough to strike fire with steel.

Crystallised Alkali

Sodium carbonate (Na_2CO_3).

Crystallised Verdigris

Cupric acetate ($Cu(C_2H_3O_2)_2 \cdot H_2O$).

Crystallised Volatile Alkali

Ammonium carbonate $(NH_4)_2CO_3$.

Crystallization

Any process in which crystals are formed from a liquid. Usually accomplished through concentrating and/or cooling a solution.

Crystals of Copper

Mostly copper acetate ($Cu(C_2H_3O_2)_2$).

Crystals of Silver (Lunar Crystals)

Silver nitrate, usually as a powder ($AgNO_3$).

Crystals of Venus

Copper acetate ($Cu(C_2H_3O_2)_2$).

Cubic Nitre

Crystallized sodium nitrate ($NaNO_3$).

Cucurbit

The lower part of an alembic. Shorter, more squat and ovoid than a matrass.

Cyprian Vitriol

Copper sulfate ($CuSO_4$).

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Damps

Any dangerous vapors in caves, mines etc.

Decantation

To a separate the supernatant liquid from a solid precipitate by pouring the liquid off, being careful that all of the solid remains in the vessel.

Decoction

Continuous application of boiling heat to a reaction mixture.

Decompounded

Doubly compounded, or composed of three or more substances.

Decrepitation

Rapid physical decomposition of some crystals when heated. Characterized by a crackling noise.

Deflagration

To cause a substance to burn rapidly, with flame.

Deliquescence

The property some crystalline substances have of dissolving spontaneously in liquid absorbed from the air.

Deliquium

Change of salt from a solid to a fluid state by contact with air only.

Demi-Metal

See Semi-Metals

Dephlegmation

To remove water from a solution, usually one of an acid or alcohol. There is a sense of purifying about the term, as opposed to simple concentration.

Dephlogisticated Acid of Salt

Chlorine (Cl_2).

Dephlogisticated Air

Oxygen (O_2).

Dephlogisticated Calx of Iron

Ferrous oxide (Hydroxide) (FeO or $Fe(OH)_2$).

Dephlogisticated Marine Acid

Chlorine (Cl_2).

Depuration

To free from impurities, purify.

Desquamation

The process of removing scaly crusts which form on a surface.

Detonation

Any rapid chemical reaction accompanied by noise and often heat and light, e.g., explosions.

Diaphoretic

Any substance which induces perspiration when administered to a patient.

Diaphoretic Antimony

Mixture of a antimony oxide and potassium antimonate (Sb_2O_3; $KSbO_3$).

Digestion

The process in which heat is continuously applied to a substance without boiling it (usually in open vessels).

Digestive Salt

Potassium chloride (KCl).

Digestive Salt of Sylvius

Potassium chloride (KCl).

Diminished Nitrous Air (Priestly)

Nitrous oxide (N_2O).

Distillation

A process in which all or some portion of a substance is vaporized and then condensed and collected.

Distillation Per Ascensum

Distillation with the collecting vessel above the heated vessel.

Distillation Per Decensum

Any distillation where the collecting vessel is below the heated vessel.

Distillation Per Obliquium

Distillation in a retort used for substances of (a)relatively low vapor pressure and (b)other properties that make distillation difficult, e.g., honey.

Distillation with Addition

Adding some substance prior to distillation that will aid the process by (1) loosening the desired volatile product chemically from its compound; (2) fixing the product not desired, thus retaining it in the vessel; (3) by adding a volatile substance desired, thus making the fixed substance volatile (addition of properties).

Diuretic Salt

Potassium acetate ($KC_2H_3O_2$).

Division

Any process in which mixtures are separated into their homogeneous components by mechanical means.

Docimacy

Assaying

Dry Way

Term used for all operations that are conducted without adding a liquid medium. Reactions done through fusion, however, are still regarded in the dry way.

Dulcification

Any process in which a caustic substance is rendered less corrosive.

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Earth

Usually a carbonate, oxide or hydroxide. Earths were originally classified by physical properties as absorbent, crystalline, and dry, insipid, not inflammable, fusible solids which often recovered their original texture after fusion.

Earth, Calcareous, Caustic

Calcium hydroxide ($Ca(OH)_2$)

Earth, Calcareous, Mild

Calcium carbonate ($CaCO_3$)

Earth, Magnesian, Mild

Magnesium carbonate ($MgCO_3$)

Earth, Silicous

Silica (SiO_2)

Earth Rhubarb

Calcium oxalate (CaC_2O_4)

Earthy Salts

Compound of acids and earths.

Eau Forte

(Strong Water) Usually concentrated nitric acid (HNO_3), sometimes (1) spirit of wine (ethanol), (2) caustic soda solution.

Ebullition

The agitating, bubbling action of a liquid that is undergoing rapid, active boiling.

Edulcorated Quicksilver

Mercurous chloride (Hg_2Cl_2)

Edulcoration

The washing of a solid (often a precipitate) with water to free it from soluble impurities such as salts and acids. Because of the latter, there are overtones of sweetening, purification, and softening with this term.

Elaeosaccharum

A mixture of an oil and sugar. Used to make oils soluble in water, wines, spirits, etc.

Electuaries

Medicinals in the form of a paste or conserve.

Elixation

The action of boiling or stewing.

Elutriation

Separation and purification of a mixture of granular solids with water by (a) decanting, (b) straining, or (c) washing.

Emetic

Any substance that induces vomiting.

Emetic Powder

Potassium antimonyl tartrate ($KSbC_4H_4O_7 \cdot (1/2) H_2O$)

Emplastrum Simplex

Impure lead oleate ($Pb(C_{18}H_{33}O_2)_2$)

Empyreumatic

Tasting or smelling or burnt organic matter.

Empyreumatic Oils

Liquid oils that (a) are acid, (b) are soluble, (c) do not retain the taste and odor of the substance from which they are obtained, (d) have a taste and/or odor of burnt organic matter.

Enfiladid Ballon

A spherical vessel with opposed, necked openings.

English Laxative Salt

Magnesium sulphate ($MgSO_4$)

English Salt

See Bitter Salt

Ens Martis

A mixture probably consisting of iron chlorides and ammonium chloride. Used as a medicine.

Ens Veneris

A mixture probably consisting of copper chlorides and ammonium chloride. Used as a medicine.

Epsom Salts

Magnesium sulfate ($MgSO_4$)

Essay

See Assay

Essence

Any essential oil.

Essential Oil

Any oil that smells the same as the vegetable from which it was obtained and has a low boiling point (below that of water)

Essential Oil of Turpentine

The most volatile portion of turpentine.

Etain de Glace

Bismuth (Bi)

Ether

In the 18th century, alykyl chlorides and nitrates often were confused with true ethers, such as ethyl ether (CH_3CH_2-O-CH_2CH_3).

Ether of Benzoin

Ehtyl benzoate ($C_9H_{10}O_2$)

Ether of Nitre

Mainly ethyl nitrite ($C_2H_5NO_2$)

Ether of Vinegar

Ethyl acetate ($C_4H_{10}O_2$)

Ether of Vitriol

Ethyl ether ($C_4H_{10}O$)

Ethiops Mineral

Mostly black mercury sulfide (Hg_2S)

Evaporation

Any process in which the liquid portion of a solution or mixture is vaporized, often with the help of heat.

Exalt

To make more spiritous, volatile, or generally more active; activate.

Exsiccate

To dry; remove moisture.

Exhalation

When parts of substances are separated by heat from the solid and fly off into the air. Used as a tool to obtain fixed parts as well as volatile parts. This includes calcination, distillation, etc.

Expression

To separate a component from organic matter or any other solids or semisolids by squeezing the material in a press. A mechanical rather than chemical means of separation.

Extemporaneous Alkali:

See white flux.

Extraction:

To separate one substance from others by using solvents.

Extract of Lead:

Impure lead acetate ($Pb(C_2H_3O_2)_2$).

Extract of Mars:

Solid ferrous tartrate ($FeC_4H_4O_6$).

Extravasation:

The escape of an organic fluid (e.g., blood, sap) from its proper vessels into surrounding tissues.

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Faints:

The second identifiable, thin, and light liquid fraction from distillation.

Fearce:

To pulverize or mascerate.

Febrifugal Salt:

Potassium sulphate (K_2SO_4).

Febrifugal Salt of Sylvius:

Potassium chloride (KCl).

[A] Ferment:

A substance actually fermenting, inclined to ferment, or used to cause fermentation, e.g., yeast.

Fetid Oil:

Any oil substance that was empyreumatic, i.e., had the odor of burned animal matter.

Filtration:

To separate a liquid from a particulate solid by passing the liquid through a porous material, e.g., cloth or paper.

Finery Cinder:

Iron oxide (Fe_3O_4).

Fire Air (Scheele)

Oxygen (O_2).

Fixed Air:

Carbon dioxide (CO_2).

Fixed Alkali (Soda):

Sodium carbonate (Na_2CO_3).

Fixed Alkali Salt:

Solid potassium carbonate (K_2CO_3).

Fixed Ammoniac (Fixed Sal Ammoniac):

Calcium chloride ($CaCl_2$).

Fixed Nitrate:

Usually potassium carbonate; sometime potassium sulfate (K_2CO_3; K_2SO_4).

Fixed Sulphur of Antimony:

Oxides of antimony, probably primarily the trioxide (Sb_2O_3) which forms when antimony ore (Sb_2S_3) is heated in air. Antimony calx.

Fixed Vegetable Alkali:

Potassium carbonate (K_2CO_3).

Fixity:

The degree of solidity of a substance as measured by the ability of that substance to resist the action of fire. The opposite of volatility.

Flores:

See Flowers.

Flores ac Vitrum Antimony:

Probably antimony trioxide (Sb_2O_3) with small amounts of antimony trisulfide (Sb_2S_3).

Flores Antim:

See Flowers of Antimony.

Flores Benzoini:

Benzoic acid (C_6H_5COOH).

Flores Martiales (Ens Veneris):

Impure ammonium chloride (NH_4Cl). Also includes iron filing used in the reaction, with possibly some chlorides of iron.

Flores Sulfurous:

See Flowers of Sulfur.

Flores Viridis Aeris:

Crystallized cupric acetate ($Cu(C_2H_3O_2)_2$).

Flores Zinc:

See Flowers of Zinc.

Flowers (Flores)

Any solid product of sublimation. Usually a powder.

Flowers of Antimony:

Antimony trioxide (Sb_2O_3).

Flowers of Arsenic (White Arsenic):

Arsenious oxide (As_2O_3).

Flowers of Benjamin:

See Flowers of Benzoin.

Flowers of Benzoin:

Benzoic acid (C_6H_5COOH).

Flowers of Phosphorus:

Volatile oxides of phosphorous (P_2O_3; P_2O_5).

Flowers of Sulfur:

Sublimed and condensed sulfur vapors (S).

Flowers of Zinc:

Volatile zinc oxide (ZnO).

Fluor (as adjective):

Flowing, an adjective indicating that the substance cannot be made solid, e.g., flour volatile alkali,; or, in referring to a mineral, a solid that is easily fusible.

Fluor Acid Air:

Silicon fluoride (SiF_4).

Fluorspar:

Calcium fluoride (CaF_2).

Focus of a Furnace:

That part of a furnace where the fuel is actually burned.

Foliated Earth of Tartar:

Potassium acetate ($KC_2H_2O_2$).

Fossil:

Any mineral substance.

Fossil Alkali:

Sodium carbonate (Na_2CO_3).
Fossil Cadmia:
A cobalt mineral, probably cobaltite ($CoAsS$).
Fossil Oil:
Clear, distilled crude oil.
Frigorific
Having property of producing cold.
Focus:
A substance which can act as a (usually opaque) surface coloring agent.
Fulginosity:
Soot or any black deposit from flames of oily substances.
Fulmination:
Any very rapid reaction which produces heat, light, and noise; e.g., explosions.
Fuming Liquor of Boyle:
Ammonium polysulfide ($(NH_4)_2S_y$).
Fuming Liquor of Libavious:
Stannic chloride solution ($SnCl_4$).
Fusion
The changing a solid body to a liquid by the action of fire.

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Galena
Lead sulfide (PbS).
Galley
A type of furnace in which several vessels are heated side by side simultaneously.
Galls
Parasitic growths, commonly found on oaks, which, when dried, ground, and dissolved were useful indicators for iron.
Gentle Calx of Lead
Lead nitrate ($Pb(NO_3)_2$.
German Ash
Potassium carbonate (K_2CO_3).
German Potash
Probably a mixture of potassium carbonate and oxide.
German Vitriol
An ore with both copper and gerrous sulfates ($CuSO_4$, $FeSO_4$).
Galacial Oil of Antimony (Butter of Antimony)
Antimony trichloride ($SbCl_3$).
Glass of (A Substance)
The fused form of the substance, especially if semitransparent.
Glass of Antimony
Probably antimony oxysulfate ($Sb_2O_2SO_4$). Prepared by fusion of antimony sulfide, antimony, and an oxide of antimony.
Glass of Borax
Fused borax.
Glass of Lead
Any fused lead compound (especially ceruse, minium, or litharge).
Glauber's Alkahest (Alkahest of Van Helmont)
Concentrated potassium carbonate solution ($K_2CO_3(aq)$).
Glauber's Sal Ammoniac
Ammonium sulphate ($(NH_4)_2SO_4$).
Glauber's Spirit of Nitre
Fuming nitric acid (HNO_3).
Globuli Martiales
Iron powder boiled in cream of tartar solution. Presumably contains some ferrous tartrate ($FeC_4H_4O_6$). A pharmaceutical preparation of iron.
Glucinum
Beryllium (Be).
Golden Spirit of Sulphur
Ammonium sulphide ($(NH_4)_2S$).
Graves
The residue left after extracting oils from animal fat by means of heat and moderate pressure.
Gravid
Heavy or dense.
Green Vitriol (Vitriol of Mars)
Ferrous sulfate ($FeSO_4$).
Grume(s) (Grumous)
(1) Viscous, clotty; (2) heap(s), clusters.
Guaic (Guyac, Guacium)
A tropical wood sometimes used for the resinous extract of that wood.
Gum
Resinous or musiloginous extracts from plants, shrubs, or trees.
Gum Acacia

Like gum arabic, but thought to be distinguishable from it; the dried resinous exudation of certain varieties of the acacia tree.

Gum Arabic

The dried exudation of certain varieties of the acacia tree.

Gum Benzoin

The dried resin of the tree Styrax benzoin.

Gum Dragon

See Gum Tragacanth.

Gum Lac

Dark-red resionous incrustation produced in certain trees by the insect Carteria lacca. When refined by certain processes it beomes "shell-lac" or "shellac."

Gum Tragacanth (Gum Dragon)

Dried gummy exhudation of the tree Astragalus gummifer and related speices.

Gypseous Earths

Used for both gypsum or the "earth" contained in it , i.e., calcium oxide. Sometimes the oxide was confused with carbonate as the "earth" of gypsum.

Gypseous Substances

Solid substances which (a) are not soluble in acids, (b) are not hard enough to strike fire from steel, (c) when mixed with water may form a paste which hardens into a solid, and (d) becomes powdery when exposed to fire.

Gypsum

Calcium sulfate dihydrate ($CaSO_4 \cdot 2H_2O$).

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Halitus

Matter in a very subtile form, as a "vapor" or "exhalation." Like these, a "halitus" was often hypothesized if a phenomenon was ascribed to material causes, but no material could be detected by known means.

Hartshorn (Hart's Horn)

Ideally, the horn of the male European red deer, but the horns of other deer species were acceptable substitutes.

Hartshorn Calcined to Whiteness

Hartshorn subjected to heat over a long period and developing into a white substance.

Hartshorn Prepared Philosophically

Much like hart's horn calcined to whiteness, but usually with less heat and for a longer period.

Head

The upper part of a distillation apparatus. Also, the bulb or other enlargement at the end of a tube.

Heavy Carburetted Hydrogen

Ethylene (C_2H_4).

Heavy Earth

Barium oxide (BaO). Also barium hydroxide and barium carbonate.

Heavy Inflammable Air

Used at various times for (a) carbon monoxide (CO), (b) water gas (a mixture of H_2 and CO), or (c) methane (CH_4).

Heavy Spar

Barium sulfate ($BaSO_4$).

Hellebore

A plant of the genus Helleborus. Usually Helleborus niger, the so-called "Christmas rose." The poisonous extract was used in dilute preparations as a medicinal in the 17th and 18th centuries.

Hemlock

The vulgar name for the poisonous plant Conium maculatum and/or its extract.

Henna

The plant Lawsonia inermis. The dried and powdered shoots and leaves were used as a dye or, with suitable medium, a cosmetic.

Hepar Antimonii

Antimony trisulfide (Sb_2S_3).

Hepar Calcis

Calcium sulfide (CaS).

Hepars

Sulfides ($-S^{2-}$)

Hepar Sulphuris (Liver of Sulphur)

Produced by heating potassium carbonate with sulphur. Not a true compound, it was a metastable mixture of potassium polysulfides and sulfate (K_2S, K_2S_2, K_2S_3, K_2S_4, K_2S_5, K_2SO_4).

Hepatic Air

Hydrogen sulfide gas (H_2S).

Hessian Crucible

A type of crucible made in Hesse, Germany, of a mixture of native clay and fine sand. Such crucibles were noted for being able to withstand sudden changes in temperature.

Homberg's (Sedative) Salt

Boric acid (H_3BO_3 (ortho); $H_2B_4O_7$ (tetra)).

Horn (Corneous) Lead

Lead chloride ($PbCl_2$).

Horn Mercury

Chloride of mercury ($HgCl_2$; Hg_2Cl_2).

Horn Silver (Luna Cornea)

Fused silver chloride (AgCl).

Horn Tin

Stannous chloride ($SnCl_2$).

Hungarian Vitriol
Usually ferrous sulfate ($FeSO_4$) but also used for copper sulfate ($CuSO_4$).

Hydromel
Mixture of honey and water, usually in equal proportions. Ferments into "mead."

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Iceland Spar (Calcite)
A particular crystal form of calcium carbonate ($CaCO_3$).

Icy Butter
Antimony chloride ($SbCl_3$).

Imbibition
To soak or saturate with a liquid.

Infernal Stone
An alkali hydroxide (NaOH, KOH). [Not to be confused with the French term pierre infernale.]

Inflammable Air
Usually hydrogen (H_2), though the usage is not constant among Priestley, Watt, Lavoisier, or Berthollet. Sometimes carbon monoxide (CO).

Inflammable Air from Metals
Hydrogen (H_2).

Infusion
The extraction of chemical substances by soaking them in a solvent, usually water. Sometimes boiling water was poured on a mixture of substances and then allowed to cool in order to aid the extraction; but if the heat were used, the temperature could not exceed that of boiling water.

Insolation
Digestion in which the heat was supplied by the sun rather than a furnace.

Inspissate
To thicken or condense.

Intermediate Salt of the Ley of Blood
Potassium ferrocyanide ($K_4Fe(CH)_6$).

Intermediate Salts
Usually normal salts; occasionally acid salts.

Intermedium
Any reagent or reactant believed to be necessary for a reaction but which does not always appear on the product.

Intumescence
The process of swelling up.

Ipecacuanha
A preparation from the root of the South American plant Cephaelis Ipecacuanha.

Iron Ochre
A mixture of silica, clay, and various oxides of iron. In red ochre the oxide is simple Fe_2O_3; in yellow ochre it is $Fe_2O_3 \cdot H_2O$.

Iron Vitriol
Ferrous sulphate ($FeSO_4$).

Isinglass
In the first half of the eighteenth century a gelatinous substance extracted from the air-bladders of certain fish. Later, a synonym for sheet mica.

Ivory-Black
A black pigment prepared by the calcination of ivory in a closed vessel.

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Jalap
A powder from the dried roots of the Mexican plant Exogonium purga. Used as a purgative.

James' Powder
A powder prepared by Dr. Robert James (1703-1776) that was used to reduce fevers.

Japanning
The coating of an object with a very dark varnish. The original varnish came from Japan, but substitutes were later found.

Jove (of Jove)
Tin, or some compound or alloy of tin.

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Kali
The plant Salsola kali or glasswort from which, oddly enough, "mineral" alkali (sodium carbonate) was extracted by calcination. Also sometimes used for crude sodium carbonate.

Kaolin
A fine, white clay used in the manufacture of porcelain.

Kelp

Impure soda (Na_2CO_3) from seaweed. In Britain, the term was sometimes used for crude sodium carbonate from any source.

Kermes Mineral	A natural mixture of antimony oxide or a mixture obtained in the laboratory by the actions of potassium carbonate on antimony sulphide.

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Lac (Laque)	A relatively thick solution of a colorant or coating.
Lac Sulphuris	See milk or sulphur.
Lapis Calaminarus (Calamine)	Mineral form of Zinc Carbonate ($ZnCO_3$)
Lapis Haematites	Hematite (Fe_2O_3)
Lapis Infernalis	Fixed vegetable alkali, I., potassium carbonate (K_2CO_3)
Lapis Philosophorum	A mixture of fused alum, vitriol, bolus, cerussa, camphor, vinegar.
Lapis Ponderous	Calcium tungstate ($CaWO_4$)
Lapis Septicus	Potassium hydroxide (KOH)
Lapis Serpentin	A mineral chiefly characterized by the presence of hydrous magnesium silicate ($Mg_3Si_2O_5(OH)_4$)
Laque	See Lac.
Laudanum	Any medicinal preparation with opium as a primary ingredient.
Lead-Glance	Lead sulphide (PbS)
Ley of (Ox-) Blood	The lixiviate from the residue produced by igniting blood with potashes.
Ley of Soapboilers	Potassium hydroxide (KOH)
Light Carburetted Hydorgen	Marsh gas or methane (CH_4)
Light Inflammable Air	Hydrogen (H_2)
Lignum Nephriticum	Two distinct woods were known as lignium nephriticum: (1) the small Mexican tree or shrub Eysenhardtia polystacha and the large Philippine tree Pterocarpus indica. In the sixteenth, seventeenth, and early eighteenth centuries, cups, powders, and dried extracts of this wood were thought to have a great medicinal powers. The infusion was flourescent.
Lignum Vitae	"Tree of Life" The wood , and sometimes the resin, of several semitropical trees, but most often referring to Guaiacum.
Limation	Filing on a metal piece to reduce it to filings. Sometimes used for simply polishing an object.
Lime	Calcium oxide (CaO).
Lime, Carbonate of	Calcium carbonate ($CaCO_3$)
Lime, Quick	Calcium oxide (CaO)
Lime, Slaked $_2$)	
Limestone	Calcium carbonate ($CaCO_3$)
Lime Water	A solution of calcium carbonate ($CaCO_3$)
Liquescent (Salts)	See Deliquescence.
Liquor Fumans Boyle (Spiritus Fumans Boyle)	Ammonium polysulphide ($(NH_4)S_2$; $(NH_4)_2S_5$).
Liquor Fumans Libavh (Fuming Liquor of Libavius)	Stannic chloride ($SnCl_4$).
Liquor of Flints	See Liquor Silicum.
Liquor Hoffman	A mixture of ethanol and ether.
Liquor of Liravius	See smokinf spirit of Libavius.
Liquor Silicum (Liquor of Flints)	A solution of potassium silicate (K_2 SiO_3). Sometimes Used for other soluble silcates.

Litharge

Yellow lead oxide (PbO)

Lithomarge

Soft, claylike substances, such as kaolin.

Litmus

A blue pigment, extracted from certain lichens. It is acid sensitive, turning red in the presence of an acid. The red form turns blue again when a base is added.

Liver of Antimony

Fused antimony sulfide (Sb_2S_3). Usually produced from the detonation of equal parts of crude antimony and potassium nitrate.

Liver of Arsenic

Fused mixture of potassium carbonate and (white) arsenic. May have contained some potassium arsenate.

Liver of Sulphur (Hepar Sulphuris)

Produced by heating potassium carbonatee with sulphur. Not a true compund, it is a metastable mixture of potassium polysulfides and sulfate. (K_2S, K_2S_2, K_2S_3, K_2S_4, K_2S_5, K_2SO_4)

Lixivial Salts

Salts prepared by lixiviations.

Lixiviate of Mars

Possibly a tincture of iron, of which there were many different preperations. Typically, these were solutions of salts of iron to which rectified spirit of wine(ethanol, (CH_3CH_2OH) was added .

Lixiviation

Separation of soluble from unsoluble solid substances by soaking the mixture of solids and removing the resulting solution which contained the soluble material.

Lixivium

A solution produced by lixiviation. Sometimes used as a general synonym for "Solution"

Lixivium of Tartar

A solution of potassium carbonate (K_2CO_3)

Load (Load)

Any ore.

Logwood

The American tree Haematoxylon Campechionum, used in dying. It produces dark shades: blacks, blues, and dark grays.

Lucillite

A variety of limestones.

Lunar Cornea

Fused silver chloride ($AgCl$).

Lunar Caustic

Fused silver nitrate ($AgNO_3$).

Lunar Crystals

Finely divided parts of silver nitrate ($AgNO_3$). In preparing these crystals great care was taken to use only the purest silver and nitric acid possible.

Lunar Nitre

Silver nitrate ($AgNO_3$).

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Mageration

The softening and weakening of a solid sample, even to the piont of partial decomposition, by soaking it in a liquid.

Magisterium Tartari Vitriolati

Probably potassium sulfate (K_2SO_4).

Magistery of (any substance)

A precipitate of any substance, i.e., a pure form of the substance which has been separated by precipitation.

Magistery of Bismuth

Basic bismuth nitrate ($BiNO_3 \cdot H_2O$); sometimes the oxide (BiO) or even the oxychloride ($BiOCl$).

Magistery of Coral

Calcium carbonate ($CaCO_3$).

Magistery of Sulfur

Precipitated milk of sulphur (S).

Magistry

Any substance prepared from the basic elements of the substance without impurities. A magistry was supposed to be closer to the ideal for a substance than was usual for real chemical preparations.

Magnesia

Magnesium carbonate ($MgCO_3$). [Modern magnesia = magnesium oxide (MgO)]. Some chemists called magnesium (Mg) by the name magnesia.

Magnesia Aerata

Magnesium carbonate ($MgCO_3$).

Magnesia Alba

Magnesium carbonate ($MgCO_3$).

Magnesia Nigra

Manganese dioxide (MnO_2).

Magnesia Salita

Magnesium chloride ($MgCl_2$).

Malachite

Basic copper carbonate ($CuCO_3 \cdot Cu(OH)_2$).

Malic Acid
An acid extracted from apples and various other fruits. Pure malic acid is $C_4H_6O_5$.

Malt
Barley or other suitable grains after a preparation for brewing or distilling that usually included soaking, germination, and drying.

Manganese
Manganese dioxide (MnO_2). Manganese as we know it was called reglus of manganese.

Manna Mercurii
Mercurous chloride (Hg_2Cl_2).

Marble
A hard, crystalline, mineral form of calcium carbonate ($CaCO_3$).

Marcasita Plumbea
Antimony (Sb).

Marcasites
Minerals similar in appearance or properties to iron pyrites (FeS_2). Later, a general term for pyrites. Sometimes the term was used for sulfides of arsenic (As_2S_2, As_2S_3, As_2S_5).

Marchpane
See Marzipan.

Marine Acid
Hydrochloric acid (HCl).

Marine Acid Air
Hydrogen chloride (HCl).

Marine Alkali
Sodium carbonate (Na_2CO_3).

Marl (Marle)
A loose soil of clays and calcium carbonate ($CuCO_3$).

Mars (of Mars)
A substance related in some way to iron.

Marsh Gas
Methane (CH_4).

Martial Balls
A mixture of iron fillings (Fe) and cream of tartar ($KHC_4H_4O_6$).

Martial Ethiops
Hydrated ferrosoferric oxide ($Fe_3O_4 \cdot xH_2O$).

Martial Extract
Concentrated tincture of mars. A concentrated solution, the chief component of which may have been ferrous hydroxide ($Fe(OH)_2$).

Marzipan
A confection of pounded almonds, sugar, and other ingredients.

Matrass
A vessel with a round bottom and long, slender neck. Used as part of several common types of distillation apparatus.

Menstruum
A solvent.

Mephitic (as adjective)
Noxious; poisonous or pestilential.

Mephitic Acid
Carbonic acid (H_2CO_3).

Mephitic Air
Carbonic acid (CO_2).

Mercurius Calcinatus
Mercuric oxide (HgO).

Merc. Calcin. Nitrat
Mercuric nitrate ($Hg(NO_3)_2$).

Mercurius Corrosivus
Mercuric chloride $HgCl_2$.

Mercuric Corrosivus Ruber
Mercuric oxide (HgO).

Mercurius Dulcis (Calomel, Mercurious Sublimatus Dulcus, Mild Mercury)
Mercurous chloride (Hg_2Cl_2).

Mercurius Praecipitatus Per Se
Mercuric oxide (HgO).

Mercurius Praecipitatus Ruber
Mercuric oxide (HgO).

Mercurius Solubilis Hahnemanni
Mercuric oxide (Hg_2O).

Mercurius Sublimatus Dulcis (Calomel, Mercurius Dulcis, Mild Mercury)
Mercurous chloride (Hg_2Cl_2).

Mercurius Sublimatus Rubeus non Corrosivas
Mercuric oxide (HgO).

Mercurius Vitae
Mixture of antimony oxychloride and antimony oxides (Sb_2O_3; Sb_2O_4, Sb_2O_5, SbOCl). In some contexts the term may mean just antimony oxychloride (SbOCl).

Mercurius Vitae Antimonii
Mixture of antimony oxychloride and antimony oxide (Sb_2O_3; Sb_2O_5, SbOCl).

Mercury of Life

See Mercurius Vitae.
Metallic Salt
Compound of a metal and an acid.
Miasma (Miasmata)
A noxious or infectious subtle material (e.g., a vapor or exhalation) thought to be from decaying organic matter. Sometimes used for any unseen poisonous or infectious substance.
Mica
A mixed mineral form composed mostly of aluminum silicate but with silicates of other metals. Several complicated minerals are variously, and in combination, referred to as mica; e.g., biotite $K(Mg, Fe)_3AlFeSi_3O_{10}(OH, F)_2$.
Microcosmic Salt
Sodium ammonium phosphate ($NaNH_4HPO_4 \cdot 4H_2O$).
Mild Alkali
Alkalies which produce effervescence with acids; i.e., carbonates ($-CO_3^{2-}$)
Mild Calcareous Earth
Calcium carbonate ($CaCO_3$).
Mild Magnesian Earth
Magnesium carbonate ($MgCO_3$).
Mild Mercury
Mercurous chloride (Hg_2Cl_2).
Mild Vegetable Alkali
Potassium carbonate (K_2CO_3).
Milk of Lime
Calcium hydroxide (suspension) ($Ca(OH)_2$).
Milk of Sulfur
Finely divided sulfur (S) in solution. Usually the product of the reaction between a soluble sulfide and an oxidizing acid.
Minderer's Spirit
A solution of ammonium acetate ($NH_4C_2H_3O_2$).
Mineral Alkali
Sodium carbonate (Na_2CO_3).
Mineral Anodyne of Hoffman (Liquor of Hoffman)
A mixture of ethanol and ether (C_2H_5OH), ($CH_3CH_2OCH_2CH_3$).
Mineral Crystal
Sal prunella = potassium nitrate with a small admixture of potassium sulfate (HNO_3; K_2SO_4).
Minium (Red Lead)
Lead tetroxide (Pb_3O_4).
Mixt
A chemical union of two or more true "elements" or "principles." Later, any substance which could be resolved into constituent parts only by chemical means. Although the term has greater philosophical complexities, it was roughly equivalent to our term "compound," but the latter is not to be considered a synonym.
Mixtura Salina
Saline mixture prepared by saturating potassium carbonate with lemon juice and adding syrup of black currants, julep.
Mofette
An exhalation or vapor of a mephitic (noxious or poisonous) gas.
Mohr's Salt
Ferrous ammonium sulfate ($FeSO_4((NH_4)_2SO_4 \cdot 6H_2O)$.
Molybdaena
Native molybdenum sulfide (MoS_2).
Mordant
Any substance which fixes or holds a colorant in the material to be dyed.
Mortify
To change or destroy the normal, external form or appearance of a substance.
Mosaic Gold
Stannic sulfide (SnS_2).
Mucilagenous Matter
Any semisolid material that was soft, moist, and viscous.
Mundic (Mundick)
Iron pyrites (FeS_2). Sometimes used for other pyrites or as a general term for pyrites.
Muriates
Chlorides ($-Cl^-$).
Muriatic Acid
Hydrochloric acid (HCl).
Muriatic Ether
Probably impure ethyl chloride (CH_3CH_2Cl).

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Naples Yellow
Lead antimoniate ($Pb_3(SbO_4)_2$).
Naptha
Any highly inflammable, volatile, naturally occurring mixture of hydrocarbons. Also could be obtained as the "lightest" fraction in the distillation of asphalts, bitumens, and petroleum.
Natrium

Sodium.

Natron (Natrum)

Sodium sesquicarbonate, a naturally occurring combination of sodium carbonate (Na_2CO_3) and sodium bicarbonate ($NaHCO_3$) in the ratio 1:1 ($Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$).

Neutral Arsenical Salt of Macquer

Potassium dihydrogen arsenate (KH_2AsO_4).

Neutral Salts

Salts resulting from the reaction of an acid and a base (hydroxide) but having no characteristics of either acid or base.

Nihil Album (sometimes just Nihil)

Flowers of zinc, zinc oxide (ZnO).

Nitrated Earths, Metals, etc.

Nitrates ($-NO_3$).

Nitre (Common Nitre)

Potassium nitrate (KNO_3).

Nitre Fixed by Tartar

A mixture of nitre and tartar left after reaction between the two.

Nitre with an earthy base

Usually calcium nitrate ($Ca(NO_3)_2$).

Nitreum (Bergman)

Nitrous acid (HNO_2).

Nitro-Aerial Spirit

The hypothetical subtle substance which was though by some to be responsible for the ability to nitre to support combustion and to be a key component of detonations

Nitrous Acid

Nitrous Acid (HNO_3).

Nitrous Acid Vapor (Priestly)

Nitrogen Dioxide (NO_2).

Nitrous Air (Priestly)

Nitric Oxide (NO)

Nitrous Ether

Ethyl nitrite ($CH_3CH_2NO_2$).

Nitrous Gas (Lavoisier)

Nitric Oxide (NO)

Nitrum Aegypticum

Sodium Carbonate (Na_2CO_3).

Nitrum Antimoniatum

Product containg potassium nitrate, nitrite, and antimonate.

Nitrum Commun

See commom Nitre

Nitrum Cubic

See Cubic Nitre

Nitrum Fixatum (Nitrum Fixum, Fixed Nitre)

An ofter impure preparation of potassium carbonate (K_2CO_3).

Nitrum Flammans

Ammonium Nitrate (NH_4NO_3).

Nitrum Regeneratum

Potassium nitrate (KNO_3).

Nitrum Saturni

Lead Nitrate ($Pb(NO_3)_2$).

Nitrum Stibnatum

Probably anitmony nitrate ($2Sb_2O_3 \cdot N_20_5$).

Nitrum Sulphure Purgatum

Mixture of potassium nitrate and potassium sulfate (KNO_3; K_2SO_4).

Nitrum Vitriolatum

Mixture of potassium nitrate and potassium bisulfate (K_2SO_4; KHSO4).

Non Metals

A term used by William Cullen and his students for the following group of substances; zinc (Zn), anitmony (Sb), bismuth (Bi). arsenic (As), platinum (Pt), cobalt (Co), nickel (Ni).

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Ochre

A class of mineral solids which, in powdered form, were commonly used as pigments. Their colors varied from yellow to brown, including reddish hues. Chemically, the ocheres are iron oxides, or mixtures of iron oaxides, in varying states of hydration. For example red ochre is primarily Fe_2O_3. Silicates, carbonates, sulfates, etc. also were commonly present with these oxides.

Ochroite

Cerium Oxide (CeO_2).

Offa Helmonth

Potassium Carbonate (K_2CO_3).

Oil

Any relatively insoluble, inflammable, somewhat viscous liquid.

Oil Gas

Mixture of methane, carbon monoxide, and butlylene (CH_4, CO, C_4H_8).
Oil of Arsenic
Arsenic trichloride ($AsCl_3$)
Oil of Chalk
Calcium chloride solution ($CaCl_2$).
Oil Cloves
An oily substance extracted from the buds and flower stalks of the clove tree Caryophyllus aromaticus. Used as medicinal
Oil of Dippel
The insoluble, viscous fraction from decomposed animal matter that has gone through repeated distillations.
Oil of Hartshorn
A crude animal oil obtained from the destructive distillation of bones
Oil of Lime
A solution of calcium chloride ($CaCl_2$).
Oil of Rue
The oil extracted from evergreens of the genus Ruta. Used as Medicinal
Oil Sulphur
Concentrated sulfuric acid. Sometimes the term was used fro alkaline sulphide of ammonia ($(NH_4)_2S$).
Oil of Tartar
Concentrated potassium carbonate solution (K_2CO_3).
Oil of Tartar per Deliquium
Potassuim carbonate, which is hydroscopic, dissolved in the water which its extracts from the air.
Oil of Venus
Concentrated solution of copper nitrate ($Cu(NO_3)_2$.
Oil of Vitriol
Sulfuric Acid (H_2SO_4).
Oil of Wine
A hypothetical component of alcohol thought to give it its odor and inflammability
Olea Terebinthine
terpentine
Olefiant Gas
Ehtylene (C_2H_2).
Oleum Dulce
See Oil of Whine
Oleum Suphuris per Campanum
Sufuric Acid (H_2SO_4) prepared by burning sufur under a bell jar and later concentrating and purifying the product by heating to drive off water and sulfur dioxide.
Oleum Succini
Concentrated succinic acid($HOOCCH_2CH_2COOH$).
Oleum Tartar per Demiquium
See Oil of Tartar per Deliquium
Oleum Vitriol
Oil of Vitriol
Orpiment
arsenic trisulfide (As_2S_3).
Oxycarburetted Hydrogen
Water gas mixture or hydrogen (H_2), carbon monoxide, (CO), and carbon dioxide (CO_2).
Oxymuriatic Acid
Chlorine (Cl_2).

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Panacea
Potassium sulfate (K_2SO_4).
Pan-Stone
Calcium sulfate ($CuSO_4$).
Parting
The operation by which gold and silver are separated from each other.
Pearl Ash
The whitest potassium carbonate (K_2CO_3) extracted from calcined plants. In a sense, then, pearl ash is purified potash.
Pearl White
Bismuth oxychloride [BiOCl].
Pelican
A special distillation apparatus. The condensing head had two curved tubes emerging on opposite sides. These tubes led down and entered the lower section or body of the vessel; thus, the condensed liquid ran back to the heated section where it was revaporized, giving a cyclic action. The pelican was especially effective for reactions that took place in the vapor phase.
Pellicle
Any thin saline crust that forms on a solution.
Per Campanum
Any process carried out under a solution.
Per Deliquium
A hygroscopic salt was said to "run per deliquium" when it changed from solid to liquid by extracting water from the air.
Perlate Salt

Sodim phosphate (Na_3PO_4).

Perspiration
Spontaneous evaporation or (less often) vaporization through heating. Also used to indicate condensation of moisture on a relatively cool body.

Perspirative
A medcinal which promoted perspiration.

Petrolia
Liquid bitumens.

Petunise
A white mineral solid used in the manufacture of porcelain.

Pewter
An alloy of tin. Originally with up to one-fifth lead, but later bismuth and copper were substituted for lead.

Philosopher's Wool
Zinc Oxide (ZnO).

Philosophical Flowers of Vitriol
Boric acid (H_3BO_3).

Philosophical Foliated Earth
Potassium acetate ($KC_2H_3O_2$).

Philosophical Mercury
An alchemical term signifying the property-bearing principle of chemical activity.

Philosophical Sal Ammoniac
Ammonium sulfate ($(NH_4)_2SO_4$).

Philosphical Spirit of Nitre
Nitric acid prepared by distilling saltpeter with oil of vitriol (HNO_3).

Philosophical Spirit of Tartar
Potassium hydrogen tartrate ($KHC_4H_4O_6$) distilled with wine.

Philosophical Spirit of Vitriol
Hydrochloric acid (HCl).

Philosophical Spirit of Wine.
Spirit of wine (alcohol) concentrated by freezing (CH_2CH_3OH).

Philosophical Water
Aqua regia. A solution of hydrochloric and nitric acids, usually in ratios from 2:1 to 4:1 (HCl to HNO_3).

Phlegm
A general term for any aqueous fraction of a distillation.

Phlogisticated Acid of Nitre
Nitrous acid (HNO_2).

Phlogisticated Acid of Vitriol
Sulphurous acid (H_2SO_3).

Phlogisticated Air
Nitrogen (N_2).

Phlogisticated Alkali
Potassium ferrocyanide ($K_4Fe(CN)_6 \cdot 3H_2O$).

Phlogisticated Calx of Iron
Ferrous oxide (hydroxide) (FeO).

Phlogisticated Earth of Molybdaena
The solid reduction of molybdic acid.

Phlogisticated Manganese
Manganous carbonate ($MnCO_3$).

Phlogisticated Nitre
Impure potassium nitrite (KNO_2).

Phlogisticated Nitrous Acid
Nitrous acid (HNO_2).

Phlogisticated Vitriolic Acid
Sulfurous acid (H_2SO_3).

Phlogiston
A hypothetical substance originally used to account for the property of inflammability. It later was made to carry many more properties and formed a central point for the theoretical beliefs of a central point for the theoretical beliefs of a number of eighteenth-century chemists.

Phlogiston Elasticum
Hydrogen (H_2).

Phosphorated Iron
Ferric phosphate ($FePO_4$).

Phosphorated Mercury
Mercuric phosphate ($Hg_3(PO_4)_2$).

Phosphorated Vegetable Alkali
Potassium phosphate (K_3PO_4).

Phosphorous
Sometimes used for any phosphorescent substance.

Phosphorous of Baldwin
Calcium nitrate ($Ca(NO_3)_2$).

Phosphorous of Homberg
Calcium chloride ($CaCl_2$).

Phosphorous of Urine

As the name implies, a form of phosphorous (P) extracted from urine.

Pierre Infernale
Fused silver nitrate <AG(NO$_3$)). [Not to be confused with "Infernal Stone."]

Pinch Beck
A gold colored alloy of about five parts cooper (Cu) to one part zinc (Zn).

Pinguious (Pinguinous)
Fatty, oily

Plaster
Any semisolid plastic mixture that could be applied to a a surface and then spontaneously cured or hardened. One of the oldest plasters is a mixture of slake lime ($Ca(Oh)_2$), sand, and hair. The term also was used to refer to impure lead oleate ($Pb(C_{18}H_{33}O_2)_2$).

Plaster of Paris
Calcium sulfate monohydrate ($(CaSO_4)_2 \cdot H_2O$).

Platina
Platinum (Pt.), or sometimes the usually impuer form of platinum found in nature that is alloyed with other exotic metals.

Plumbago
Carbon (C) in the form of graphite.

Plumbum Album
Basic lead carbonate ($2PbCO_3 \cdot Pb(OH)_2$). Sometimes the term was applied to basic lead acetate ($Pb(C_2H_3O_2) \cdot Pb(OH)_2 \cdot H_2O$).

Plumbum Cinereum
Bismuth (Bi).

Plumbum Corneum (Horn Lead)
Lead chloride ($PbCl_2$).

Plumbum Stridens
Tin (Sn)

Pneumatic
Pertaining to subtle, rarified, or vaporous substances such as air. In modern terms, gaseous.

Pneumatic Trough
An apparatus developed over the eighteeth century from John Mayow (1641-1679) through Stephen Hales (1677-1761) to Antoine Lavoisier (1743-1794). The trough was any large pan or vat in which inverted bottles full of water could be supported. In glass tubes conducted the gases from the vessels in which the were generated outside the trough to the inverted bottle in the trough, where the gases were trapped and held.

Point of Saturation
The instant when the exact proportions of the two "saline principles" (one from an acid, the other from a base) unite to form a perfectly neutral salt.

Pomphlix
Flowers of zinc (ZnO).

Ponderous Spar
Barium Sulfate ($BaSO_4$).

Pot Ash
Potassium carbonate (K_2CO_3).

Powder of Algaroth
Antimony oxychoride (SbOCl)

Precipitant
A substance serving as intermediary to separate two other substances from each other.

Praecipitate Per Se
Mercuric Oxide (HgO).

Praecipitatus Albus
Mercurous chloride (Hg_2Cl_2).

Praecipitatus Vigonis
Mercuric Oxide (HgO).

Precipitate of Sulfur
Precipitated milk of sulfur (S).

Precipitation
The phenomenon in which a solid is formed within a solution and falls to the bottom of the vessel in which the solution was contained.

Primus Metal
See Prince Rupert's Metal

Prince Rupert's Metal (Bath Metal, Primus Metal, Princes Metal)
A brass metal alloy in which the ratios of copper (Cu) to Zinc (Zn) are approximately 4 to 1.

Prince's Metal
See Prince Rupert's Metal

Principle
One of the simplest forms of matter, from which other substances are formed through combinations with other principles or other combinations of principles. Although there are similariteies to the modern term "element", the two are not truly synonymous.

Proximate Principles
Components obtained through the chemical analysis which themselves are compounds but presumed to be simpler than the original substance.

Prussian Blue
Ferric ferrocyanide ($Fe_4[Fe(Cn)_6]_3$).

Prussian Acid
Hydrocyanic acid (HCN).

Pulvis Algarothi
Antimonious oxychloride (SbOCl).

Pulvis Fulminans
An explosive mixture made from potassium nitrate, potasium carbonate, and sufur.

Pumice
A light porous stone of mixed silicates.

Pure Clay
Alumina. Aluminum Oxide (Al_2O_3).

Pure Ponderous Earth
Baryta. Barium Oxide. (BaO)

Purfication
Any process in which one substance is rendered free, or relatively free, of other substance. Common methods included distillation, crystallization, and precipitation.

Pyrites
Originally, any mineral which could strike sparks from steel. The term was often used to refer iron pyrites (FeS_2).

Pyroligneous Acid
Crude acetic acid from wood ($HC_2H_3O_2$).

Pyroligneous Spirit
Methyl alcohol (CH_3OH).

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Quadrangular Nitre
Sodium Nitrate ($NaNO_3$).

Quartation
The process of combining gold (Au) and silver (Ag) in the ratio 1:3. When the combination is dissolved in nitric acid, the silver is dissolved and the gold is separated, free from impurities.

Quartz
A mineral whose primary component is silicon dioxide (SiO_2). Its color and other aspects of its appearance depended on the impurities present.

Quicklime
Calcium oxide (CaO).

Quicksilver
Mercury (Hg).

Quicksilver Calcined Per Se
Mercuric oxide (HgO).

Quintessence
A mixture of an essential oil and alcohol.

Quintessence of Lead
Acetone (CH_3COCH_3).

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Rabel's Water
The liquid obtained by macerating poppy flowers in a mixture of sulphuric acid and alcohol for some days and then filtering.

Ramous
(1) Individual (fundamental) particles of viscous or rigid bodies; (2) branching or filiment-like parts of a liquid mixture.

Realgar
Arsenic disulfide (As_2S_2).

Receiver
The vessel attached to the condensing part of a distillation apparatus in order to receive the condensed products from the distillation.

Recrement
Solid waste or refuse from a chemical operation, e.g., scoria.

Rectification
The purifying or refining of a substance by one or (usually) more distillations.

Red Arsenic (Realgar)
Native arsenic disulphide (As_2S_2).

Red Bole
A red clay that contained silicates of iron and aluminum. Used as a red pigment and as a base for gilding.

Red Flowers of Antimony
Probably antimony sulfide (Sb_2S_5).

Red Ochre
A mineral solid approximately 95 percent red iron oxide (Fe_2O_3). An old and important pigment.

Red Precipitate
See Red Precipitate of Mercury.

Red Precipitate of Mercury
Impure mercuric oxide (HgO).

Red Saunders (Red Sanders)
The wood from the tree Pterocarpus santalinus, commonly called red sandlewood. Used in dyeing.

Reductoin
The returning of a substance to a previous or original condition; e.g., the restoring of a metal to the metallic state from its oxide.

Refractory Earths
Mineral substances that do not fuse under the action of fire.

Refrigoratory
A vessel at the top or head of some stills that is surrounded by or filled with cold water to condense any vapors in tubes or vessels within it.

Regenerated Marine Salt
Potassium chloride (KCl).

Regenerated Sea Salt
Potassium chloride (KCl).

Regenerated Tartar
Potassium acetate ($KC_2H_3O_2$). In this form, the compound was made from distilled vinegar and salt of tartar.

Reguline Caustic
Potassium carbonate (K_2CO_3).

Regulus
The pure form of a metal, e.g., regulus of antimony.

Retory
A vessel with a long neck bent down at the point where it joins the body of the vessel. Especially suited for the distillation of substances under low heat.

Revivification
The restoration of a metal to the metallic state from one of its compounds. Similar to, but broader in scope, than "reduction."

Risigallum
See Rock Alum.

Rochelle Salt (Seignette Salt)
Potassium sodium tartrate ($KNaC_4H_4O_6 \cdot 4H_2O$).

Rock Alum
Usually larger crystals or formations of potassium aluminum sulfate ($KAl(SO_4)_2 \cdot 12H_2O$). Alum of this quality often was imported from Italy.

Rock-Crystal
Pure, colorless, transparent, crystalline quartz occurring naturally in large prismatic crystals. Silicon dioxide (SiO_2).

Rog
Concentrated native vegetable acid. From the usual preparations, it would be primarily citric acid ($C_6H_8O_7$).

Roman Vitriol
Copper sulfate ($CuSO_4$). In Britain this terms was sometimes used for ferrous sulfate ($FeSO_4$).

Russian Pot Ash
Potassium carbonate (K_2CO_3).

Rust of Copper
See Verdigris.

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Sacchareted Lime
Calcium oxalate (CaC_2O_4).

Saccharum Saturni
Lead acetate ($Pb(C_2H_3O_2)_2$).

Saffron
A range of orange-yellow colors. The color called saffron comes from the dye of the same name, which is an extract of the plant *Crocus sativus*.

Saffron of Gold.
See Aurum Fulminans.

Saffron of Iron.
See Saffron of Mars.

Saffron of Mars
Any yellowish iron compound, e.g., hydrated ferroso ferric oxide ($Fe_3O_4 \cdot xH_2O$) or ferric sulfide (Fe_2S_3).

Saffron of Metal
A mixture of antimony sulfide (Sb_2S_3), nitre (KNO_3), and antimony sulfate ($Sb_2(SO_4)_3$).

Sal Absinthi (Salt of Wormwood)
Mostly potassium carbonate (K_2CO_3).

Sal Albus
Borax (sodium tetraborate) ($Na_2B_4O_7 \cdot 10H_2O$).

Sal Alkali Vitriolatum
Potassium sulfate (K_2SO_4).

Sal Alkanus Vegetablis
Potassium carbonate (K_2CO_3).

Sal Amarum
Magnesium sulfate ($MgSO_4$).

Sal Ammoniac (Sal Armoniac)
Ammonium chloride (NH_4Cl). Sometimes used for other ammonium salts.

Sal Ammoniacum Fixum
Calcium chloride ($CaCl_2$)

Sal Ammoniacum Volatilis
A term variously used for any salt solution that gave off the odor of ammonia. When referring to solid salts the term meant ammonium carbonate ($(NH_4)_2CO_3$).

Sal Anglicum (Epsom Salt)
Magnesium sulfate ($MgSO_4$).
Sal Catharticum
Magnesium sulfate ($MgSO_4$).
Sal Catharticum Amarum
Magnesium sulfate ($MgSO_4$).
Sal Catholicum
Potassium sulfate (K_2SO_4).
Sal de Duobus
Potassium sulfate (K_2SO_4).
Sal de Seignette (Sal de Soinette)
See Seignetteís Salt.
Sal Digestiv
Potassium chloride (KCl).
Sal di Modena
Magnesium sulfate ($MgSO_4$).
Sal Diureticus
Potassium acetate ($KC_2H_3O_2$).
Sal Duplicatum
Potassium sulphate (K_2SO_4).
Sal Enixum
Potassium sulfate (K_2SO_4).
Sal Epsom (Epsom Salt)
Magnesium sulfate ($MgSO_4$).
Sales Medii
See Sal Medium.
Sales Salsi
See Sal Salsam.
Sal gemme (Sal Gem)
Sodium chloride ($NaCl$).
Sal Gentianae
Mostly potassium carbonate (K_2CO_3).
Sal Glauber (Glauberís salt)
Sodium sulfate (Na_2SO_4).
Sal Guaiaci ex Ligno
Mostly potassium carbonate (K_2CO_3).
Saline Bodies (Cullen)
Substances which are (a) sapid, (b) miscible with water, and (c) noninflammable.
Salited Earths, Metals, etc.
Chlorides (Cl^-).
Sal Juniperi
Mostly potassium carbonate (K_2CO_3).
Sal Kali (Sodium Carbonate)
Soda (Na_2CO_3).
Sal Marinus
Sea Salt; mostly sodium chloride ($NaCl$).
Sal Marinus Fontan
Sodium chloride ($NaCl$) as found in or near landlocked bodies of water.
Sal Marinus Regeneratus
Potassium chloride (KCl).
Sal Martis
Ferrous sulfate ($FeSO_4$).
Sal Medium (Sal Salsum) (Sales Medii)
Any neutral salt that would not precipitate solutions made with acid or alkaline slats and would not change the color of syrup of violets.
Salmiac
See Salt Ammoniac.
Sal Mirabile (Glauber's salt)
Sodium sulphate (Na_2SO_4).
Sal Nitriforme Inflammable
Probably ammonium nitrate ($(NH_4)NO_3$).
Sal Nitrii
Potassium nitrate (KNO_3).
Sal Perlatum
Sodium phosphate (Na_2PO_4).
Sal Polychrestrum
Potassium sulphate (K_2SO_4).
Sal Polychrestrum Anglorum (Sal Polychrestrum Glaseri)
Potassium sulphate (K_2SO_4).
Sal Polychrestrum de Rochelle
See Sal Polychrestrum de Seignette.
Sal Polychrestrum de Seignette
Potassium sodium tartrate ($NaKC_4H_4O_6$).

Sal Polychrestrum e Nitro et Sulphure

Potassium sulfate (K_2SO_4).

Sal Polychrestrum Glaseri

Potassium sulfate (K_2SO_4).

Sal Prunellae

A mixutre of potassium nitrate and potassium sulfate (KNO_3; K_2SO_4).

Sal Rupellensis (Rochelle Salt)

Hydrated potassium sodium tartrate ($KNaC_4H_4O_6 \cdot 4H_2O$).

Sal Salsam

Any neutral combination of anacid with alkali. (see also Neutral Salts, Sal Medium, or Salts.)

Sal Sapientiae

Potassium sulfate (K_2SO_4).

Sal Saturni

Lead acetate ($PbC_2H_3O_2$).

Sal Sedivatus (Sedative Salt)

Boracic boric acid, (H_3BO_3).

Sal Sennerti

Potassium acetate ($KC_2H_3O_2$).

Sal Soda (Salt Soda, Soda)

Sodium carbonate (Na_2CO_3).

Sal Succini (Salt of Amber)

Succinic acid ($HO_2CCH_2CH_2CO_2H$).

Salt

In the 16th and 17th centuries this term denoted a group of solid soluble, nonimflammable substances with characteristic tastes. In the 18th century salts gradually became to be thought of in terms of process, as, for example, the product of the reaction between acids and bases, acids and other salts, or between two salts, etc. Some chemists regarded acids and bases themselves as salts or at least some saline substances. In general, salts were increasingly recognized as the largest and most important class of substances as the eighteenth century progressed.

Salt Alembroth

A mixture of equal parts of corrosive sublimate (mercuric chloride, $HgCl_2$) and sal ammoniac (NH_4Cl). Used as a flux for metals.

Sal Tartari

Potassium carbonate (K_2CO_3). It usually was produced by strongly heating tartar.

Salt Ash

Magnesium chloride ($MgCl_2$).

Salt of Amber

Succinic acid ($C_4H_6O_4$).

Salt of Art

See Salt Alembroth.

Salt of Benzoin

Benzoic acid (C_6H_5COOH).

Salt of Centaury

Solid residues obtained from the calcination of any of the plant species of the genus Centaurea.

Salt of Chalk

Calcium acetate ($Ca(C_2H_3O_2)_2$).

Salt of Colcothar

Probably impure ferric hydroxide($Fe(OH)_3$).

Salt of Coral

Calcium acetate ($Ca(C_2H_3O_2)_2$).

Salt of Crab's Eye

Calcium acetate ($Ca(C_2H_3O_2)_2$).

Salt of England

Ammonium carbonate ($(NH_4)_2CO_3$).

Salt of Epsom

See Epsom Salt.

Salt of Gall-Nuts

Tannic acid ($C_{76}H_{52}O_{46}$).

Salt of Glass

A mixture of the various salts found in raw materials used in glassmaking. These included fixed alkali (potassium carbonate), common salt (sodium chloride), Glauber's salt (sodium sulfate), vitriolate tartar (potassium sulfate), etc.

Salt of Hartshorn

Ammonium carbonate ($(NH_4)_2CO_3$).

Salt of Human Blood

A mixture if ammonium salts, including ammonium hydroxide (NH_4OH), and various organic solids.

Salt of Lead (Sugar of Lead) (Sal Saturn)

Lead acetate ($Pb(C_2H_3O_2)_2$).

Salt of Lime

Calcium carbonate ($CaCO_3$) precipitated from limewater (calcium hydroxide solution, $Ca(OH)_2$) by a carbonate compound.

Salt of Mars

Most often used for ferrous sulfate ($FeSO_4$). Occasionally used as a general term for any iron salt and as a specific name for ferrous acetate ($Fe(C_2H_3O_2)_2$).

Salt of Milk

Probably calcium lactate ($Ca(C_3H_5O_3)_2$).

Salt of Oxbone

Impure ammonium salts from bone extracts of cattle (NH_4OH).
Salt of Science
See Salt Alembroth.
Salt of Sedlitz
See Sedlitz Salt. (Sometimes sedlitz salt was confused with Glauber's salt.)
Salt of Soda
See Soda.
Salt of Sorrel
Acid potassium oxylate (KHC_2O_4).
Salt of Steel
Loosely applied to various iron salts. Most commonly applied to martial vitriol. (Ferrous Sulfate; $FeSO_4$).
Salt of Sulphur
Impure potassium sulfate (K_2SO_4).
Salt of Sylvius (Febrifugal Salt of Sylvius)
Potassium chloride (KCl).
Salt of Tachenius
Impure potassium and sodium carbonates (K_2CO_3, Na_2CO_3) obtained from the incomplete combustion of plant products. These salts contained organic impurities.
Salt of Tartar
Potassium carbonate (K_2CO_3).
Salt of Urine
Impure ammonium salts extracted from urine.
Salt of Vinegar
Impure potassium sulfate. Probably mixed with acetates and citrates.
Salt of Wisdom
See Salt Alembroth.
Salt of Wormwood
Mostly potassium carbonate (K_2CO_3).
Sal Vitrioli
Ferrous sulfate ($FeSO_4$).
Sal Volatile Fixatum
Ammonium sulfate ($(NH_4)_2SO_4$).
Sal Volatile Oleosi
Any solid extracted from animals or vegetable matter containing ammonium salts, e.g., salts of hartshorn, etc.
Sandarach
(1) See Realgar; (2) a resin from the tree Callitris quadrivalvis.
Sadniver (Glass Gall)
A solution containing a mixture of salts found on the surface of glass after vitrification.
Saphire
See Sapphire.
Sapid
To have a decided, yet pleasant taste.
Saponaceous
To be soapy, slippery, sometimes foaming.
Sapphire
A clear blue gem material which is like ruby, a crystalline form of alumina. (Al_2O_3
Sarcocolla
A gum resin imported form the Middle East.
Sarsparilla
The roots of plants of the family smilaceae from which gummy and resious extracts are obtained.
Sassafras
A term applied both to the reee Sassafras officinale and to its bark when dried and prepared.
Saturation
The action by which a "perfect" union between an acid and an alkali is accomplished. Its product is a neutral salt.
Saturn (of Saturn)
Used in referring to lead or to compounds containing lead.
Saunders
See Red Saunders.
Scammony
A gummy, resinous juice from the root of the plant Convolvulvus scammonia.
Scheele's Green
Cupric hydrogen arsenite ($CuHAsO_3$).
Schorl
A black mineral. Now known as a variety of tourmaline.
Schwartz Blei Weiss (Black White-Lead)
Plumago (graphite) (C_N).
Scordium
The plant Teucrium scordium from which gummy and resious extracts are obtained. It has an odor of garlic.
Scoria
The undesirable solid residues or slag which remain after a metal has been separated from an ore.
Scorification
Any process which produces scoria or slag. Sometimes used for processes which ield metal or semimetals. Scorifiation usually involved the addition of other substances to the ore, then heating.

Secret Fixed Sulphur of the Philosophers
Calcined residue when sulphur is distilled with linseed oil.

Secret Sal Ammoniac (Glauber's Secret Sal Ammoniac)
Ammonium sulfate ($(NH_4)_2SO_4$)).

Sedative Salt
Usually boric acid, but sometimes sodium tetraborate ($Na_2B_4O_7$).

Sedative Spar
Calcium borate (CaB_4O_7).

Sedlitz Salt (Epsom Salt)
Magnesium Sulphate ($MgSO_4$).

Seignette's Salt
Sodium potassium tartrate (Rochelle's salt) ($NaKC_4H_4O_6$).

Selenite
The various minerals forms of Calcium sulphate ($CaSO_4$).

Selenitic Spar
Any mineral assigned to the family of "spars" that could be calcined like gypsum ($CaSO_4 \cdot 2H_2O$).

Semi-Metals
Substances which have the properties characteristic of metals except for ductility and which sublime. Different chemists had different lists, but most included antimony (Sb), arsenic (As); bismuth (Bi), cobalt (Co), and Zinc (Zn). Some included mercury (Hg) and, later in the century, nickel (Ni).

Sena (Senna)
Several similar plants of the genus Cassia from the leaves of which gummy and resinous extracts were obtained.

Senegal
A gum extract from the root of the North American species Polygala senega.

Senna
See Sena.

Separationg-Glass
A vessel narrow at the top, then bellying out in the center, and narrowing again to a hollow tube or stem. Shaped somewhat like the modern speparatory funnel anbd often used for similiar purposes.

Serpentine
A steatite, usually green.

Shoot
When crystals appeared, especially suddenly in a saturated solution, they were said to "shoot".

Siderum
Iron phosphide (Fe_3P).

Silex
Silicon dioxide (SiO_2).

Silicious Earth (Silcia)
Silicon dioxide (SiO_2).

Similor
A copper zinc alloy with a color approximating that of real gold.

Slaked Lime
Calcium hydroxide ($Ca(OH)_2$).

Smalt
A blue, glassy substance used as a pigment. The blue comes from cobaltous oxide (CuO). Smalt also contains silica (SiO_2).

Smelting
The process opf extracting a metal from its ore.

Smo(a)king Spirit of Libavius
Primarily stannous chloride ($SnCl_2$) but with chlorides of mercury mixed in.

Smo(a)king Spirit of Nitre
Concentrated nitric acid (HNO_3).

Snow of Antimony
See Flowers of Antimony.

Soap
In general, any chemical combination of acids, bases, or salts with oils that exhibit detergent action. Common soap was the product of sodium hydroxide with an oil or fat.

Soap of Glass
Manganese dioxide (MnO_2) in its role of agent to remove color bodies from glass while the glass is molten.

Soap-Rock
See Steatites.

Soapstone
See Steatite

Soda
Sodium carbonate (Na_2CO_3)

Soda Baryllia (Spanish)
Sodium carbonate (Na_2CO_3)

Soda Hispanica (Washing Soda)
Sodium carbonate (Na_2CO_3)

Solder
Any fusible metal alloy used for joining two pieces of metal. Most types were alloys of tin and lead.

Soluble Tartar
Normal potassium tartrate. Probably ($K_2C_4H_4O_6$)

Solution

Any liquid in which one component called the "solute" is dispersed in a second component called the "solvent."

Solvend (Cullen)
Solute

Soot
Carbon and hydrocarbon deposits from incomplete combustion of fuels.

Sorrel
Various plants of the genus Rumex from which an acid salt (acid potassium acetate) was extracted.

Spanish Earth
Vitriols (mixture) ($CuSO_4$; $FeSO_4$).

Spanish Green
Basic copper carbonate ($2CuCO_3 \cdot Cu(OH)_2$).

Spanish White
Bismuth oxychloride (or oxynitrate) ($BiOCl$; $BiONO_3$

Spar
A class of compounds characterized by a crystalline form that features shiny reflective plate surfaces.

Spath (Spat) Stone
A naturally occurring mineral solid containing mostly calcium sulfate ($CaSO_4$).

Spathic Iron Ore
Ferrous carbonate ($FeCO_3$)

Specificum Purgans Paracelsi
Potassium sulfate (K_2SO_4)

Spermaceti
The white fatty substance obtained from the head of the sperm whale. Used in pharmaceuticals and candles.

Sphacelated
Gangerenous

Spikenard
The aromatic extract from the Indian plant Nardostachys jalamansi. The term was also used for the plant itself.

Spirit
(1) Any liquor obtained from another substance by distillation; (2) later, any subtle substance dissolved in another substance. The concept gradually veered ttoward what we now call the gaseous state.

Sp. Ammon. Cum Calce Viva
Ammonium carbonate ($(NH_4)_2CO_3$).

Spirit Ammon. Sal. Vol.
Mostly ammonium carbonate ($(NH_4)_2CO_3$).

Spirit of Alum
Sulfuric acid (H_2SO_4) obtained from the destructive distillation of alum ($KAl(SO_4)_2 \cdot 12H_2O$).

Spirit of Hartshorn
Strong solution of ammonia produced by the distillation of hartshorn (NH_4O_4).

Spirit of Libavius
Stannic cholride ($SnCl_4$).

Spirit of Mindererus
Ammonium acetate solution ($NH_4(C_2H_3O_2$).

Spirit of Wine
Ethanol (ethyl alcohol) (C_2H_5OH).

Spiritus Aceti
The acetic acid ($HC_2H_3O_2$) obtained from distilling any fermented material which produces this acid, e.g., vinegar.

Spiritus Beguini
Ammonium polysulfide (fuming liquor of Boyle) ($(NH_4)_2S$).

Spiritus CC
Ammonium carbonate ($(NH_4)_2CO_3$).

Spiritus Nitri Coagulatus
Potassium nitrate (KNO_3).

Spiritus Nitri Dulcis (Sweet spirit of Nitre)
Ethyl nitrite ($C_2H_5NO_2$).

Spiritus Sal Ammoniacum
See Spirit of Sal Amomoniac.

Spiritus Salis Ammoniaci Cum Sale Alkali Parata
Ammonium carbonate ($(NH_4)_2CO_3$).

Spiritus Salis Coagulatus
Potassium chloride (KCl).

Spiritus Sulphuris
See Spirit of Vitriol or Spirit of Sulphur

Spiritus Sulphuris Volatilus Beguinii
Ammonium polysulphide ($(NH_4)_2S$).

Spirit Veneris
Sulphuric acid (H_2SO_4).

Spiritus Vitrioli
See Spirit of Vitriol.

Spiritus Vitrioli Coagulatus
Potassium sulfate (K_2SO_4).

Sp. Mind.
See Spirit of mindererus

Spout

Any hollow projection from a vessel that is used to direct the liquid flow while pouring. This term was most commonly applied to the spout on an alembic.

Spuma Lupi
The minderal from which tungsten was extracted.

Stagnant Gas (Marsh Gas)
Methane (CH_4).

Stamping
Crushing of ores.

Stannum Anglici
Tin (Sn) from England.

Stannum Glaciale
Bismuth (Bi)

Starkey's Soap
Saponaceous substance from the reaction between potassium carbonate and essential oil of turpentine.

Steatite
A mineral substance composed mostly of various forms of magnesium silicate, e.g., ($Mg_3Si_4O_{11} \cdot H_2O$).

Steel
Regarded as a form of iron which (a) contained a larger portion of the inflammable principle and (b) had fewer chemical impurities.

Stibiated Tarter
Potassium antimonyl tartrate ($KSbC_4H_4O_7$).

Stibium
Antimony sulfide (Sb_2S_3).

Stick Laque
See Lac.

Stinking Sulphureous Air
Hydrogen sulphide (H_2S).

Stone of bologna
A variety of barium sulfate ($BaSO_4$) that became phosphorescent when calcined.

Spirit of Niter "Besiardique"
Nitric acid added to "Butter of Antimony" and the mixture distilled to get a liquor which holds the "Regulus of Antimony" in solution.

Spirit of Nitre
Dilute nitric acid (HNO_3).

Spirit of Ammoniac
Ammonia (NH_3), or ammonium hydroxide solution (NH_4OH).

Spirit of Salt
hydrochloric acid (HCl).

Spirit of Saturn
Impure acetone made from lead acetate (CH_3COCH_3).

Spirit of Sea-Salt
Hydrochloric acid (HCl).

Spirit of Sulfer
Mixture of sulfuric and sulfurous acids (H_2SO_4; H_2SO_3).

Spirit of Tatar
Potassium hydrogen tartrate (KHC4H4O6). Product of the dry distillation of crude tartar.

Spirit of Urine
Ammonium carbonate ($(NH_4)_2CO_3$). Derived from an impure solution of ammonia obtained by the distillation of urine.

Spirit of Venus
Concentrated and relatively pure acetic acid ($HC_2H_3O_2$).

Spirit of Verdigris
Acetic acid ($HC_2H_3O_2$).

Spirit of Vinegar
Impure acetic acid obtained by distilling vinegar ($HC_2H_3O_2$).

Spirit of Vitriol
Dilute sulfuric acid (H_2SO_4) and/ or sulfurous acid (H_2SO_3).

Strontia
Strontium oxide (SrO).

Sublimate
Solid or concrete products of sublimation. Not powder.

Sublimation
A property possessed by some substances enabling their going directly from the solid to the gaseous state without passing through the liquid phase.

Subsatnia Ferrea Vitrioli
Ferric oxide (Fe_2O_3).

Succinum
Amber.

Sudorific
Any medicinal substance which promoted, or was believed to promote, sweating.

Sugar of (A Subtance)
Usually signifying an acetate ($C_2H_3O_2$).

Sugar of Lead
Lead acetate ($Pb(C_2H_3O_2)_2$).

Sulphur
(a) As a "principle," in the seventeenth and early eighteenth centuries the substantive causes of the properties of inflammablility, color, and odor; (b) in the doctrined of phlogiston, a compound composed of vitriolic (sulfuric) acid and the inflammable principle, "phlogiston."

Sulphur Album Fixum
Potassium nitrate (KNO_3).

Sulphurated Iron
Ferrous sulphide (FeS).

Sulphur Minerale
Solid mineral sulphur (S).

Sulphur Of Antimony (Golden Sulphur of Antimony)
The orange sulfide of antimony, usually a mixture of the trisulfide (Sb_2S_3) with some of the pentasulfide (Sb_2S_5).

Sulphureous Salt of Stahl
Impure potassium sulfite (K_2SO_3).

Sulphureous Acid
Sulfurous acid (H_2SO_4).

Sulphurets
Sulfides (S).

Sulphureum (Bergman)
Sulfurous acid (H_2SO_3).

Sulphurous Acid (Pre-Lavoisier)
Sulfuric acid (H_2SO_4).

Sulphur Vivum
Naturally occurring sulphur (S).

Superolefiant Gas (Dalton)
Butylene (C_4H_8).

Swedish Acid
Hydrofluoric acid (HF).

Sweetened Spirit of Salt
Ethyl chloride (C_2H_5Cl).

Sweet Mercury (Mercureous Dulis)
Mercurous chloride (Hg_2Cl_2).

Sweet Principle from oils and fats
Glycerol ($HOCH_2CHOHCH_2OH$).

Sweet Sublimate
Mercurous chloride (Hg_2Cl_2).

Sympathetic Ink
Any solution that is colorless but becomes dark (and thus visible) by heating, by addition of other chemicals, etc.

Syrup of Violets
A water extract of the petals of violets.

Syrupus Violatum
See Syrup of Violets.

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Tabasheer (Tabachir)
A white powder formed at the joints of bamboo shoots. Imported from the Orient and used as a medicinal.

Talc
A mixture of magnesium metasilicilate ($Mg_3H_2(SiO_4)_3$) with magnesium silicate ($Mg_3Si_4O_{11} \cdot H_2O$).

Talky Earths
(a) fibrous earths; (b) earths that suffer no change from the action of acids or fire; (c) earths that do not become viscid or hard when made into aqueous paste, e.g., asbestos.

Tannin
Any astringent vegetable substance that can react with animal hyde and convert it to leather. The most common tannin was tannic acid extracted from oak-galls.

Tar
The dense, black, inflammable liquid or semisolid obtained from the distillation of various woods or coal. A complex mixture of hydrocarbons and organic compounds.

Tartar
Potassium hydrogen tartrate ($K_4HC_4H_4O_6$).

Tartarated Alkali of Tartar
Potassium tartrate ($K_2C_4H_4O_6$).

Tarter Emetic (Stibiated Tartar)
potassium antimonyl tartrate ($KSbC_4H_4O_7$).

Tartarified Iron
see Chalybs Tartar.

Tartarified Tincture of Iron
Ferrous tartrate solution ($FeC_4H_4O_6$).

Tartarin
A term occasionally used for potassium carbonate (K_2CO_3).

Tartarized Tartar
Potassium tartrate ($K_2C_4H_4O_6$).

Tartarized Tincture of Mars
Not a true alcohol solution, this medicinal was dubbed a tincture largely because of its deep color. Probably iron tartrate ($FeC_4H_4O_6$).
Tartarum Regeneratum (Regenerated Tartar)
Potassium acetate ($KC_2H_3O_3$) for the most part, but also used for assorted potassium salts. Not very well defined.
Tartarum Solubus (Soluble Salt of Tartar)
Potassium tartrate ($K_2C_4H_4O_6$).
Tartarum Tartisatum
Potassium tartrate ($K_2C_4H_4O_6$).
Tartarum Vitriolatum (Vitriolated Tartar)
Potassium sulfate (K_2SO_4).
Tartarus Citratus
Potassium citrate ($K_3C_6H_5O_7 \cdot H_2O$).
Tartarus Nitratus
Potassium nitrate (KNO_3.
Tartarus Tartarisatus
Potassium tartrate ($K_2C_4H_4O_6$).
Tartarus Vitriolatus
Potassium sulfate (K_2SO_4).
Tartre Stybie (Tartar Emetic)
Potassium antimonyl tartrate ($KSbC_4H_4O_7$).
Tar Water
A solution of the water-soluble components of tar. Mostly alcohols and polar organic materials.
Tectum Argenti
Bismuth (Bi).
Terebinth
The resin from the terebinth tree Pistacia terebinthuis.
Terebinthaceous
Impregnated with turpentine, having turpentine as a component, or just similar to turpentine.
Terebinthine
The refined portion or the "spirit" of the resin from the terebinth and other trees having similar resins. Very similar to what we now call turpentine.
Terra Anglica Rubra
Ferric oxide (Fe_2O_3).
Terra Foliata Nitri
Potassium acetate ($KC_2H_3O_2$).
Terra Foliata Tartari
See Regenerated Tartar.
Terra Foliata Tartari Crystallisabilis
Sodium acetate ($NaC_2H_3O_2$).
Terra Foliata Secretissima
Solid potassium acetate ($(KC_2H_3O_2)_2$).
Terra Francisca
Assorted sulfates (e.g., $FeSO_4$, $CuSO_4$)
Terra Molybdaenea
Molybdic acid ($H_2MoO_4(H_2)$).
Terra Ponderosa
Barium sulfate ($BaSO_4$).
Terra Ponderosa Acetate
Barium acetate ($Ba(C_2H_3O_2)_2$).
Terra Ponderosa Aerata
Barium carbonate ($BaCO_3$).
Terra Ponderosa Molybdaenata
Barium molybdate ($BaMoO_4$).
Terra Foliee Animale
Ammonium acetate ($NH_4C_2H_3O_2$).
Terra Foliee Crystallisee
Sodium acetate ($NaC_2H_3O_2$).
Test
A large cupel used for refining substantial quantities of gold and silver by means of lead.
Testaceous Earths
Mineral solids that came from or were chemically similar to shells. Thus, "testaceous powders" were prepared from shells.
Testing
The operation of refining gold and silver by means of lead.
Theriac
A general term for an antidote for the poison of a venomous snake.
Tincal (Tinkal)
Crude borax imported from India.
Tinct. Tartari
Solution of potassium hydroxide (KOH) in alcohol.
Tinctura Antimonii
See Tincture of Antimony.
Tincture

A solution in which ethanol is the primary solvent. The term was applied most often to colored solutions.

Tincture of Antimony

A medicinal prepared from antimony metal and liver of suphur (potassium polysulfides).

Tincture of Coral

Crude acetone (CH_3COCH_3).

Tincture of Mars

A general term for various medicinal preparations involving iron salts. Common components included ferrous hydroxide and mixed tartrates and oxides.

Tincture of Mars of Mynsight

An alcohol solution in which the solute is primarily ferric chloride ($FeCl_3$).

Tin-Glass

Bismuth (Bi).

Tinging

When one substance tinges or slightly colors another.

Torrefaction

Roasting of ores in the hope of removing impurities.

Tourmaline (Tourmalin, Ash-Stone)

A mineral solid consisting of various forms of silicoborate, including the black mineral "Schorl."

Tournsole

See Turnsol.

Triplesalts

Salts which seemed to have three components rather than the usual two, e.g., alum ($KAl\ (SO_4)_2 \cdot 12H_2O$).

Tripoli (Infusoria Earth, Rotten-Stone)

A finely divided mineral solid used for polishing. Obtained from the shells of diatoms.

Tritorium

A vessel used for the separation of immisicible liquids. It was often shaped somewhat like two modern separatory funnels cut near their tops and fused together. Basically the same as a separating glass.

Trituration

Mechanical breakdown or division of solid substances through grinding; e.g., with mortar and pestle, in a mill, etc.

Triture

See Trituration.

Trona

Naturally occurring sodium carbonate (Na_2CO_3). It usually had some bicarbonate ($NaHCO_3$) in it as well.

Tubulated Retort

A retort which had a sealable opening in the top to allow addition or removal of material without changing the position of the retort.

Tung Spat

See Heavy Spar.

Tunsgten (Scheelite)

Native calcium tungstate ($CaWO_4$)

Turmaric

A powder mad from the root of the imported East Indian plant Curcuna Longa.

Turners Yellow

Yellow lead oxychloride ($PbCl_2 \cdot 3PbO$).

Turnsol (e)

The bluish purple substance from the plant lichen Crozophora tinctoria. Used as an indicator. Synonymous with litmus.

Turpentine

A resinous liquid extracted from various trees. Originally the extract of the terebinith tree Distacia terebinthus.

Turpeth Mineral (Turbeth Mineral)

Basic mercuric sulphate ($HgSO_4 \cdot 2HgO$).

Tutenag (Chinese Copper)

A term occasionally applied to zinc (Zn). Also used for a white metal alloy (Chinese copper) which consisted primarily of copper (Cu), zinc (Zn), and nickel (Ni). Used to alloy silver in coins and jewelry items.

Tutia

See Tutty.

Tutty

Zinc oxide (ZnO).

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Uliginous

Any water, oozing matter like that in a swamp.

Ulmin

A mucilagenous substance from the inner bark of the elm.

Ultramarine

A blue pigment mad from the gem mineral lapis lazuli. The relative composition of ultramarine is not fixed, but the largest component is a sodium aluminum silicate combined with sulphur.

Umber

A mineral solid which exists in a range of brown hues. Chemically, umber is mostly a mixture of hydrous ferric oxide ($Fe_2O \cdot xH_2O$) and manganese dioxide (MnO_2). It was believed by many in the eighteenth century to be a fossil wood originally found in Umbria near Spoleto in Italy.

Unctuous

Oily; i.e., viscous, adherent and lubricating.

Unctuous Oils
Oils that have little or no taste or odor but are relatively "oily"; i.e., are viscous, adherent, and lubricating.

Urinou Salts
Usually any ammonium salt. Sometimes any of the alkali carbonates.

Ustulation
The loss of volatile components of a substance without loss of texture or body. Cf. Calcination.

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Vague Acid of Mines
An aeriform fluid which was probably largely sulphur dioxide (SO_2).

Vapour
Rather loosely applied to any aeriform substance or phase. Perhaps the best eighteenth century definition was any aeriform substance that could be liquefied by cold.

Vapour of Arsenic
Aresenious oxide (As_2O_3)

Varnish
A resin in solution. "Spirit" varnishes were resins dissolved in turpentine or alcohol. "Oil" varnishes were resins dissolved in linseed and/or other oils.

Vegetable Acid
Any acidic substance extracted from whole or fermented vegetable matter. Thus, the term was applied to acetic (CH_3COOH), citric ($C_6H_8O_7$), and tartaric ($C_4H_6O_6$) acids, etc.

Vegetable Acid, Fermentative
Primarily acetic acid from vinegar ($HC_2H_3O_2$).

Vegetative Acid, Native
Citric acid ($C_6H_8O_7$)

Vegetable Alkali (Potash)
Potassium carbonate (K_2CO_3).

Vegetable Ammoniacal Salt
Solid ammonium acetate ($NH_4C_2H_3O_2$)

Vegetable Salt
See Tartarified Tartar or Soluble Tartar.

Venus (of Venus)
Usually suggested either copper or a compound of copper. Sometimes it simply indicated an acetate. ($C_2H_3O_2^-$).

Verdigris (Verdigrise)
A basic copper acetate ($Cu(C_2H_3O_2)_2 \cdot 2Cu(OH)_2$). Long used as a green pigment.

Verditer (Blue Verditer; Blue Bice)
A blue pigment made from a basic copper carbonate ($2CuCO_3 \cdot Cu(OH)_2$) which is chemically the same as azurite.

Vermillion
The red pigment made from cinnabar (mercuric sulfide, HgS). See Cinnabar.

Vine Black
A preparation of carbon from the twigs and wood of vines. Used as a black pigment.

Vinegar of Lead
Primarily lead acetate ($Pb(C_2H_3O_2)_2$).

Vital Air
Oxygen (O_2)

Vitiated Air
Air from which oxygen has been removed, thus mainly nitrogen.

Vitresant (Vitrifiable)
Any solid that could be made into "glass".

Vitrifiable Earths (Vitreous Earths)
Mineral substances which fuse under the action of fire.

Vitrification
The chemical part of the process of making glass or of any high-temperature process which produced a glass-like substance.

Vitriol
Used mainly for ferrous sulfate ($FeSO_4$), but a generic term for sulfates. As with many old terms, the usage varied; e.g., some used the term for nitrates of silver and copper.

Vitriol, Blue
Copper sulfate ($CuSO_4$)

Vitriol, Green
Ferrous (or iron) sulfate ($FeSO_4$)

Vitriol, White
Zinc sulfate ($ZnSO_4$)

Vitriol (or Vitriolic) Acid
Sulphuric acid (H_2SO_4)

Vitriolated Earths, Metals, etc.
Sulphates.

Vitriolated Ether
Diethyl ether ($C_4H_{10}O$).

Vitriolated Tartar
Potassium sulfate (K_2SO_4)

Vitriolic Ether
Diethyl ether ($C_4H_{10}O$).

Vitriol of Goslar (White Vitriol)
Zinc sulfate ($ZnSO_4$)

Vitriol of Jove
Stannous sulfate ($SnSO_4$)

Vitriol of Jupiter
Stannous acetate ($Sn(C_2H_3O_2)_2$)

Vitriol of Mars (Green Vitriol)
Ferrous sulfate ($FeSO_4$)

Vitriol of Quick Silver
Mercuric nitrate ($Hg(NO_3)_2$)

Vitriol of Saturn
Lead acetate ($Pb(C_2H_3O_2)$)

Vitriol of Silver
Occasionally, early in the century, silver nitrate ($AgNO_3$). As the century progressed, the term was more reasonably applied to silver sulfate (Ag_2SO_4)

Vitriol of Venus
Cupric sulfate ($CuSO_4$)

Vitriolum Album
See White Vitriol.

Vitriolum Ammonium
Ammonium sulfate ($(NH_4)_2SO_4$)

Vitriolum Anglicum
Ferrous sulfate ($FeSO_4$)

Vitriolum Veneris cum Alkali Fixo Praecipitatum
Basic copper acetate ($Cu(C_2H_3O_2)_2 \cdot CuO \cdot 6\ H_2O$)

Vitrium Antimonii (Glass of Antimony)
Fused antimony oxide (Sb_2O_3)

Vivifying Spirit
A hypothetical principle in the air which, according to some early eighteenth century chemists, was the active agent in combustion and respiration.

Volatile
An adjective usually used to indicate not only that a substance naturally gave off some aeriform component (as indicated by an odor) but also that it decomposed easily and gave off one or more aeriform components to the air on heating.

Volatile Acid of Nitre
Nitrous acid (HNO_2)

Volatile Acid of Sulfur (Phlogisticated Vitriolic Acid)
Sulfurous acid (H_2SO_3)

Volatile Alkali
A term most commonly used for solutions of ammonia; e.g., ammonium hydroxide.

Volatile Alkali in its Concrete Form
Ammonium carbonate (NH_4CO_3)

Volatile Liver of Sulfur
Volatile product from heating sulfur with quicklime and ammonium chloride.

Volatile Sal Ammoniac
Ammonium hydroxide solution.

Volatile Salt
Ammonium carbonate ($(NH_4)_2CO_3$)

Volatile Salt of Amber
See Salt of Amber

Volatile Salt of Hartshorn
Ammonium carbonate (NH_4CO_3)

Volatile Spirit of Sal Ammoniac
Ammonium hydroxide (NH_4OH) obtained from quicklime (calcium oxide) and sal ammoniac (ammonium chloride).

Volatile Spirit of Sulfur
The aeriform product from burning sulfur; mostly sulfur dioxide

Volatile Vitriol of Venus
Copper acetate $Cu(C_2H_3O_2)_2$

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Wash
Any fermented mixture which, after distillation, would produce distilled spirits (ethanol CH_3CH_2OH, with impurities).

Water gas
Mixture of hydrogen (H_2) and carbon monoxide (CO)

Water of Minderus
A solution of ammonium acetate ($NH_4C_2H_3O_2$).

Water of Rabel
A solution of ethyl ether ($CH_3CH_2OCH_2CH_3$) in ethanol (CH_3CH_2OH)

Wax
A term referring to beeswax only, as the hydrocarbon waxes were not available in the eighteenth century.

Whey
The liquid which remains after milk is curdled, usually in the process of cheese-making
White Arsenic
Arsenious oxide (As_2O_3)
White Calx of Antimony
Mixture of antimony oxide (Sb_2O_3) and potassium oxide (K_2O).
White Copper
An alloy of arsenic (As), copper (Cu), and zinc (Zn).
White Copperas
Zinc sulphate ($ZnSO_4$)
White Lead
Basic lead carbonate ($Pb(CO_3)_2 \cdot Pb\ (OH)_2$)
White Manganese
Manganous carbonate ($MnCO_3$)
White Precipitated Mercury (Precipitate of Sublimate of Mercury)
Mercurammonium chloride ($HgNH_2Cl$)
White Vitriol
Zinc sulphate ($ZnSO_4$)
Wind Furnace
A reverberating furnace.
Wine
Often used more broadly by eighteenth-century chemists to include any potable liquid which had become "spiritous" through fermentation; e.g., beer, cider, and mead.
Witherite
Barium carbonate ($BaCO_3$).
Woad
A blue dye prepared from the leaves of the plant Isatis tinctoria.
Wolfram
A mineral substance Spumi lupi that was under investigation in the 18th century.
Wood Ash
Potassum carbonate (K_2CO_3)
Worm
A long, coiled tube, usually of copper, attached to the head of a distillation apparatus for the purpose of increasing condensation. A worm commonly was used in ditilling spirits.
Wormwood
The plant Artemisia absinthium, the leaves of which were used to make an extract by distillation. Used as a medicinal.
Wort
An infusion of grain, usually malt, which was fermented to produce beer.
Woulfe Bottle
A bottle with two or more necked orifices that was used in distillation.

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Yellow
A yellow coloring agent produced by treating indigo with dilute nitric acid. This substance proved to be unstable and seldom was used as dye.
Yellow Aqua Fortis
Concentrated nitric acid (HNO_3).
Yellow Arsenic
Arsenious sulphide (As_2S_3).
Yellow Ochre
Hydrated ferric oxide ($Fe_2O_3 \cdot H_2O$).
Yttria
A mixture of rare earth elements from the mineral gadolinite. Primarily the trioxide of yttrium (Y_2O_3).

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Zaffre (Saffre)
A gray or reddish powder composed mostly of cobalt oxide (CaO).
Zeolites
A group of mineral solids which are various hydrated silicates, primarily of aluminum, calcium, potassium, and sodium. Although not really related, they share the property of swelling and "boiling" under the heat of the blowpipe.
Zinc (Zinco, Zinetum)
Regarded in the eighteenth century as a semi-metal because of its relative brittleness.

Johann Wolfgang Döbereiner (1780-1849)

An Attempt to Group Elementary Substances according to Their Analogies

Poggendorf's *Annalen der Physik und Chemie* **15**, 301-7 (1829) [from Henry M. Leicester & Herbert S. Klickstein, eds., *A Source Book in Chemistry, 1400-1900* (Cambridge, MA: Harvard, 1952)]

The work of Berzelius on the determination of the atomic weights of bromine and iodine has interested me greatly, since it has established the idea, which I expressed earlier in my lectures, that perhaps the atomic weight of bromine might be the arithmetical mean of the atomic weights of chlorine and iodine. This mean is (35.470+126.470)/2 = 80.470 [sic-- L&K]. This number is not much greater than that found by Berzelius (78.383); however, it comes so close that it may almost be hoped that the difference will vanish entirely after repeated careful and exact determinations of the atomic weights of these three salt-forming elements. This idea was the motive for an attempt which I made twelve years ago to group substances by their analogies. At that time I found that the specific gravity and atomic weight of strontia are very close to the arithmetic mean of the specific gravities and atomic weights of lime and baryta, since

> $[356.019(=Ca^{\cdot})+956.880(=Ba^{\cdot})]/2 = 656.449(=Sr^{\cdot})$[1]

and the actual value for strontia is 647.285.

In the alkali group, according to this view, soda stands in the middle, since if we take the value for the atomic weight of lithia, determined by Gmelin, = 195.310, and the value for potash = 589.916, then the arithmetic mean of these numbers,

> (195.310+589.916)/2 = 392.613,

which comes very close to the atomic value for soda, which Berzelius determined as = 390.897.

For the group including phosphorus and arsenic, the third member is missing. Mitscherlich, the discoverer of isomorphology, will know how to find this if it exists.

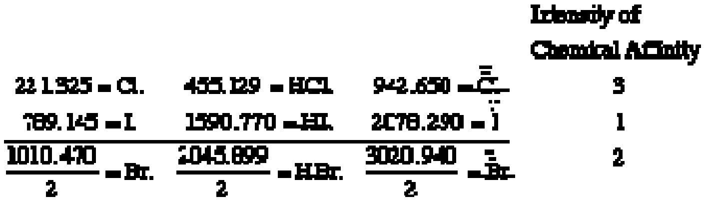
If sulfur, selenium, and tellurium belong to one group, which can well be assumed, since the specific gravity of selenium is exactly the arithmetic mean of the specific gravities of sulfur and tellurium, and all three substances combine with hydrogen to form characteristic hydrogen acids, then selenium forms the middle member, since

> [32.239(=S) + 129.243(=Te)]/2 = 80.741

and the empirically found atomic value for selenium is 79.263.[2]

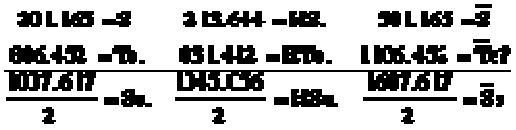
Fluorine indeed belongs to the salt-forming elements, but certainly not to the group of chlorine, bromine, and iodine; rather to another class of salt-forming substances which perhaps are related to the first as the alkaline earths are to the alkalies. Since it has a very small value, it apparently forms the first member of the assumed group, and in this case there would still be two more members to discover, if triads are actually a law for all groups of chemical substances. If the values shown by the atomic weights of the substances which are here grouped together are compared with the intensity of the chemical affinity which these substances possess, then we find that in the alkalies and alkaline earths the first is *directly* proportional to the last, but in the salt-forming elements they are *inversely* proportional. Thus potash, which has the largest value among the alkalies, is the strongest, while lithia, which has the smallest value, is the weakest, and soda, which holds the middle value between potash and lithia, is weaker than potash and stronger than lithia. Baryta, lime, and strontia behave in the same way. However, chlorine, which has the smallest value, is the most powerful, and iodine, which possesses the greatest value, is the weakest in salt formation, and bromine lies between both. If we express the intensity of the chemical affinity of the grouped substances by the numbers 1, 2, and 3, then these considerations can clearly be arranged in the following way:

- (a) Salt-forming elements and their acids.



			Intensity of Chemical Affinity
221.325 = Cl.	455.129 = HCl	942.650 = $\ddot{\bar{Cl}}$	3
789.145 = I	1590.770 = HI.	2078.290 = $\ddot{I}$	1
$\frac{1010.470}{2}$ = Br.	$\frac{2045.899}{2}$ = H.Br.	$\frac{3020.940}{2}$ = $\ddot{\bar{Br}}$	2

- (b) Acid-forming elements and their acids.



201.165 = S	213.644 = HS.	501.165 = $\bar{S}$	3
806.452 = Te.	831.412 = HTe.	1106.452 = $\bar{Te}$?	1
$\frac{1007.617}{2}$ = Se.	$\frac{1045.056}{2}$ = HSe.	$\frac{1607.617}{2}$ = $\bar{S}e$,	2

- (c) Alkali-forming elements and alkalies.

$$\begin{array}{lll} 91.310 = \mathrm{L.} & 191.310 = \dot{\mathrm{L}} & 1 \\ 489.916 = \mathrm{K.} & 589.916 = \dot{\mathrm{K}} & 3 \\ \hline \frac{581.226}{2} = \mathrm{Na.} & \frac{781.226}{2} = \dot{\mathrm{Na}} & 2 \end{array}$$

- (d) Alkaline-earth-forming elements and alkaline earths.

$$\begin{array}{lll} 256.019 = \mathrm{Ca.} & 356.019 = \dot{\mathrm{Ca}} & 1 \\ 856.880 = \mathrm{Ba.} & 956.880 = \dot{\mathrm{Ba}} & 3 \\ \hline \frac{1112.899}{2} = \mathrm{Sr.} & \frac{1312.899}{2} = \dot{\mathrm{Sr}} & 2 \end{array}$$

Hydrogen, oxygen, nitrogen, and carbon appear to stand isolated from the substances which form bases, acids, and salts. The fact that the arithmetical mean of the atomic weights of oxygen = 16.026 and carbon 12.256 expresses the atomic weight of nitrogen = 14.138 cannot be considered here, because no analogies occur between these three substances.

The earth metals and the earths themselves belong together, according to their similarities, but I have not yet placed them successfully. It is true that they form boron and silicon, as well as $\mathrm{B}^{\cdots}$ and $\mathrm{Sl}^{\cdots}$; aluminum and beryllium, and also $\mathrm{Al}^{\cdots}$ and $\mathrm{Be}^{\cdots}$; yttrium and cerium, and also $\mathrm{Y}^{\cdot}$ and $\mathrm{Ce}^{\cdot}$, which are special groups, but each of them lacks a third member. Magnesium stands entirely alone, and zirconium belongs with titanium and tin.

The group of heavy metal alum-forming substances is fully filled. Its factors are iron oxide ~~Fe~~$^{\cdots}$, manganese oxide ~~Mn~~$^{\cdots}$, and chromium oxide ~~Cr~~$^{\cdots}$; the last apparently forms the middle member, since

(979.426 ~~Fe~~$^{\cdots}$ + 1011.574~~Mn~~$^{\cdots}$)/2 = 995.000 ~~Cr~~$^{\cdots}$ [*sic* -- L&K]

According to Mitscherlich, $\mathrm{Fe}^{\cdot}$, $\mathrm{Mn}^{\cdot}$, $\mathrm{Ni}^{\cdot}$, $\mathrm{Co}^{\cdot}$, $\mathrm{Zn}^{\cdot}$, and $\mathrm{Cu}^{\cdot}$ are isomorphic with magnesia. This is a highly interesting series of substances, since, first, they all belong to the magnetic metals, and second, they are the best conductors of electricity. But how shall we arrange them if the triad is to be taken as a principle of grouping? In nature, Fe, Mn, and Co occur as oxides which are frequently found together, and the oxides of Ni, Zn, and Cu, as an Englishman says, occur together in an ore from which the Chinese prepare their white copper, which the Germans call *Argentan*. If this is so, then in the first group manganese forms the third member, since

(439.213 $\mathrm{Fe}^{\cdot}$ + 468.991 $\mathrm{Co}^{\cdot}$)/2 = 454.102 $\mathrm{Mn}^{\cdot}$

and in the second group it is copper which occupies this position, since

(469.675 $\mathrm{Ni}^{\cdot}$ + 503.226 $\mathrm{Zn}^{\cdot}$)/2 =486.450 $\mathrm{Cu}^{\cdot}$

However, the atomic weight of $\mathrm{Cu}^{\cdot}$ is 495.695, and the specific gravity of copper is not the arithmetical mean of the specific gravities of nickle and zinc, and I therefore believe that these six oxides must be grouped in another way. A rigorous experimental revision of the specific gravities and atomic weights will perhaps remove this doubt.

The most interesting series of analogous metals are those which occur in platinum ores, where platinum, palladium, rhodium, iridium, osmium, and pluranium belong. They fall into two groups according to their specific gravities and atomic weights. Platinum, iridium, and osmium belong in the first group, and in the second, palladium, rhodium, and pluranium. (The latter represents osmium, while rhodium corresponds to iridium and palladium to platinum.) For the members of the first group, the atomic weights, according to the most recent work of Berzelius, are as follows: for platinum, 1233.260; for iridium, 1233.260; for osmium, 1244.210. Now, since the specific gravity of iridium is very near the arithmetical mean of the specific gravities of platinum and osmium (the last, according to Berzelius, =10), then iridium must be considered the middle member

(1233.260 + 1244.210)/2 = 1238.735

The atomic weights for the members of the second group, according to the same admirable scientist, are, for palladium, 665.840; for rhodium, 651.400. Thus we get, for pluranium, 636.960, if the atomic weight of the latter stands so near the atomic weights of platinum and iridium, and if rhodium is placed in the middle of this group.[3]

The specific gravity and atomic weight of lead are fairly near the arithmetical mean of the specific gravities and atomic weights of silver and mercury, and I therefore believe that these three metals can be placed together.

Whether tin and cadmium, antimony and bismuth, gold and tungsten, or tungsten and tantalum, etc., belong together, and which may be the missing analogous members, I will not venture to decide.

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[1] [In the notation of this time, a dot over an element symbol denotes an oxygen atom and a bar denotes a double atom (*i.e.*, two atoms). For example, ~~Cl~~$^{\cdot\cdot\cdot\cdot\cdot}$ denotes Cl_2O_5. Note: unless the symbol is part of a larger equation, I am rendering dotted symbols with superscript dots, not, as in the original typography, dots directly over the symbol. --CJG]

[2] Tellurium certainly has a still higher degree of oxidation than $Te^{\cdot\cdot}$. Perhaps it can be converted to $Te^{\cdot\cdot\cdot}$ under the same conditions in which Mitscherlich has formed $Se^{\cdot\cdot\cdot}$ from Se. [original note]

[3] The existence of pluranium still remains in some doubt. P. [P. is Poggendorf. This is editor's note from the original journal.--CJG]

Dmitrii Mendeleev (1834-1907)

On the Relationship of the Properties of the Elements to their Atomic Weights

D. Mendelejeff, *Zeitschrift für Chemie* **12**, 405-6 (1869) [from David M. Knight, ed., *Classical Scientific Papers--Chemistry, Second Series*, 1970; translation from German by Carmen Giunta. Note: I have included hyperlinks from three of the blank places in this table to accounts of the discoveries of the corresponding elements at the ChemTeam site. I have left element symbols as they were in the German abstract. --CJG]

By ordering the elements according to increasing atomic weight in vertical rows so that the horizontal rows contain analogous elements, still ordered by increasing atomic weight, one obtains the following arrangement, from which a few general conclusions may be derived.

			Ti=50	Zr=90	?=180
			V=51	Nb=94	Ta=182
			Cr=52	Mo=96	W=186
			Mn=55	Rh=104,4	Pt=197,4
			Fe=56	Ru=104,4	Ir=198
			Ni=Co=59	Pd=106,6	Os=199
H=1			Cu=63,4	Ag=108	Hg=200
	Be=9,4	Mg=24	Zn=65,2	Cd=112	
	B=11	Al=27,4	?=68	Ur=116	Au=197?
	C=12	Si=28	?=70	Sn=118	
	N=14	P=31	As=75	Sb=122	Bi=210?
	O=16	S=32	Se=79,4	Te=128?	
	F=19	Cl=35,5	Br=80	J=127	
Li=7	Na=23	K=39	Rb=85,4	Cs=133	Tl=204
		Ca=40	Sr=87,6	Ba=137	Pb=207
		?=45	Ce=92		
		?Er=56	La=94		
		?Yt=60	Di=95		
		?In=75,6	Th=118?		

1. The elements, if arranged according to their atomic weights, exhibit a periodicity of properties.

2. Chemically analogous elements have either similar atomic weights (Pt. Ir, Os), or weights which increase by equal increments (K, Rb, Cs).

3. The arrangement according to atomic weight corresponds to the *valence* of the element and to a certain extent the difference in chemical behavior, for example Li, Be, B, C, N, O, F.

4. The elements distributed most widely in nature have *small* atomic weights, and all such elements are marked by the distinctness of their behavior. They are, therefore, the *representative* elements; and so the lightest element H is rightly chosen as the most representative.

5. The *magnitude* of the atomic weight determines the properties of the element. Therefore, in the study of compounds, not only the quantities and properties of the elements and their reciprocal behavior is to be taken into consideration, but also the *atomic weight* of the elements. Thus the compounds of S and Tl [sic--Te was intended], Cl and J, display not only many analogies, but also striking differences.

6. One can predict the discovery of many *new* elements, for example analogues of Si and Al with atomic weights of 65-75.

7. A few atomic weights will probably require correction; for example Te cannot have the atomic weight 128, but rather 123-126.

8. From the above table, some new analogies between elements are revealed. Thus Bo (?) [sic--apparently Ur was intended] appears as an analogue of Bo and Al, as is well known to have been long established experimentally.

(Russian Chemical Society 1, 60)

Dmitrii Mendeleev (1834-1907)

The Periodic Law of the Chemical Elements.

Journal of the Chemical Society, **55**, 634-56 (1889)

By Professor MENDELÉEFF

(FARADAY LECTURE delivered before the Fellows of the Chemical Society in the Theatre of the Royal Institution, on Tuesday, June 4th, 1889.)

The high honour bestowed by the Chemical Society in inviting me to pay a tribute to the world-famous name of Faraday by delivering this lecture has induced me to take for its subject the Periodic Law of the Elements--this being a generalisation in chemistry which has of late attracted much attention.

While science is pursuing a steady onward movement, it is convenient from time to time to cast a glance back on the route already traversed, and especially to consider the new conceptions which aim at discovering the general meaning of the stock of facts accumulated from day to day in our laboratories. Owing to the possession of laboratories, modern science now bears a new character, quite unknown not only to antiquity but even to the preceding century. Bacon's and Descartes' idea of submitting the mechanism of science simultaneously to experiment and reasoning has been fully realised in the case of chemistry, it having become not only possible but always customary to experiment. Under the all-penetrating control of experiment, a new theory, even if crude, is quickly strengthened, provided it be founded on a sufficient basis; the asperities are removed, it is amended by degrees, and soon loses the phantom light of a shadowy form or of one founded on mere prejudice; it is able to lead to logical conclusions and to submit to experimental proof. Willingly or not, in science we all must submit not to what seems to us attractive from one point of view or from another, but to what represents an agreement between theory and experiment; in other words, to demonstrated generalisation and to the approved experiment. Is it long since many refused to accept the generalisations involved in the law of Avogadro and Ampère, so widely extended by Gerhardt? We still may hear the voices of its opponents; they enjoy perfect freedom, but vainly will their voices rise so long as they do not use the language of demonstrated facts. The striking observations with the spectroscope which have permitted us to analyse the chemical constitution of distant worlds, seemed, at first, applicable to the task of determining the nature of the atoms themselves; but the working out of the idea in the laboratory soon demonstrated that the characters of spectra are determined--not directly by the atoms, but by the molecules into which the atoms are packed; and so it became evident that more verified facts must be collected before it will be possible to formulate new generalisations capable of taking their place beside those ordinary ones based upon the conception of simple bodies and atoms. But as the shade of the leaves and roots of living plants, together with the relics of a decayed vegetation, favour the growth of the seedling and serve to promote its luxurious development, in like manner sound generalisations--together with the relics of those which have proved to be untenable--promote scientific productivity, and ensure the luxurious growth of science under the influence of rays emanating from the centres of scientific energy. Such centres are scientific associations and societies. Before one of the oldest and most powerful of these I am about to take the liberty of passing in review the 20 years' life of a generalisation which is known under the name of the Periodic Law. It was in March, 1869, that I ventured to lay before the then youthful Russian Chemical Society the ideas upon the same subject, which I had expressed in my just written "Principles of Chemistry."

Without entering into details, I will give the conclusions I then arrived at, in the very words I used:--

"1. The elements, if arranged according to their atomic weights, exhibit an evident *periodicity* of properties.

"2. Elements which are similar as regards their chemical properties have atomic weights which are either of nearly the same value (*e.g.*, platinum, iridium, osmium) or which increase regularly (*e.g.*, potassium, rubidium, caesium).

"3. The arrangement of the elements, or of groups of elements in the order of their atomic weights corresponds to their so-called *valencies* as well as, to some extent, to their distinctive chemical properties--as is apparent among other series in that of lithium, beryllium, barium, carbon, nitrogen, oxygen and iron [sic. The printed speech in *J. Chem. Soc.* says barium and iron. Obviously boron (B) and fluorine (F) are meant. Mendeleev's 1869 paper lists the symbols B and F rather than the names of the elements.--CJG]

"4. The elements which are the most widely diffused have *small* atomic weights.

"5. The *magnitude* of the atomic weight determines the character of the element just as the magnitude of the molecule determines the character of a compound body.

"6. We must expect the discovery of many yet *unknown* elements, for example, elements analogous to aluminium and silicon, whose atomic weight would be between 65 and 75.

"7. The atomic weight of an element may sometimes be amended by a knowledge of those of the contiguous elements. Thus, the atomic weight of tellurium must lie between 123 and 126, and cannot be 128.

"8. Certain characteristic properties of the elements can be foretold from their atomic weights.

"The aim of this communication will be fully attained if I succeed in drawing the attention of investigators to those relations which exist between the atomic weights of dissimilar elements, which, as far as I know, have hitherto been almost completely neglected. I believe that the solution of some of the most important problems of our science lies in researches of this kind."

To-day, 20 years after the above conclusions were formulated, they may still be considered as expressing the essence of the now well-known periodic law.

Reverting to the epoch terminating with the sixties, it is proper to indicate three series of data without the knowledge of which the periodic law could not have been discovered, and which rendered its appearance natural and intelligible.

In the first place, it was at that time that the numerical value of atomic weights became definitely known. Ten years earlier such knowledge did not exist, as may be gathered from the fact that in 1860 chemists from all parts of the world met at Karlsruhe in order to come to some agreement, if not with respect to views relating to atoms, at any rate as regards their definite representation. Many of those present probably remember how vain were the hopes of coming to an understanding, and how much ground was gained at that Congress by the followers of the unitary theory so brilliantly represented by Cannizzaro. I vividly remember the impression produced by his speeches, which admitted of no compromise, and seemed to advocate truth itself, based on the conceptions of Avogadro, Gerhardt and Regnault, which at that time were far from being generally recognised. And though no understanding could be arrived at, yet the objects of the meeting were attained, for the ideas of Cannizzaro proved, after a few years, to be the only ones which could stand criticism, and which represented an atom as--"the smallest portion of an element which enters into a molecule of its compound." Only such real atomic weights--not conventional ones--could afford a basis for generalisation. It is sufficient, by way of example, to indicate the following cases in which the relation is seen at once and is perfectly clear:--

K = 39 Rb = 85 Cs = 133
Ca = 40 Sr = 87 Ba = 137

whereas with the equivalents then in use--

K = 39 Rb = 85 Cs = 133
Ca = 20 Sr = 43.5 Ba = 68.5

the consecutiveness of change in atomic weight, which with the true values is so evident, completely disappears.

Secondly, it had become evident during the period 1860-70, and even during the preceding decade, that the relations between the atomic weights of analogous elements were governed by some general and simple laws. Cooke, Cremers, Gladstone, Gmelin, Lenssen, Pettenkofer, and especially Dumas, had already established many facts bearing on that view. Thus Dumas compared the following groups of analogous elements with organic radicles--

	Diff.		**Diff.**		**Diff.**		**Diff.**
		Mg = 12		P = 31		O = 8	
			8		44		8
Li = 7		Ca = 20		As = 75		S = 16	
	16		3 x 8		44		3 x 8
Na = 23		Sr = 44		Sb = 119		Se = 40	
	16		3 x 8		2 x 44		3 x 8
K = 39		Ba = 68		Bi = 207		Te = 64	

and pointed out some really striking relationships, such as the following:--

F = 19.
Cl = 35.5 = 19 + 16.5.
Br = 80 = 19 + 2 x 16.5 + 28.
I = 127 = 2 x 19 + 2 x 16.5 + 2 x 28.

A. Strecker, in his work "Theorien und Experimente zur Bestimmung der Atomgewichte der Elemente" (Braunschweig, 1859), after summarising the data relating to the subject, and pointing out the remarkable series of equivalents--
Cr = 26.2 Mn = 27.6 Fe = 28 Ni = 29 Co = 30
Cu = 31.7 Zn = 32.5
remarks that: "It is hardly probable that all the above-mentioned relations between the atomic weights (or equivalents) of chemically analogous elements are merely accidental. We must, however, leave to the future the discovery of the *law* of the relations which appears in these figures."[1]

In such attempts at arrangement and in such views are to be recognised the real forerunners of the periodic law; the ground was prepared for it between 1860 and 1870, and that it was not expressed in a determinate form before the end of the decade, may, I suppose, be ascribed to the fact that only analogous elements had been compared. The idea of seeking for a relation between the atomic weights of all the elements was foreign to the ideas then current, so that neither the *vis tellurique* of De Chancourtois, nor the *law of octaves* of Newlands, could secure anybody's attention. And yet both De Chancourtois and Newlands, like Dumas and Strecker, more than Lenssen and Pettenkofer, had made an approach to the periodic law and had discovered its germs. The solution of the problem advanced but slowly, because the facts, and not the law, stood foremost in all attempts; and the law could not awaken a general interest so long as elements, having no apparent connection with each other, were included in the same octave, as for example:--

1st octave of Newlands	H	F	Cl	Co & Ni	Br	Pd	I	Pt & Ir
7th Ditto	O	S	Fe	Se	Rh & Ru	Te	Au	Os or Th

Analogies of the above order seemed quite accidental, and the more so as the octave contained occasionally 10 elements instead of eight, and when two such elements as Ba and V, Co and Ni, or Rh and Ru, occupied one place in the octave.[2] Nevertheless, the fruit was ripening, and I now see clearly that Strecker, De Chancourtois and Newlands stood foremost in the way toward the discovery of the periodic law, and that they merely wanted the boldness necessary to place the whole question at such a height that its reflection on the facts could be clearly seen.

A third circumstance which revealed the periodicity of chemical elements was the accumulation, by the end of the sixties, of new information respecting the rare elements, disclosing their many-sided relations to the other elements and to each other. The researches of Marignac on niobium, and those of Roscoe on vanadium were of special moment. The striking analogies between vanadium and phosphorus on the one hand, and between vanadium and chromium on the other, which became so apparent in the investigations connected with that element, naturally induced the comparison of V = 51 with Cr = 52, Nb = 94 with Mo = 96, and Ta = 192 with W = 194; while, on the other hand, P = 31 could be compared with S = 32, As = 75 with Se = 79, and Sb = 120 with Te = 125. From such approximations there remained but one step to the discovery of the law of periodicity.

The law of periodicity was thus a direct outcome of the stock of generalisations and established facts which had accumulated by the end of the decade 1860-1870: it is an embodiment of those data in a more or less systematic expression. Where, then, lies the secret of the special importance which has since been attached to the periodic law, and has raised it to the position of a generalisation which has already given to chemistry unexpected aid, and which promises to be far more fruitful in the future and to impress upon several branches of chemical research a peculiar and original stamp? The remaining part of my communication will be an attempt to answer this question.

In the first place we have the circumstance that, as soon as the law, made its appearance, it demanded a revision of many facts which were considered by chemists as fully established by existing experience. I shall return, later on, briefly to this subject, but I wish now to remind you that the periodic law, by insisting on the necessity for a revision of supposed facts, exposed itself at once to destruction in its very origin. Its first requirements, however, have been almost entirely satisfied during the last 20 years; the supposed facts have yielded to the law, thus proving that the law itself was a legitimate induction from the verified facts. But our inductions from data have often to do with such details of a science so rich in facts, that only generalisations which cover a wide range of important phenomena can attract general attention. What were the regions touched on by the periodic law? This is what we shall now consider.

The most important point to notice is, that periodic functions, used for the purpose of expressing changes which are dependent on variations of time and space, have been long known. They are familiar to the mind when we have to deal with motion in closed cycles, or with any kind of deviation from a stable position, such as occurs in pendulum-oscillations. A like periodic function became evident in the case of the elements, depending on the mass of the atom. The primary conception of the masses of bodies or of the masses of atoms belongs to a category which the present state of science forbids us to discuss, because as yet we have no means of dissecting or analysing their conception. All that was known of functions dependent on masses derived its origin from Galileo and Newton, and indicated that such functions either decrease or increase with the increase of mass, like the attraction of celestial bodies. The numerical expression of the phenomena was always found to be proportional to the mass, and in no case was an increase of mass followed by a recurrence of properties such as is disclosed by the periodic law of the elements. This constituted such a novelty in the study of the phenomena of nature that, although it did not lift the veil which conceals the true conception of mass, it nevertheless indicated that the explanation of that conception must be searched for in the masses of the atoms; the more so, as all masses are nothing but aggregations, or additions, of chemical atoms which would be best described as chemical individuals. Let me remark by the way that though the Latin word "individual" is merely a translation of the Greek word "atom," nevertheless history and custom have drawn so sharp a distinction between the two words, and the present chemical conception of atoms is nearer to that defined by the Latin word than by the Greek, although this latter also has acquired a special meaning which was unknown to the classics. The periodic law has shown that our chemical individuals display a harmonic periodicity of properties, dependent on their masses. Now, natural science has long been accustomed to deal with periodicities observed in nature, to seize them with the vice of mathematical analysis, to submit them to the rasp of experiment. And these instruments of scientific thought would surely, long since, have mastered the problem connected with the chemical elements, were it not for a new feature which was brought to light by the periodic law and which gave a peculiar and original character to the periodic function.

If we mark on an axis of abscissae a series of lengths proportional to angles, and trace ordinates which are proportional to sines or other trigonometrical functions, we get periodic curves of a harmonic character. So it might seem, at first sight, that with the increase of atomic weights the function of the properties of the elements should also vary in the same harmonious way. But in this case there is no such continuous change as in the curves just referred to, because the periods do not contain the infinite number of points constituting a curve, but a *finite* number only of such points. An example will better illustrate this view. The atomic weights--

Ag = 108 Cd = 112 In = 113 Sn = 118
Sb = 120 Te = 125 I = 127

steadily increase, and their increase is accompanied by a modification of many properties which constitutes the essence of the periodic law. Thus, for example, the densities of the above elements decrease steadily, being respectively--

10.5 8.6 7.4 7.2 6.7 6.4 4.9

while their oxides contain an increasing quantity of oxygen:--

Ag_2O Cd_2O_2 In_2O_3 Sn_2O_4 Sb_2O_5 Te_2O_6 I_2O_7

But to connect by a curve the summits of the ordinates expressing any of these properties would involve the rejection of Dalton's law of multiple proportions. Not only are there no intermediate elements between silver, which gives AgCl, and cadmium, which gives $CdCl_2$, but, according to the very essence of the periodic law there can be none; in fact a uniform curve would be inapplicable in such a case, as it would lead us to expect elements possessed of special properties at any point of the curve. The periods of the elements have thus a character very different from those which are so simply represented by geometers. They correspond to points, to numbers, to sudden changes of the masses, and not to a continuous evolution. In these sudden changes destitute of intermediate steps or positions, in the absence of elements intermediate between, say, silver and cadmium, or aluminium and silicon, we must recognise a problem to which no direct application of the analysis of the infinitely small can be made. Therefore, neither the trigonometrical functions proposed by Ridberg and Flavitzky, nor the pendulum-oscillations suggested by Crookes, nor the cubical curves of the Rev. Mr. Haughton, which have been proposed for expressing the periodic law, from the nature of the case, can represent the periods of the chemical elements. If geometrical analysis is to be applied to this subject it will require to be modified in a special manner. It must find the means of representing in a special way not only such long periods as that comprising,

K Ca Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga G[e] As Se Br,

but short periods like the following:--

Na Mg Al Si P S Cl.

In the theory of numbers only do we find problems analogous to ours, and two attempts at expressing the atomic weights of the elements by algebraic formulae seem to be deserving of attention, although neither of them can be considered as a complete theory, nor as promising finally to solve the problem of the periodic law. The attempt of E. J. Mills (1886) does not even aspire to attain this end. He considers that all atomic weights can be expressed by a logarithmic function,

$15(n - 0.9375^t)$,

in which the variables n and t are *whole numbers*. Thus, for oxygen, n = 2, and t = 1, whence its atomic weight is = 15.94; in the case of chlorine, bromine, and iodine, n has respective values of 3, 6, and 9, while t = 14, 18, and 20.

Another attempt was made in 1888 by B. N. Tchitchérin. Its author places the problem of the periodic law in the first rank, but as yet he has investigated the alkaline metals only. Tchitchérin first noticed the simple relations existing between the atomic volumes of all alkaline metals; they can be expressed, according to his views, by the formula

$A(2 - 0.00535An)$,

where A is the atomic weight, and n is equal to 8 for lithium and sodium, to 4 for potassium, to 3 for rubidium, and to 2 for caesium. If n remained equal to 8, during the increase of A, then the volume would become zero at A = 46 2/3, and it would reach its maximum at A = 23 1/3. The close approximation of the number 46 2/3 to the difference between the atomic weights of analogous elements (such as Cs - Rb, I - Br, and so on); the close correspondence of the number 23 1/3 to the atomic weight of sodium; the fact of n being necessarily a whole number, and several other aspects of the question, induce Tchitchérin to believe that they afford a clue to the understanding of the nature of the elements; we must, however, await the full development of his theory before pronouncing judgment on it. What we can at present only be certain of is this: that attempts like the two above named must be repeated and multiplied, because the periodic law has clearly shown that the masses of the atoms increase abruptly, by steps, which are clearly connected in some way with Dalton's law of multiple proportions; and because the periodicity of the elements finds expression in the transition from RX to RX_2, RX_3, RX_4, and so on till RX_8, at which point the energy of the combining forces being exhausted, the series begins anew from RX to RX_2, and so on.

While connecting by new bonds the theory of the chemical elements with Dalton's theory of multiple proportions, or atomic structure of bodies, the periodic law opened for natural philosophy a new and wide field for speculation. Kant said that there are in the world "two things which never cease to call for the admiration and reverence of man: the moral law within ourselves, and the stellar sky above us." But when we turn our thoughts towards the nature of the elements and the periodic law, we must add a third subject, namely, "the nature of the elementary individuals which we discover everywhere around us." Without them the stellar sky itself is inconceivable; and in the atoms we see at once their peculiar individualities, the infinite multiplicity of the individuals, and the submission of their seeming freedom to the general harmony of Nature.

Having thus indicated a new mystery of Nature, which does not yet yield to rational conception, the periodic law, together with the revelations of spectrum analysis, have contributed to again revive an old but remarkably long-lived hope--that of discovering, if not by experiment, at least, by a mental effort, the *primary matter*--which had its genesis in the minds of the Grecian philosophers, and has been transmitted, together with many other ideas of the classic period, to the heirs of their civilisation. Having grown, during the times of the alchemists up to the period when experimental proof was required, the idea has rendered good service; it induced those careful observations and experiments which later on called into being the works of Scheele, Lavoisier, Priestley and Cavendish. It then slumbered awhile, but was soon awakened by the attempts either to confirm or to refute the ideas of Prout as to the multiple proportion relationship of the atomic weights of all the elements. And once again the inductive or experimental method of studying Nature gained a direct advantage from the old Pythagorean idea: because atomic weights were determined with an accuracy formerly unknown. But again the idea could not stand the ordeal of experimental test, yet the prejudice remains and has not been uprooted, even by Stas; nay, it has gained a new vigour, for we see that all which is imperfectly worked out, new and unexplained, from the still scarcely studied rare metals to the hardly perceptible nebulae, have been used to justify it. As soon as spectrum analysis appears as a new and powerful weapon of chemistry, the idea of a primary matter is immediately attached to it. From all sides we see attempts to constitute the imaginary substance *helium*[3] the so much longed for primary matter. No attention is paid to the circumstance that the helium line is only seen in the spectrum of the solar protuberances, so that its universality in Nature remains as problematic as the primary matter itself; nor to the fact that the helium line is wanting amongst the Fraunhofer lines of the solar spectrum, and thus does not answer to the brilliant fundamental conception which gives its real force to spectrum analysis.

And finally, no notice is even taken of the indubitable fact that the brilliancies of the spectral lines of the simple bodies vary under different temperatures and pressures; so that all probabilities are in favour of the helium line simply belonging to some long since known element placed under such conditions of temperature, pressure, and gravity as have not yet been realised in our experiments. Again, the idea that the excellent investigations of Lockyer of the spectrum of iron can be interpreted in favour of the compound nature of that element, evidently must have arisen from some misunderstanding. The spectrum of a compound body certainly does not appear as a sum of the spectra of its components; and therefore the observations of Lockyer can be considered precisely as a proof that iron undergoes no other changes at the temperature of the sun but those which it experiences in the voltaic arc--provided the spectrum of iron is preserved. As to the shifting of some of the lines of the spectrum of iron while the other lines maintain their positions, it can be explained, as shown by M. Kleiber (*Journal of the Russian Chemical and Physical Society*, 1885, 147), by the relative motion of the various strata of the sun's atmosphere, and by Zöllner's laws of the relative brilliancies of different lines of the spectrum. Moreover, it ought not to be forgotten that if iron were really proved to consist of two or more unknown elements, we simply should have an increase of the number of our elements--not a reduction, and still less a reduction of all of them to one single primary matter.

Feeling that spectrum analysis will not yield a support to the Pythagorean conception, its modern promoters are so bent upon its being confirmed by the periodic law, that the illustrious Berthelot, in his work *Les origines de l'Alchimie*, 1885, 313, has simply mixed up the fundamental idea of the law of periodicity with the ideas of Prout, the alchemists, and Democritus about primary matter.[4] But the periodic law, based as it is on the solid and wholesome ground of experimental research, has been evolved independently of any conception as to the nature of the elements; it does not in the least originate in the idea of an unique matter; and it has no historical connection with that relic of the torments of classical thought, and therefore it affords no more indication of the unity of matter or of the compound character of our elements, than the law of Avogadro, or the law of specific heats, or even the conclusions of spectrum analysis. None of the advocates of an unique matter have ever tried to explain the law from the standpoint of ideas taken from a remote antiquity when it was found convenient to admit the existence of many gods--and of an unique matter.

When we try to explain the origin of the idea of an unique primary matter, we easily trace that in the absence of inductions from experiment it derives its origin from the scientifically philosophical attempt at discovering some kind of unity in the immense diversity of individualities which we see around. In classical times such a tendency could only be satisfied by conceptions about the immaterial world. As to the material world, our ancestors were compelled to resort to some hypothesis, and they adopted the idea of unity in the formative material, because they were not able to evolve the conception of any other possible unity in order to connect the multifarious relations of matter. Responding to the same legitimate scientific tendency, natural science has discovered throughout the universe a unity of plan, a unity of forces, and a unity of matter, and the convincing conclusions of modern science compel everyone to admit these kinds of unity. But while we admit unity in many things, we none the less must also explain the individuality and the apparent diversity which we cannot fail to trace everywhere. It has been said of old, "Give a fulcrum, and it will become easy to displace the earth." So also we must say, "Give anything that is individualised, and the apparent diversity will be easily understood." Otherwise, how could unity result in a multitude?

After a long and painstaking research, natural science has discovered the individualities of the chemical elements, and therefore it is now capable not only of analysing, but also of synthesising; it can understand and grasp the general and unity, as well as the individualised and the multitudinous. Unity and the general, like time and space, like force and motion, vary uniformly; the uniform admit of interpolations, revealing every intermediate phase. But the multitudinous, the individualised--like ourselves, like the chemical elements, like the members of a peculiar periodic function of elements, like Dalton's multiple proportions--is characterised in another way: we see in it--side by side with a connecting general principle--leaps, breaks of continuity, points which escape from the analysis of the infinitely small--a complete absence of intermediate links. Chemistry has found an answer to the question as to the causes of multitudes; and while retaining the conception of many elements, all submitted to the discipline of a general law, it offers an escape from the Indian Nirvana--the absorption in the universal, replacing it by the individualised. However, the place for individuality is so limited by the all-grasping, all-powerful universal, that it is merely a fulcrum for the understanding of multitude in unity.

Having touched upon the metaphysical bases of the conception of an unique matter which is supposed to enter into the composition of all bodies, I think it necessary to dwell upon another theory, akin to the above conception,--the theory of the compound character of the elements now admitted by some,--and especially upon one particular circumstance which being related to the periodic law is considered to be an argument in favour of that hypothesis.

Dr. Pelopidas, in 1883, made a communication to the Russian Chemical and Physical Society on the periodicity of the hydrocarbon radicles, pointing out the remarkable parallelism which was to be noticed in the change of properties of hydrocarbon radicles and elements when classed in groups. Professor Carnelley, in 1886, developed a similar parallelism. The idea of M. Pelopidas will be easily understood if we consider the series of hydrocarbon radicles which contain, say, 6 atoms of carbon:--

I	II	III	IV	V	VI	VII	VIII
C_6H_{13}	C_6H_{12}	C_6H_{11}	C_6H_{10}	C_6H_9	C_6H_8	C_6H_7	C_6H_6

The first of these radicles, like the elements of the Ist group, combines with Cl, OH, and so on, and gives the derivatives of hexyl alcohol, $C_6H_{13}(OH)$; but, in proportion as the number of hydrogen atoms decreases, the capacity of the radicles of combining with, say, the halogens increases. C_6H_{12} already combines with 2 atoms of chlorine; C_6H_{11} with 3 atoms, and so on. The last members of the series comprise the radicles of acids; thus C_6H_8, which belongs to the VIth group, gives, like sulphur, a bibasic acid, $C_6H_8O_2(OH)_2$, which is homologous with oxalic acid. The parallelism can be traced still further--because C_6H_5 appears as a monovalent radicle of benzene--and with it begins a new series of aromatic derivatives, so analogous to the derivatives of the fat series. Let me also mention another example from among those which have been given by M. Pelopidas. Starting from the alkaline radicle of monomethylammonium, $N(CH_3)H_3$, or NCH_6, which presents many analogies with the alkaline metals of the Ist group, he arrives, by successively diminishing the number of the atoms of hydrogen, at a seventh group which contains cyanogen, CN, which has long since been compared to the halogens of the VIIth group.

The most important consequence which, in my opinion, can be drawn from the above comparison is that the periodic law, so apparent in the elements, has a wider application than might appear at first sight; it opens up a new vista of chemical evolutions. But, while admitting the fullest parallelism between the periodicity of the elements and that of the compound radicles, we must not forget that in the periods of the hydrocarbon radicles we have a *decrease* of mass as we pass from the representatives of the first group to the next; while in the periods of the elements the mass *increases* during the progression. It thus becomes evident that we cannot speak of an identity of periodicity in both cases, unless we put aside the ideas of mass and attraction, which are the real corner-stones of the whole of natural science and even enter into those very conceptions of simple bodies which came to light a full hundred years later than the immortal principles of Newton.[5]

From the foregoing, as well as from the failures of so many attempts at finding in experiment and speculation a proof of the compound character of the elements and of the existence of primordial matter, it is evident, in my opinion, that this theory must be classed amongst mere utopias. But utopias can only be combatted by freedom of opinion, by experiment, and by new utopias. In the republic of scientific theories freedom of opinions is guaranteed. It is precisely that freedom which permits me to criticise openly the widely diffused idea as to the unity of matter in the elements. Experiments and attempts at confirming that idea have been so numerous that it really would be instructive to have them all collected together, if only to serve as a warning against the repetition of old failures. And, now, as to new utopias which may be helpful in the struggle against the old ones, I do not think it quite useless to mention a *phantasy* of one of my students who imagined that the weight of bodies does not depend upon their mass, but upon the character of the motion of their atoms. The atoms, according to this new utopian, may all be homogeneous or heterogeneous, we know not which; we know them in motion only, and that motion they maintain with the same persistence as the stellar bodies maintain theirs. The weights of atoms differ only in consequence of their various modes and quantity of motion; the heaviest atoms may be much simpler than the lighter ones; thus an atom of mercury may be simpler than an atom of hydrogen--the manner in which it moves causes it to be heavier. My interlocutor even suggested that the view which attributes the greater complexity to the lighter elements finds confirmation in the fact that the hydrocarbon radicles mentioned by Pelopidas, while becoming lighter as they lose hydrogen, change their properties periodically in the same manner as the elements change theirs according as the atoms grow heavier.

The French proverb, *La critique est facile mais l'art est difficile*, however, may well be reversed in the case of all such ideal views, as it is much easier to formulate than to criticize them. Arising from the virgin soil of newly established facts, the knowledge relating to the elements, to their masses, and to the periodic changes of their properties, has given a motive for the formation of utopian hypotheses, probably because they could not be foreseen by the aid of any of the various metaphysical systems, and exist, like the idea of gravitation, as an independent outcome of natural science, requiring the acknowledgment of general laws, when these have been established with the same degree of persistency as is indispensable for the acceptance of a thoroughly established fact. Two centuries have elapsed since the theory of gravitation was enunciated, and although we do not understand its cause, we still must regard gravitation as a fundamental conception of natural philosophy, a conception which has enabled us to perceive much more than the metaphysicians did or could with their seeming omniscience. A hundred years later the conception of the elements arose; it made chemistry what it now is; and yet we have advanced as little in our comprehension of simple bodies since the times of Lavoisier and Dalton as we have in our understanding of gravitation. The periodic law of the elements is only 20 years old: it is not surprising therefore that, knowing nothing about the causes of gravitation and mass, or about the nature of the elements, we do not comprehend the *rationale* of the periodic law. It is only by collecting established laws, that is by working at the acquirement of truth, that we can hope gradually to lift the veil which conceals from us the causes of the mysteries of Nature and to discover their mutual dependency. Like the telescope and the microscope, laws founded on the basis of experiment are the instruments and means of enlarging our mental horizon.

In the remaining part of my communication I shall endeavour to show, and as briefly as possible, in how far the periodic law contributes to enlarge our range of vision. Before the promulgation of this law the chemical elements were mere fragmentary, incidental facts in Nature; there was no special reason to expect the discovery of new elements, and the new ones which were discovered from time to time appeared to be possessed of quite novel properties. The law of periodicity first enabled us to perceive undiscovered elements at a distance which formerly was inaccessible to chemical vision; and long ere they were discovered new elements appeared before our eyes possessed of a number of well-defined properties. We now know three cases of elements whose existence and properties were foreseen by the instrumentality of the periodic law. I need but mention the brilliant discovery of *gallium*, which proved to correspond to eka-aluminium of the periodic law, by Lecoq de Boisbaudran; of *scandium*, corresponding to eka-boron, by Nilson; and of *germanium*, which proved to correspond in all respects to eka-silicium, by Winckler. When, in 1871, I described to the Russian Chemical Society the properties, clearly defined by the periodic law, which such elements ought to possess, I never hoped that I should live to mention their discovery to the Chemical Society of Great Britain as a confirmation of the exactitude and the generality of the periodic law. Now, that I have had the happiness of doing so, I unhesitatingly say that although greatly enlarging our vision, even now the periodic law needs further improvements in order that it may become a trustworthy instrument in further discoveries.[6]

I will venture to allude to some other matters which chemistry has discerned by means of its new instrument, and which it could not have made out without a knowledge of the law of periodicity, and I will confine myself to simple bodies and to oxides.

Before the periodic law was formulated the atomic weights of the elements were purely empirical numbers, so that the magnitude of the equivalent, and the atomicity or the value in substitution possessed by an atom, could only be tested by critically examining the methods of determination, but never directly by considering the numerical values themselves; in short, we were compelled to move in the dark, to submit to the facts, instead of being masters of them. I need not recount the methods which permitted the periodic law at last to master the facts relating to atomic weights, and I would merely call to mind that it compelled us to modify the valencies of *indium* and *cerium*, and to assign to their compounds a different molecular composition. Determinations of the specific heats of these two metals fully confirmed the change. The trivalency of *yttrium*, which makes us now represent its oxide as Y_2O_3 instead of as YO, was foreseen (in 1870) by the periodic law, and it now has become so probable that Cleve, and all other subsequent investigators of the rare metals, have not only adopted it but have also applied it without any new demonstration to bodies so imperfectly known as those of the cerite and gadolinite group, especially since Hildebrand determined the specific heats of lanthanum and didymium and confirmed the expectations suggested by the periodic law. But here, especially in the case of didymium, we meet with a series of difficulties long since foreseen through the periodic law, but only now becoming evident, and chiefly arising from the relative rarity and insufficient knowledge of the elements which usually accompany didymium.

Passing to the results obtained in the case of the rare elements *beryllium*, *scandium* and *thorium*, it is found that these have many points of contact with periodic law. Although Avdéeff long since proposed the magnesia formula to represent beryllium oxide, yet there was so much to be said in favour of the alumina formula, on account of the specific heat of the metals and the isomorphism of the two oxides, that it became generally adopted and seemed to be well established. The periodic law, however, as Brauner repeatedly insisted (*Berichte*, 1878, 872; 1881, 53) was against the formula Be_2O_3; it required the magnesium formula BeO, that is, an atomic weight of 9, because there was no place in the system for an element like beryllium having an atomic weight of 13.5. This divergence of opinion lasted for years, and I often heard that the question as to the atomic weight of beryllium threatened to disturb the generality of the periodic law, or, at any rate, to require some important modifications of it. Many forces were operating in the controversy regarding beryllium, evidently because a much more important question was at issue than merely that involved in the discussion of the atomic weight of a relatively rare element; and during the controversy the periodic law became better understood, and the mutual relations of the elements became more apparent than ever before. It is most remarkable that the victory of the periodic law was won by the researches of the very observers who previously had discovered a number of facts in support of the trivalency of beryllium. Applying the higher law of Avogadro, Nilson and Petterson have finally shown that the density of the vapour of the beryllium chloride, $BeCl_2$, obliges us to regard beryllium as bivalent in conformity with the periodic law.[7] I consider the confirmation of Avdéeff's and Brauner's view as important in the history of the periodic law as the discovery of scandium, which, in Nilson's hands, confirmed the existence of the eka-boron.

The circumstance that *thorium* proved to be quadrivalent, and Th = 232, in accordance with the views of Chydenius and the requirements of the periodic law, passed almost unnoticed, and was accepted without opposition, and yet both thorium and uranium are of great importance in the periodic system, as they are its last members and have the highest atomic weights of all the highest elements.

The alteration of the atomic weight of uranium from U = 120 into U = 240 attracted more attention, the change having been made on account of the periodic law, and for no other reason. Now that Roscoe, Rammelsberg, Zimmermann, and several others have admitted the various claims of the periodic law in the case of uranium, its high atomic weight is received without objection, and it endows that element with a special interest.

While thus demonstrating the necessity of modifying the atomic weights of several insufficiently known elements, the periodic law enabled us also to detect errors in the determination of the atomic weights of several elements whose valencies and true position among other elements were already well known. Three such cases are especially noteworthy: those of tellurium, titanium and platinum. Berzelius had determined the atomic weight of *tellurium* to be 128, while the periodic law claimed for it an atomic weight below that of iodine, which had been fixed by Stas at 126.5, and which was certainly not higher than 127. Brauner then undertook the investigation, and he has shown that the true atomic weight of tellurium is lower than that of iodine, being near to 125. For *titanium* the extensive researches of Thorpe have confirmed the atomic weight of Ti = 48, indicated by the law, and already foreseen by Rose, but contradicted by the analyses of Pierre and several other chemists. An equally brilliant confirmation of the expectations based on the periodic law has been given in the case of the series osmium, iridium, platinum, and gold. At the time of the promulgation of the periodic law the determinations of Berzelius, Rose, and many others gave the following figures:--

Os = 200; Ir = 197; Pt = 198; Au = 196.

The expectations of the periodic law[8] have been confirmed, first, by new determinations of the atomic weight of *platinum* (by Seubert, Dittmar and M'Arthur), which proved to be near to 196 (taking O = 16, as proposed by Marignac, Brauner, and others); secondly, by Seubert having proved that the atomic weight of *osmium* is really lower than that of platinum, and that it is near to 191; and thirdly, by the investigations of Krüss, and Thorpe and Laurie proving that the atomic weight of *gold* exceeds that of platinum, and approximates to 197. The atomic weights which were thus found to require correction were precisely those which the periodic law had indicated as affected with errors; and it has been proved therefore that the periodic law affords a means of testing experimental results. If we succeed in discovering the exact character of the periodical relationships between the increments in atomic weights of allied elements discussed by Ridberg in 1885, and again by Razaroff in 1887, we may expect that our instrument will give us the means of still more closely controlling the experimental data relating to atomic weights.

Let me next call to mind that, while disclosing the variation of chemical properties,[9] the periodic law has also enabled us to systematically discuss many of the physical properties of elementary bodies, and to show that these properties are also subject to the law of periodicity. At the Moscow Congress of Russian Naturalists in August, 1869, I dwelt upon the relations which existed between density and the atomic weight of the elements. The following year Professor Lothar Meyer, in his well-known paper,[10] studied the same subject in more detail, and thus contributed to spread information about the periodic law. Later on, Carnelley, Laurie, L. Meyer, Roberts-Austen, and several others applied the periodic system to represent the order in the changes of the magnetic properties of the elements, their melting points, the heats of formation of their haloid compounds, and even of such mechanical properties as the coefficient of elasticity, the breaking stress, &c., &c. These deductions, which have received further support in the discovery of new elements endowed not only with chemical but even with physical properties which were foreseen by the law of periodicity, are well known; so I need not dwell upon the subject, and may pass to the consideration of oxides.[11]

In indicating that the gradual increase of the power of elements of combining with oxygen is accompanied by a corresponding decrease in their power of combining with hydrogen, the periodic law has shown that there is a limit of oxidation, just as there is a well-known limit to the capacity of elements for combining with hydrogen. A single atom of an element combines with at most four atoms of either hydrogen or oxygen: and while CH_4 and SiH_4 represent the highest hydrides, so RuO_4 and OsO_4 are the highest oxides. We are thus led to recognise types of oxides, just as we have had to recognise types of hydrides.[12]

The periodic law has demonstrated that the maximum extent to which different non-metals enter into combination with oxygen is determined by the extent to which they combine with hydrogen, and that the sum of the number of equivalents of both must be equal to 8. Thus chlorine, which combines with 1 atom, or 1 equivalent of hydrogen, cannot fix more than 7 equivalents of oxygen, giving Cl_2O_7: while sulphur, which fixes 2 equivalents of hydrogen, cannot combine with more than 6 equivalents or 3 atoms of oxygen. It thus becomes evident that we cannot recognise as a fundamental property of the elements the atomic valencies deduced from their hydrides; and that we must modify, to a certain extent, the theory of atomicity if we desire to raise it to the dignity of a general principle capable of affording an insight into the constitution of all compound molecules. In other words, it is only to carbon, which is quadrivalent with regard both to oxygen and hydrogen, that we can apply the theory of constant valency and of bond, by means of which so many still endeavour to explain the structure of compound molecules. But I should go too far if I ventured to explain in detail the conclusions which can be drawn from the above considerations. Still, I think it necessary to dwell upon one particular fact which must be explained from the point of view of the periodic law in order to clear the way to its extension in that particular direction.

The higher oxides yielding salts the formation of which was foreseen by the periodic system--for instance, in the short series beginning with sodium--

Na_2O, MgO, Al_2O_3, SiO_2, P_2O_5, SO_3, Cl_2O_7,

must be clearly distinguished from the higher degrees of oxidation which correspond to hydrogen peroxide and bear the true character of peroxides. Peroxides such as Na_2O_2, BaO_2, and the like have long been known. Similar peroxides have also recently become known in the case of chromium, sulphur, titanium, and many other elements, and I have sometimes heard it said that discoveries of this kind weaken the conclusions of the periodic law in so far as it concerns the oxides. I do not think so in the least, and I may remark, in the first place, that all these peroxides are endowed with certain properties--obviously common to all of them, which distinguish them from the actual, higher, salt-forming oxides, especially their easy decomposition by means of simple contact agencies; their incapacity of forming salts of the common type; and their capacity of combining with other peroxides (like the faculty which hydrogen peroxide possesses of combining with barium peroxide, discovered by Schoene). Again, we remark that some groups are especially characterised by their capacity of generating peroxides. Such is, for instance, the case in the VIth group, where we find the well-known peroxides of sulphur, chromium, and uranium; so that further investigation of peroxides will probably establish a new periodic function, foreshadowing that molybdenum and wolfram will assume peroxide forms with comparative readiness. To appreciate the constitution of such peroxides, it is enough to notice that the peroxide form of sulphur (so-called persulphuric acid) stands in the same relation to sulphuric acid as hydrogen peroxide stands to water:--

$H(OH)$, or H_2O, responds to $(OH)(OH)$, or H_2O_2,

and so also--

$H(HSO_4)$, or H_2SO_4 responds to $(HSO_4)(HSO_4)$, or $H_2S_2O_8$.

Similar relations are seen everywhere, and they correspond to the principle of substitutions which I long since endeavoured to represent as one of the chemical generalisations called into life by the periodic law. So also sulphuric acid, if considered with reference to hydroxyl, and represented as follows--

$HO(SO_2OH)$,

has its corresponding compound in dithionic acid--

$(SO_2OH)(SO_2OH)$, or $H_2S_2O_6$.

Therefore, also, phosphoric acid, $HO(POH_2O_2)$, has, in the same sense, its corresponding compound in the subphosphoric acid of Saltzer:--

$(POH_2O_2)(POH_2O_2)$, or $H_4P_2O_6$;

and we must suppose that the peroxide compound corresponding to phosphoric acid, if it be discovered, will have the following structure:--

$(H_2PO_4)_2$ or $H_2P_4O_8 = 2\ H_2O + 2\ PO_3$.[13]

As far as is known at present, the highest form of peroxides is met with in the peroxide of uranium, UO_4, prepared by Fairley;[14] while OsO_4 is the highest oxide giving salts. The line of argument which is inspired by the periodic law, so far from being weakened by the discovery of peroxides, is thus actually strengthened, and we must hope that a further exploration of the region under consideration will confirm the applicability to chemistry generally of the principles deduced from the periodic law.

Permit me now to conclude my rapid sketch of the oxygen compounds by the observation that the periodic law is especially brought into evidence in the case of the oxides which constitute the immense majority of bodies at our disposal on the surface of the earth.

The oxides are evidently subject to the law, both as regards their chemical and their physical properties, especially if we take into account the cases of polymerism which are so obvious when comparing CO_2 with Si_nO_{2n}. In order to prove this I give the densities s and the specific volumes v of the higher oxides of two short periods. To render comparison easier, the oxides are all represented as of the form R_2O_n. In the column headed Δ the differences are given between the volume of the oxygen compound and that of the parent element, divided by n, that is, by the number of atoms of oxygen in the compound:--[15]

	s.	**v.**	**Δ.**		**s.**	**v.**	**Δ.**	
Na_2O	2.6	24	-22	K_2O	2.7	35	-55	
Mg_2O_2	3.6	22	-3	Ca_2O	3.15	36	-7	
Al_2O_3	4.0	26	+1.3	Sc_2O_3	3.86	35	0	
Si_2O_4	2.65	45	5.2	Li_2O_4	4.2	38	+5	[sic. Ti_2O_4 is meant for Li_2O_4.--CJG]
P_2O_5	2.39	59	6.2	V_2O_5	3.49	52	6.7	
S_2O_6	1.96	82	8.7	Cr_2O_6	2.74	73	9.5	

I have nothing to add to these figures, except that like relations appear in other periods as well. The above relations were precisely those which made it possible for me to be certain that the relative density of eka-silicon oxide would be about 4.7; germanium oxide, actually obtained by Winckler, proved, in fact, to have the relative density 4.703.

The foregoing account is far from being an exhaustive one of all that has already been discovered by means of the periodic law telescope in the boundless realms of chemical evolution. Still less is it an exhaustive account of all that may yet be seen, but I trust that the little which I have said will account for the philosophical interest attached in chemistry to this law. Although but a recent scientific generalisation, it has already stood the test of laboratory verification and appears as an instrument of thought which has not yet been compelled to undergo modification; but it needs not only new applications, but also improvements, further development, and plenty of fresh energy. All this will surely come, seeing that such an assembly of men of science as the Chemical Society of Great Britain has expressed the desire to have the history of the periodic law described in a lecture dedicated to the glorious name of Faraday.

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[1] "Es ist wohl kaum anzunehmen, dass alle im Vorhergehenden hervorgehobenen Beziehungen zwischen den Atomgewichten (oder Aequivalenten) in chemischen Verhältnissen einander ähnliche Elemente bloss zufällig sind. Die Auffindung der in diesen Zahlen *gesetzlichen* Beziehungen müssen wir jedoch der Zukunft überlassen."

[2] To judge from J. A. R. Newlands' work, *On the Discovery of the Periodic Law*, London, 1884, p. 149; "On the Law of Octaves" (from the *Chemical News*, **12**, 83, August 18, 1865.)

[3] That is, a body having a wave-length equal to 0.0005875 millimetre.

[4] He maintains (on p. 309) that the periodic law requires two new analogous elements, having atomic weights of 48 and 64, occupying positions between sulphur and selenium, although nothing of the kind results from any of the different readings of the law.

[5] It is noteworthy that the year in which Lavoisier was born (1743)--the author of the idea of elements and of the indestructibility of matter--is later by exactly one century than the year in which the author of the theory of gravitation and mass was born (1643 N.S.). The affiliation of the ideas of Lavoisier and those of Newton is beyond doubt.

[6] I foresee some more new elements, but not with the same certitude as before. I shall give one example, and yet I do not see it quite distinctly. In the series which contains Hg = 204, Pb = 206, and Bi = 208,we can guess the existence (at the place VI-11) of an element analogous to tellurium, which we can describe as dvi-tellurium, Dt having an atomic weight of 212, and the property of forming the oxide DtO_3. If this element really exists, it ought in the free state to be an easily fusible, crystalline, non-volatile metal of a grey colour, having a density of about 9.3, capable of giving a dioxide, DtO_2, equally endowed with feeble acid and basic properties. This dioxide must give on active oxidation an unstable higher oxide, DtO_3, which should resemble in its properties PbO_2 and Bi_2O_5. Dvi-tellurium hydride, if it be found to exist, will be a less stable compound than even H_2Te. The compounds of dvi-tellurium will be easily reduced, and it will form characteristic definite alloys with other metals.

[7] Let me mention another proof of the bivalency of beryllium which may have passed unnoticed, as it was published in the Russian chemical literature. Having remarked (in 1884) that the density of such solutions of chlorides of metals, MCl_n, as contain 200 mols. of water (or a large and constant amount of water) regularly increases as the molecular weight of the dissolved salt increases, I proposed to one of our young chemists, J. Burdakoff, that he should investigate the beryllium chloride. If its molecule is $BeCl_2$ its weight must be = 80; and in such a case it must be heavier than the molecule of KCl = 74.5, and lighter than that of MgCl = 93. On the contrary, if beryllium chloride is a trichloride, BCl_3 = 120, its molecule must be heavier than that of $CaCl_2$ = 111, and lighter than that of $MnCl_2$ =126. Experiment has shown the correctness of the former formula, the solution $BeCl_2$ + 200 H_2O having (at 15°/4°) a density of 1.0138, this being a higher density than that of the solution KCl + 200 H_2O (=1.0121), and lower than that of $MgCl_2$ + 200 H_2O (=1.0203). The bivalency of beryllium was thus confirmed in the case both of the dissolved and the vaporised chloride.

[8] I pointed them out in the *Liebig's Annalen*, Supplement Band viii, 1871, p. 211.

[9] Thus, in the typical small period of

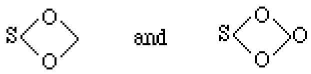
Li, Be, B, C, N, O, F,

we see at once the progression from the alkaline metals to the acid non-metals, such as are the halogens.

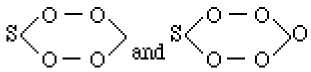
[10] *Liebig's Annalen*, Erz. Bd. vii, 1870.

[11] A distinct periodicity can also be discovered in the spectra of the elements. Thus the researches of Hartley, Ciamician, and others have disclosed, first, the homology of the spectra of analogous elements; secondly, that the alkaline metals have simpler spectra than the metals of the following groups; and thirdly, that there is a certain likeness between the complicated spectra of manganese and iron on the one hand, and the no less complicated spectra of chlorine and bromine on the other hand, and their likeness corresponds to the degree of analogy between those elements which is indicated by the periodic law.

[12] Formerly it was supposed that, being a bivalent element, oxygen can enter into any grouping of the atoms, and there was no limit foreseen as to extent to which it could further enter into combination. We could not explain why bivalent sulphur, which forms compounds such as



could not also form oxides such as--



while other elements, as for instance, chlorine, form compounds such as--

Cl-O-O-O-O-K.

[13] In this sense, oxalic acid, $(COOH)_2$, also corresponds to carbonic acid, OH(COOH), in the same way that dithionic acid corresponds to sulphuric acid, and subphosphoric acid to phosphoric; therefore, if a peroxide, corresponding to carbonic acid, be obtained, it will have the structure of $(HCO_3)_2$, or $H_2C_2O_6 = H_2O + C_2O_5$. So also lead must have a real peroxide, Pb_2O_5.

[14] The compounds of uranium prepared by Fairley seem to me especially instructive in understanding the peroxides. By the action of hydrogen peroxide on uranium oxide, UO_3, a peroxide of uranium, $UO_4 4H_2O$, is obtained (U = 240) if the solution be acid; but if hydrogen peroxide act on uranium oxide in the presence of caustic soda, a crystalline deposit is obtained, which has the composition $Na_4UO_8 4H_2O$, and evidently is a combination of sodium peroxide, Na_2O_2, with uranium peroxide UO_4. It is possible that the former peroxide, $UO_4 4H_2O$, contains the elements of hydrogen peroxide and uranium peroxide, U_2O_7, or even $U(OH)_6H_2O_2$, like the peroxide of tin recently discovered by Spring, which has the constitution $Sn_2O_5H_2O_2$.

[15] Δ thus represents the average increase of volume for each atom of oxygen contained in the higher salt-forming oxide. The acid oxides give, as a rule, a higher value of Δ, while in the case of the strongly alkaline oxides its value is usually negative.

Julius Lothar Meyer (1830-1895)

Table from *Annalen der Chemie, Supplementband* **7**, 354 (1870).

Periodic table according to Lothar Meyer, 1870

I.	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**
	B=11,0	Al=27,3		--		?In=113,4	Tl=202.7	
			--		--		--	
	C=11,97	Si=28		--		Sn=117,8		Pb=206,4
			Ti=48		Zr=89,7		--	
	N=14,01	P=30,9		As=74,9		Sb=122,1		Bi=207,5
			V=51,2		Nb=93,7		Ta=182,2	
	O=15,96	31,98		Se=78		Te=128?		--
			Cr=52,4		Mo=95,6		W=183,5	
--	F=19,1	Cl=35,38		Br=79,75		J=126,5		--
			Mn=54,8		Ru=103,5		Os=198,6 ?	
			Fe=55,9		Rh=104,1		Ir=196,7	
			Co=Ni=58,6		Pd=106,2		Pt=196,7	
Li=7,01	Na=22,99	K=39,04		Rb=85,2		Cs=132,7		--
			Cu=63,3		Ag=107,66		Au=196,2	
?Be=9.3	Mg=23,9	Ca=39,9		Sr=87,0		Ba=136,8		--
			Zn=64,9		Cd=111,6		Hg=199,8	

John A. R. Newlands (1837-1898)

On Relations among the Equivalents

Chemical News Vol. 7, Feb. 7, 1863, pp. 70-72.

To the Editor of the CHEMICAL NEWS.

SIR,--Many chemists, and M. Dumas in particular, have, on several occasions, pointed out some very interesting relations between the equivalents of bodies belonging to the same natural family or group; and my present purpose is simply to endeavour to proceed a little further in the same direction. I must, however, premise that many of the observations here collected together are well known already, and are only embodied in my communication for the purpose of rendering it more complete.

Before proceeding any further, I may also remark, that in the difficult task of grouping the elementary bodies, I have been guided more by chemical characteristics than by physical appearances, and have, therefore, taken no notice of the ordinary distinction between metals and non-metallics. The numbers which I have attached to the various groups are merely for the purpose of reference, and have no further significance whatever. For the sake of perspicuity, I have employed the old equivalent numbers, these atomic weights being, with one or two exceptions, taken from the 8th edition of "Fownes' Manual."

The following are among the most striking relations observed on comparing the equivalents of analogous elements. (In order to avoid the frequent repetition of the word "equivalent," I have generally used the names of the different elements as representing their equivalent numbers--thus, when I say that zinc is the mean of magnesium and cadmium, I intend to imply that the equivalent of zinc is the mean of those of magnesium and cadmium, and so on, throughout the paper):--

Group I. Metals of the alkalies:-- Lithium, 7; sodium, 23; potassium, 39; rubidium, 85, caesium, 123; thallium, 204.

The relation among the equivalents of this group (see CHEMICAL NEWS, January 10, 1863) may, perhaps, be most simply stated as follows:--

1 of lithium + 1 of potassium = 2 of sodium.
1 " + 2 " = 1 of rubidium.
1 " + 3 " = 1 of caesium.
1 " + 4 " = 163, the equivalent of a metal not yet discovered.
1 " + 5 " = 1 of thallium.

Group II. Metals of the alkaline earths:-- Magnesium, 12; calcium, 20; strontium, 43.8; barium, 68.5.

In this group, strontium is the mean of calcium and barium.

Group III. Metals of the earths:-- Beryllium, 6.9; aluminium, 13.7; zirconium, 33.6; cerium, 47; lanthanium, 47; didymium, 48; thorium, 59.6.

Aluminium equals two of beryllium, or one-third of the sum of beryllium and zirconium. (Aluminium also is one-half of manganese, which, with iron and chromium, forms sesquioxides, isomorphous, with alumina.)

1 of zirconium + 1 of aluminium = 1 of cerium.
1 " + 2 " = 1 of thorium.

Lanthanium and didymium are identical with cerium, or nearly so.

Group IV. Metals whose protoxides are isomorphous with magnesia:-- Magnesium, 12; chromium, 26.7; manganese, 27.6; iron, 28; cobalt, 29.5; nickel, 29.5; copper, 31.7; zinc, 32.6; cadmium, 56.

Between magnesium and cadmium, the extremities of this group, zinc is the mean. Cobalt and nickel are identical. Between cobalt and zinc, copper is the mean. Iron is one-half of cadmium. Between iron and chromium, manganese is the mean.

Group V.-- Fluorine, 19; chlorine, 35.5; bromine, 80; iodine, 127.

In this group, bromine is the mean between chlorine and iodine.

Group VI.-- Oxygen, 8; sulphur, 16; selenium, 39.5; tellurium, 64.2.

In this group selenium is the mean between sulphur and tellurium.

Group VII.-- Nitrogen, 14; phosphorus, 31; arsenic, 75; osmium, 99.6; antimony, 120.3; bismuth, 213.

In this group arsenic is the mean between phosphorus and antimony.

Osmium approaches the mean of arsenic and antimony, and is also almost exactly half the difference between nitrogen and bismuth, the two extremities of this group; thus, (213-14)/2 = 99.5.

Bismuth equals 1 of antimony + 3 of phosphorus; thus, 120.3 + 93 = 213.3.

Group VIII.-- Carbon, 6; silicon, 14.20; titanium, 25; tin, 58.

In this group the difference between tin and titanium is nearly three times as great as that between titanium and silicon.

Group IX.-- Molybdenum, 46; vanadium, 68.6; tungsten, 92; tantalium, 184.

In this group vanadium is the mean between molybdenum and tungsten.

Tungsten equals 2 of molybdenum, and tantalium equals 4 of molybdenum.

Group X.-- Rhodium, 52.2; ruthenium, 52.2; palladium, 53.3; platinum, 98.7; iridium, 99.

In this group the first three are identical, or nearly so, and are rather more than half of the other two. (I may mention, by the way, that platinum is rather more than the half of gold; thus 98.7 x 2 = 197.4, gold being 197.)

Group XI.-- Mercury, 100; lead, 103.7; silver, 108.

Lead is here the mean of the other two.

If we deduct the member of a group having the lowest equivalent from that immediately above it, we frequently observe that the numbers thus obtained bear a simple relation to each other, as in the following examples:--

Member of group having lowest equivalent.	One immediately above the preceding.	Difference.
Magnesium 12	Calcium 20	8
Oxygen 8	Sulphur 16	8
Carbon 6	Silicon 14.2	8.2
Lithium 7	Sodium 23	16
Fluorine 19	Chlorine 35.5	16.5
Nitrogen 14	Phosphorus 31	17

A similar relation, though not quite so obvious as the above, may be shown by deducting the lowest member of a triad from the highest. The numbers thus obtained in the different triads correspond to a great extent. (By a triad I understand a group of analogous elements, the equivalent of one of which is the mean of the other two.) Of this relation I append a few examples:--

Lowest term of triad.	Highest term of triad.	Difference.
Lithium 7	Potassium 39	32
Magnesium 12	Cadmium 56	44
Molybdenum 46	Tungsten 92	46
Sulphur 16	Tellurium 64.2	48.2
Calcium 20	Barium 68.5	48.5
Phosphorus 31	Antimony 120.3	89.3
Chlorine 35.5	Iodine 127	91.5

In the relation previously pointed out, the difference between the lowest member of a group, and the next above it, was either 8, or 8 x 2 = 16; and in the first of these triads the difference is 8 x 4 = 32; in the next four it approaches 8 + 6 = 48 [sic; obviously 8 x 6 is intended--CJG]; and in the last two triads it is nearly twice as great.

The difference between the highest member of the platinum group, viz., iridium 99, and the lowest, rhodium 52.2, is 46.8, a number which approximates very closely to those obtained in some of the above triads; and it, therefore, appears possible that the platinum metals are the extremities of a triad, the central term or mean of which is at present unknown.

I am, &c.

J. A. R. N.

P.S. With the view of economising space I have omitted most of the calculations, which, however, are very simple, and can be verified in a moment by the reader. The equivalents thus obtained by calculation will be found to approximate those procured by experiment, as closely as can be expected in such cases.

I also freely admit that some of the relations above pointed out are more apparent than real; others, I trust, will prove of a more durable and satisfactory description.

Relations between Equivalents.

Chemical News Vol. 10, July 30, 1864, pp. 59-60.

To the Editor of the CHEMICAL NEWS.

SIR,-- In your impression of the 2nd inst. a correspondent, under the name of "Studiosus," has called attention to the existence of a law to the effect "that the atomic weights of the elementary bodies are, with few exceptions, either exactly or very nearly multiples of eight."

Now, in a letter "On Relations among the Equivalents," which was signed with my initials, and inserted in the CHEMICAL NEWS of February 7, 1863, I called attention to the numerical differences between the equivalents of certain allied elements, and showed that such differences were generally multiples of eight, as in the following examples:--

Member of a Group having Lowest Equivalent.	One immediately above the Preceding.	Difference. H=1	O=1
Magnesium 24	Calcium 40	16	1
Oxygen 16	Sulphur 32	16	1
Lithium 7	Sodium 23	16	1
Carbon 12	Silicon 28	16	1
Fluorine 19	Chlorine 35.5	16.5	1.031
Nitrogen 14	Phosphorus 31	17	1.062
Lowest Term of Triad.	**Highest Term of Triad.**		
Lithium 7	Potassium 39	32	2
Magnesium 24	Cadmium 112	88	5.5
Molybdenum 96	Tungsten 184	88	5.5
Phosphorus 31	Antimony 122	91	5.687
Chlorine 35.5	Iodine 127	91.5	5.718
Potassium 39	Caesium 133	94	5.875
Sulphur 32	Tellurium 129	97	6.062
Calcium 40	Barium 137	97	6.062

In the last of the above columns the difference is given referred to 16, the equivalent of oxygen, as unity, and it will be seen that, generally speaking, the equivalent of oxygen is the unit of these differences, just as the equivalent of hydrogen, in "Prout's law," is the unit of the atomic weights. Exceptions there are, however, in both cases which render it necessary to take one half or one quarter of the equivalent of oxygen in the one case, and of hydrogen in the other, in order to represent all the numbers obtained as multiples by a whole number of the given standard.

Now, if the law of "Studiosus" had any real existence, the above facts would resolve themselves into particular cases of its application. For if "the atomic weights are multiples of eight," any differences between them must also be divisible by eight. We have here the symbols and the atomic weights of sixty-one elements, placed in their numerical order, and in the third column is the difference between each atomic weight and the one immediately preceding it:--

H	1			Ca	40	1		Ce	92	2.5		V	137	0
Li	7	6		Ti	50	10		La	92	0		Ta	138	1
G	9	2		Cr	52.5	2.5		Di	96	4		W	184	46
B	11	2		Mn	55	2.5		Mo	96	0		Nb	195	11
C	12	1		Fe	56	1		Ro	104	8		Au	196	1
N	14	2		Co	58.5	2.5		Ru	104	0		Pt	197	1
O	16	2		Ni	58.5	0		Pd	106.5	2.5		Ir	197	0
Fl	19	3		Cu	63.5	5		Ag	108	1.5		Os	199	2
Na	23	4		Y	64	0.5		Cd	112	4		Hg	200	1
Mg	24	1		Zn	65	1		Sn	118	6		Tl	203	3
Al	27.5	3.5		As	75	10		U	120	2		Pb	207	4
Si	28	0.5		Se	79.5	4.5		Sb	122	2		Bi	210	3
P	31	3		Br	80	0.5		I	127	5		Th	238	28
S	32	1		Rb	85	5		Te	129	2				
Cl	35.5	3.5		Sr	87.5	2.5		Cs	133	4				
K	39	3.5		Zr	89.5	2		Ba	137	4				

Now, it will be observed that in all the above differences the number eight occurs but once, and we never meet with a multiple of eight, whereas if the law of "Studiosus" were true the equivalents of the elements, in whatever order they might be placed, should, when not identically the same, differ either by eight or by some multiple of eight in every case.

While upon the subject of "relations among the equivalents," I may observe that the most important of these may be seen at a glance in the following table:--

			Triad.			
			Lowest term.	**Mean.**	**Highest term.**	
I.		Li 7	+17 = Mg 24	Zn 65	Cd 112	
II.		B 11				Au 196
III.		C 12	+16 = Si 28		Sn 118	
IV.		N 14	+17 = P 31	As 75	Sb122	+88 = Bi 210
V.		O 16	+16 = S 32	Se 79.5	Te 129	+70 = Os 199
VI.		F 19	+16.5 = Cl 35.5	Br 80	I 127	
VII.	Li 7	+16 = Na 23	+16 = K 39	Rb 85	Cs 133	+70 = Tl 203
VIII.	Li 7	+17 = Mg 24	+16 = Ca 40	Sr 87.5	Ba 137	+70 = Pb 207
IX.			Mo 96	V 137	W 184	
X.			Pd 106.5		Pt 197	

This table is my no means as perfect as it might be; in fact, I have some by me of a more complete character, but as the position to be occupied by the various elements is open to considerable controversy, the above only is given as containing little more than those elementary groups the existence of which is almost universally acknowledged.

I now subjoin a few explanatory remarks on the different groups contained in the above table, the number attached to each group being merely for the purpose of reference.

Group II.-- Boron is here classed with gold, both these elements being triatomic, although the latter is sometimes monatomic.

Group III.-- Silicon and tin stand to each other as the extremities of a triad. Titanium is usually classed along with them, and occupies a position intermediate between silicon and the central term or mean of the triad, which is at present wanting; thus,

> (Si 28 + Sn 118)/2 = 73, mean of triad, and
> (Si 28 + Mean of triad 73)/2 = 50.5, the eq. of Ti being 50.

Group IV.-- The equivalent of antimony is nearly the mean of those of phosphorus and bismuth; thus,

> (31+210)/2 = 120.5, the eq. of Sb being 122.

Group VII.-- The relations which M. Dumas has pointed out between the members of this group are well known; a slight alteration must be made, owing to the atomic weight of caesium having been raised. The relations, then, will be thus:--

Li + K = 2 Na, or in figures, 7 + 39 = 46
Li + 2 K = Rb, " " 7 + 78 = 85
2 Li + 3 K = Cs, " " 14 + 117 = 131
Li + 5 K = Tl, " " 7 + 195 = 202
3 Li + 5 K = 2 Ag, " " 21 + 195 = 216

The equivalent of silver is thus connected with those of the alkali metals. It may also, which amounts to the same thing, be viewed as made up of the equivalents of sodium and rubidium, thus, 23 + 85 = 108. It is likewise nearly the mean between rubidium and caesium, thus, (85+133)/2 = 109.

Group VIII.-- If lithium may be considered as connected with this group as well as with the foregoing (and by some chemists its oxide is viewed as a connecting link between the alkalies and the alkaline earths), we may perform the same calculations in this group that M. Dumas has done in the preceding, thus,- -

Li + Ca = 2 Mg, or in figures, 7 + 40 = 47
Li + 2 Ca = Sr " " 7 + 80 = 87
2 Li + 3 Ca = Ba " " 14 + 120 = 134
Li + 5 Ca = Pb " " 7 + 200 = 207

Again, there are two triads in the group of alkali metals, one which has been long known--viz., lithium, sodium, and potassium, and the other, which was pointed out by Mr. C. W. Quin, in the CHEMICAL NEWS of November 9, 1861--viz., potassium, rubidium, and caesium. Potassium is thus the highest term of one triad and the lowest term of another.

In like manner, if we include lithium, we shall have among the metals of the alkaline earths two triads, the first comprising lithium, magnesium, and calcium, and the second calcium, strontium, and barium, calcium standing at the top of one triad and at the bottom of the other.

The element lead occupies a position in relation to the metals of the alkaline earths similar to that filled by thallium in the group of alkali metals. Osmium appears to play a similar part in the sulphur group, and bismuth in the phosphorus group. The analogous term in the chlorine group is not yet known. Thallium, in its physical properties, bears some resemblance to lead, and it frequently happens that similar terms taken from different groups, such as oxygen and nitrogen, or sulphur and phosphorus, bear more physical resemblance to each other than they do to the members of the groups to which, for chemical reasons we are compelled to assign them.

It will be observed that the difference between the equivalents of tellurium and osmium, caesium, and thallium, and barium and lead, respectively, is the same in each case--viz., 70.

Group X.-- Palladium and platinum appear to be the extremities of a triad, the mean of which is unknown.

So frequently are relations to be met with among the equivalents of allied elements, that we may almost predict that the next equivalent determined, that of indium, for instance, will be found to bear a simple relation to those of the group to which it will be assigned.

In conclusion, I may mention that the equivalents I have adopted in this letter were taken from the highly-interesting and important paper by Professor Williamson, lately published in the *Journal of the Chemical Society*.

I am, &c.

John A. R. Newlands, F.C.S.
Laboratory, 19, Great St. Helens, E. C., July 12.

On Relations Among the Equivalents

Chemical News Vol. 10, August 20, 1864, pp. 94-95.

To the Editor of the CHEMICAL NEWS.

SIR,-- In addition to the facts stated in my late communication, may I be permitted to observe that if the elements are arranged in the order of their equivalents, calling hydrogen 1, lithium 2, glucinum 3, boron 4, and so on (a separate number being attached to each element having a distinct equivalent of its own, and where two elements happen to have the same equivalent, both being designated by the same number), it will be observed that elements having consecutive numbers frequently either belong to the same group or occupy similar positions in different groups, as in the following examples:--

		No.		**No.**		**No.**		**No.**		**No.**	
Group	a.	N	6	P	13	As	26	Sb	40	Bi	54
"	b.	O	7	S	14	Se	27	Te	42	Os	50
"	c.	Fl	8	Cl	15	Br	28	I	41	--	--
"	d.	Na	9	K	16	Rb	29	Cs	43	Tl	52
"	e.	Mg	10	Ca	17	Sr	30	Ba	44	Pb	53

Here the difference between the number of the lowest member of a group and that immediately above it is 7; in other words, the eighth element starting from a given one is a kind of repetition of the first, like the eighth note of an octave in music. The differences between the numbers of the other members of a group are frequently twice as great; thus in the nitrogen group, between N and P there are 7 elements; between P and As, 13; between As and Sb, 14; and between Sb and Bi, 14.

In conclusion, I may remark that just as we have several examples of the apparent existence of triads, the extremities of which are known, whilst their centres are wanting (such as the metals of the platinum group, which may be conceived to be the extremities of three distinct triads, and perhaps also silver and gold may be related to each other in this manner), so we may look upon certain of the elements, e.g., Mn, Fe, Co, Ni, and Cu, as the centres of triads, the extremes of which are at present unknown, or, perhaps, in some cases only unrecognised.

I am, &c.

John A. R. Newlands, F.C.S.
Laboratory, 19, Great St. Helens, E. C., August 8.

On the Law of Octaves.

Chemical News Vol. 12, Aug. 18, 1865, p. 83.

To the Editor of the CHEMICAL NEWS.

SIR,-- With your permission, I would again call attention to a fact pointed out in a communication of mine, inserted in the CHEMICAL NEWS for August 20, 1864.

If the elements are arranged in the order of their equivalents, with a few slight transpositions, as in the accompanying table, it will be observed that elements belonging to the same group usually appear on the same horizontal line.

No.	No.	No.	No.	No.	No.	No.	No.
H 1	F 8	Cl 15	Co & Ni 22	Br 29	Pd 36	I 42	Pt & Ir 50
Li 2	Na 9	K 16	Cu 23	Rb 30	Ag 37	Cs 44	Tl 51
G 3	Mg 10	Ca 17	Zn 25	Sr 31	Bd [sic-Cd] 38	Ba & V 45	Pb 54
Bo 4	Al 11	Cr 19	Y 24	Ce & La 33	U 40	Ta 46	Th 56
C 5	Si 12	Ti 18	In 26	Zr 32	Sn 39	W 47	Hg 52
N 6	P 13	Mn 20	As 27	Di & Mo 34	Sb 41	Nb 48	Bi 55
O 7	S 14	Fe 21	Se 28	Ro & Ru 35	Te 43	Au 49	Os 51

(NOTE.-- Where two elements happen to have the same equivalent, both are designated by the same number.)

It will also be seen that the numbers of analogous elements generally differ either by 7 or by some multiple of seven; in other words, members of the same group stand to each other in the same relation as the extremities of one or more octaves in music. Thus, in the nitrogen group, between nitrogen and phosphorus there are 7 elements; between phosphorus and arsenic, 14; between arsenic and antimony, 14; and lastly, between antimony and bismuth, 14 also.

This peculiar relationship I propose to provisionally term the "Law of Octaves".

I am, &c.

John A. R. Newlands, F.C.S.
Laboratory, 19, Great St. Helen's, E.C., August 8, 1865.

Report on the Law of Octaves

[The following account of Newlands' paper on the law of octaves was published in *Chemical News* Vol. 13, March 9, 1866, p. 113. It was written by a reporter whose name I do not have; it is not in Newlands' words.--CJG]

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, March 1.

...

Mr. JOHN A. R. NEWLANDS read a paper entitled "*The Law of Octaves, and the Causes of Numerical Relations among the Atomic Weights*." The author claims the discovery of a law according to which the elements analogous in their properties exhibit peculiar relationships, similar to those subsisting in music between a note and its octave. Starting from the atomic weights on Cannizzarro's system, the author arranges the known elements in order of succession, beginning with the lowest atomic weight (hydrogen) and ending with thorium (=231.5); placing, however, nickel and cobalt, platinum and iridium, cerium and lanthanum, &c., in positions of absolute equality or in the same line. The fifty-six elements so arranged are said to form the compass of eight octaves, and the author finds that chlorine, bromine, iodine, and fluorine are thus brought into the same line, or occupy corresponding places in his scale. Nitrogen and phosphorus, oxygen and sulphur, &c., are also considered as forming true octaves. The author's supposition will be exemplified in Table II., shown to the meeting, and here subjoined:--

Table II.--Elements arranged in Octaves.

No.	No.	No.	No.	No.	No.	No.	No.
H 1	F 8	Cl 15	Co & Ni 22	Br 29	Pd 36	I 42	Pt & Ir 50
Li 2	Na 9	K 16	Cu 23	Rb 30	Ag 37	Cs 44	Os 51
G 3	Mg10	Ca 17	Zn 24	Sr 31	Cd 38	Ba & V 45	Hg 52
Bo 4	Al 11	Cr 19	Y 25	Ce & La 33	U 40	Ta 46	Tl 53
C 5	Si 12	Ti 18	In 26	Zr 32	Sn 39	W 47	Pb 54
N 6	P 13	Mn 20	As 27	Di & Mo 34	Sb 41	Nb 48	Bi 55
O 7	S 14	Fe 21	Se 28	Ro & Ru 35	Te 43	Au 49	Th 56

Dr. GLADSTONE made objection on the score of its having been assumed that no elements remain to be discovered. The last few years had brought forth thallium, indium, caesium, and rubidium, and now the finding of one more would throw out the whole system. The speaker believed there was as close an analogy subsisting between the metals named in the last vertical column as in any of the elements standing on the same horizontal line.

Professor G. F. FOSTER humorously inquired of Mr. Newlands whether he had ever examined the elements according to the order of their initial letters? For he believed that any arrangement would present occasional coincidences, but he condemned one which placed so far apart manganese and chromium, or iron from nickel and cobalt.

Mr. NEWLANDS said that he had tried several other schemes before arriving at that now proposed. One founded upon the specific gravity of the elements had altogether failed, and no relation could be worked out of the atomic weights under any other system than that of Cannizzarro.

...

William Ramsay (1852-1916)

An Undiscovered Gas.

Nature **56**, 378 (1897). Address to the Section B (Chemistry) of British Association for the Advancement of Science. [facsimile from David Knight, ed., *Classic Papers in Chemistry, second series* (New York: American Elsevier, 1970).]

A sectional address to the members of the British Association falls under one of three heads. It may be historical, or actual, or prophetic; it may refer to the past, the present, or the future. In many cases, indeed in all, this classification overlaps. Your former Presidents have given sometimes a historical introduction, followed by an account of the actual state of some branch of our science, and, though rarely, concluding with prophetic remarks. To those who have an affection for the past, the historical side appeals forcibly; to the practical man, and to the investigator engaged in research, the actual, perhaps, presents more charm; while to the general public, to whom novelty is often more of an attraction than truth, the prophetic aspect excites most interest. In this address I must endeavour to tickle all palates; and perhaps I may be excused if I take this opportunity of indulging in the dangerous luxury of prophecy, a luxury which the managers of scientific journals do not often permit their readers to taste.

The subject of my remarks to-day is a new gas. I shall describe to you later its curious properties; but it would be unfair not to put you at once in possession of the knowledge of its most remarkable property--it has not yet been discovered. As it is still unborn, it has not yet been named. The naming of a new element is no easy matter. For there are only twenty-six letters in our alphabet, and there are already over seventy elements. To select a name expressible by a symbol which has not already been claimed for one of the known elements is difficult, and the difficulty is enhanced when it is at the same time required to select a name which shall be descriptive of the properties (or want of properties) of the element.

It is now my task to bring before you the evidence for the existence of this undiscovered element.

It was noticed by Döbereiner, as long ago as 1817, that certain elements could be arranged in groups of three. The choice of the elements selected to form these triads was made on account of their analogous properties, and on the sequence of their atomic weights, which had at that time only recently been discovered. Thus calcium, strontium, and barium formed such a group; their oxides, lime, strontia, and baryta are all easily slaked, combining with water to form soluble lime-water, strontia-water, and baryta-water. Their sulphates are all sparingly soluble, and resemblance had been noticed between their respective chlorides and between their nitrates. Regularity was also displayed by their atomic weights. The numbers then accepted were 20, 42.5, and 65; and the atomic weight of strontium, 42.5, is the arithmetical mean of those of the other two elements, for $(65+20)/2 = 42.5$. The existence of other similar groups of three was pointed out by Döbereiner, and such groups became known as "Döbereiner's triads".

Another method of classifying the elements, also depending on their atomic weights, was suggested by Pettenkofer, and afterwards elaborated by Kremers, Gladstone, and Cook. It consisted in seeking for some expression which would represent the differences between the atomic weights of certain allied elements. Thus, the difference between the atomic weight of lithium, 7, and sodium, 23, is 16; and between that of sodium and of potassium, 39, is also 16. The regularity is not always so conspicuous; Dumas, in 1857, contrived a somewhat complicated expression which, to some extent, exhibited regularity in the atomic weights of fluorine, chlorine, bromine, and iodine; and also of nitrogen, phosphorus, arsenic, antimony and bismuth.

The upshot of these efforts to discover regularity was that in 1864, Mr. John Newlands, having arranged the elements in eight groups, found that when placed in the order of their atomic weights, "the eighth element, starting from a given one, is a kind of repetition of the first, like the eighth note of an octave in music." To this regularity he gave the name "The Law of Octaves."

The development of this idea, as all chemists know, was due to the late Prof. Lothar Meyer, of Tübingen, and to Prof. Mendeléeff, of St. Petersburg. It is generally known as the "Periodic Law." One of the simplest methods of showing this arrangement is by means of a cylinder divided into eight segments by lines drawn parallel to its axis; a spiral line is then traced round the cylinder, which will, of course, be cut by these lines eight times at each revolution. Holding the cylinder vertically, the name and atomic weight of an element is written at each intersection of the spiral with a vertical line, following the numerical order of the atomic weights. It will be found, according to Lothar Meyer and Mendeléeff, that the elements grouped down each of the vertical lines from a natural class; they possess similar properties, form similar compounds, and exhibit a graded relationship between their densities, melting-points, and many of the other properties. One of these vertical columns, however, differs from the others, inasmuch as on it there are three groups, each consisting of three elements with approximately equal atomic weights. The elements in question are iron, cobalt, and nickel; palladium, rhodium, and ruthenium; and platinum, iridium, and osmium. There is apparently room for a fourth group of three elements in this column, and it may be a fifth. And the discovery of such a group is not unlikely, for when this table was first drawn up Prof. Mendeléeff drew attention to certain gaps, which have since been filled up by the discovery of gallium, germanium, and others.

The discovery of argon at once raised the curiosity of Lord Rayleigh and myself as to its position in this table. With a density of nearly 20, if a diatomic gas, like oxygen and nitrogen, it would follow fluorine in the periodic table; and our first idea was that argon was probably a mixture of three gases, all of which possessed nearly the same atomic weights, like iron, cobalt, and nickel. Indeed, their names were suggested, on this supposition, with patriotic bias, as Anglium, Scotium, and Hibernium! But when the ratio of its specific heats had, at least in our opinion, unmistakably shown that it was molecularly monatomic, not diatomic, as at first conjectured, it was necessary to believe that its atomic weight was 40, and not 20, and that it followed chlorine in the atomic table, and not fluorine. But here arises a difficulty. The atomic weight of chlorine is 35.5, and that of potassium, the next element in order in the table, is 39.1; and that of argon, 40, follows, and does not precede, that of potassium, as it might be expected to do. It still remains possible that argon, instead of consisting wholly of monatomic molecules, may contain a small percentage of diatomic molecules; but the evidence in favour of this supposition is, in my opinion, far from strong. Another possibility is that argon, as at first conjectured, may consist of a mixture of more than one element; but, unless the atomic weight of one of the elements in the supposed mixture is very high, say 82, the case is not bettered, for one of the elements in the supposed trio would still have a higher atomic weight than potassium. And very careful experiments, carried out by Dr. Norman Collie and myself, on the fractional diffusion of argon, have disproved the existence of any such element with high atomic weight in argon, and, indeed, have practically demonstrated that argon is a simple substance, and not a mixture.

The discovery of helium has thrown a new light on this subject. Helium, it will be remembered, is evolved on heating certain minerals, notably those containing uranium; although it appears to be contained in others in which uranium is not present, except in traces. Among these minerals are cleveite, monazite, fergusonite, and a host of similar complex mixtures, all containing rare elements, such as niobium, tantalum, yttrium, cerium, &c. The spectrum of helium is characterised by a remarkably brilliant yellow line, which had been observed as long ago as 1868 by Profs. Frankland and Lockyer in the spectrum of the sun's chromosphere, and named "helium" at that early date.

The density of helium proved to be very close to 2.0, and, like argon, the ratio of its specific heat showed that it, too, was a monatomic gas. Its atomic weight therefore is identical with its molecular weight, viz. 4.0, and its place in the periodic table is between hydrogen and lithium, the atomic weight of which is 7.0.

The difference between the atomic weights of helium and argon is thus 36, or 40-4. Now there are several cases of such a difference. For instance, in the group the first member of which is fluorine we have--

Fluorine	19	
		16.5
Chlorine	35.5	
		19.5
Manganese	55	

In the oxygen group--

Oxygen	16	
		16
Sulphur	32	
		20.3
Chromium	52.3	

In the nitrogen group--

Nitrogen	14	
		17
Phosphorus	31	
		20.4
Vanadium	51.4	

And in the carbon group--

Carbon	12	
		16.3
Silicon	28.3	
		19.8
Titanium	48.1	

These instances suffice to show that approximately the differences are 16 and 20 between consecutive members of the corresponding groups of elements. The total differences between the extreme members of the short series mentioned are--

Manganese - Fluorine	36
Chromium - Oxygen	36.3
Vanadium - Nitrogen	37.4
Titanium - Carbon	36.1

This is approximately the difference between the atomic weights of helium and argon, 36.

There should, therefore, be an undiscovered element between helium and argon, with an atomic weight 16 units higher than that of helium, and 20 units lower than that of argon, namely 20. And if this unknown element, like helium and argon, should prove to consist of monatomic molecules, then its density should be half its atomic weight, 10. And pushing the analogy still further, it is to be expected that this element should be as indifferent to union with other elements as the two allied elements.

My assistant, Mr. Morris Travers, has indefatigably aided me in a search for this unknown gas. There is a proverb about looking for a needle in a haystack; modern science, with the aid of suitable magnetic appliances, would, if the reward were sufficient, make short work of that proverbial needle. But here is a supposed unknown gas, endowed no doubt with negative properties, and the whole world to find it in. Still, the attempt had to be made.

We first directed our attention to the sources of helium--minerals. Almost every mineral which we could obtain was heated in a vacuum, and the gas which was evolved examined. The results are interesting. Most minerals give off gas when heated, and the gas contains, as a rule, a considerable amount of hydrogen, mixed with carbonic acid, questionable traces of nitrogen, and carbonic oxide. Many of the minerals, in addition, gave helium, which proved to be widely distributed, though only in minute proportion. One mineral--malacone--gave appreciable quantities of argon; and it is noteworthy that argon was not found except in it (and, curiously, in much larger amount than helium), and in a specimen of meteoric iron. Other specimens of meteoric iron were examined, but were found to contain mainly hydrogen, with no trace of either argon or helium. It is probable that the sources of meteorites might be traced in this manner, and that each could be relegated to its particular swarm.

Among the minerals examined was one to which our attention had been directed by Prof. Lockyer, named eliasite, from which he said that he had extracted a gas in which he had observed spectrum lines foreign to helium. He was kind enough to furnish us with a specimen of this mineral, which is exceedingly rare, but the sample which we tested contained nothing but undoubted helium.

During a trip to Iceland in 1895, I collected some gas from the boiling springs there; it consisted, for the most part, of air, but contained somewhat more argon than is usually dissolved when air is shaken with water. In the spring of 1896 Mr. Travers and I made a trip to the Pyrenees to collect gas from the mineral springs of Cauterets, to which our attention had been directed by Dr. Bouchard, who pointed out that these gases are rich in helium. We examined a number of samples from the various springs, and confirmed Dr. Bouchard's results, but there was no sign of any unknown lines in the spectrum of these gases. Our quest was in vain.

We must now turn to another aspect of the subject. Shortly after the discovery of helium, its spectrum was very carefully examined by Profs. Runge and Paschen, the renowned spectroscopists. The spectrum was photographed, special attention being paid to the invisible portions, termed the "ultra-violet" and "infra-red." The lines thus registered were found to have a harmonic relation to each other. They admitted of division into two sets, each complete in itself. Now, a similar process had been applied to the spectrum of lithium and to that of sodium, and the spectra of these elements gave only one series each. Hence, Profs. Runge and Paschen concluded that the gas, to which the provisional name of helium had been given, was, in reality, a mixture of two gases, closely resembling each other in properties. As we know no other elements with atomic weights between those of hydrogen and lithium, there is no chemical evidence either for or against this supposition. Prof. Runge supposed that he had obtained evidence of the separation of these imagined elements from each other by means of diffusion; but Mr. Travers and I pointed out that the same alteration of spectrum, which was apparently produced by diffusion, could also be caused by altering the pressure of the gas in the vacuum tube; and shortly after Prof. Runge acknowledged his mistake.

These considerations, however, made it desirable to subject helium to systematic diffusion, in the same way as argon had been tried. The experiments were carried out in the summer of 1896 by Dr. Collie and myself. The result was encouraging. It was found possible to separate helium into two portions of different rates of diffusion, and consequently of different density by this means. The limits of separation, however, were not very great. On the one hand, we obtained gas of a density close on 2.0; and on the other, a sample of density 2.4 or thereabouts. The difficulty was increased by the curious behaviour, which we have often had occasion to confirm, that helium possesses a rate of diffusion too rapid for its density. Thus, the density of the lightest portion of the diffused gas, calculated from its rate of diffusion, was 1.874; but this corresponds to a real density of about 2.0. After our paper, giving an account of these experiments, had been published, a German investigator, Herr A. Hagenbach, repeated our work and confirmed our results.

The two samples of gas of different density differ also in other properties. Different transparent substances differ in the rate at which they allow light to pass through them. Thus, light travels through water at a much slower rate than through air, and at a slower rate through air than through hydrogen. Now Lord Rayleigh found that helium offers less opposition to the passage of light than any other substance does, and the heavier of the two portions into which helium had been split offered more opposition than the lighter portion. And the retardation of the light, unlike what has usually been observed, was nearly proportional to the densities of the samples. The spectrum of these two samples did not differ in the minutest particular; therefore it did not appear quite out of the question to hazard the speculation that the process of diffusion was instrumental, not necessarily in separating two kinds of gas from each other, but actually in removing light molecules of the same kind from heavy molecules. This idea is not new. It had been advanced by Prof. Schützenberger (whose recent death all chemists have to deplore), and later, by Mr. Crookes, that what we term the atomic weight of an element is really a mean; that when we say the atomic weight of oxygen is 16, we merely state that the average atomic weight is 16; and it is not inconceivable that a certain number of molecules have a weight somewhat higher than 32, while a certain number have a lower weight.

We therefore thought it necessary to test this question by direct experiment with some known gas; and we chose nitrogen, as a good material with which to test the point. A much larger and more convenient apparatus for diffusing gases was built by Mr. Travers and myself, and a set of systematic diffusions of nitrogen was carried out. After thirty rounds, corresponding to 180 diffusions, the density of the nitrogen was unaltered, and that of the portions which should have diffused most slowly, had there been any difference in rate, was identical with that of the most quickly diffusing portion--*i.e.* with that of the portion which passed first through the porous plug. This attempt, therefore, was unsuccessful; but it was worth carrying out, for it is now certain that it is not possible to separate a gas of undoubted chemical unity into portions of different density by diffusion. And these experiments rendered it exceedingly improbable that the difference in density of the two fractions of helium was due to separation of light molecules of helium from heavy molecules.

The apparatus used for diffusion had a capacity of about two litres. It was filled with helium, and the operation of diffusion was carried through thirty times. There were six reservoirs, each full of gas, and each was separated into two by diffusion. To the heavier portion of one lot, the lighter portion of the next was added, and in this manner all six reservoirs were successfully passed through the diffusion apparatus. This process was carried out thirty times, each of the six reservoirs having had its gas diffused each time, thus involving 180 diffusions. After this process, the density of the more quickly diffusing gas was reduced to 2.02, while that of the less quickly diffusing had increased to 2.27. The light portion on re-diffusion hardly altered in density, while the heavier portion, when divided into three portions by diffusion, showed a considerable difference in density between the first third and last third. A similar set of operations was carried out with a fresh quantity of helium, in order to accumulate enough gas to obtain a sufficient quantity for a second series of diffusions. The more quickly diffusing portions of both gases were mixed and re-diffused. The density of the lightest portion of these gases was 1.98; and after other 15 diffusions, the density of the lightest portion had not decreased. The end had been reached; it was not possible to obtain a lighter portion by diffusion. The density of the main body of this gas is therefore 1.98; and its refractivity, air being taken as unity, is 0.1245. The spectrum of this portion does not differ in any respect from the usual spectrum of helium.

As re-diffusion does not alter the density or the refractivity of this gas, it is right to suppose that either one definite element has now been isolated; or that if there are more elements than one present, they possess the same, or very nearly the same, density and refractivity. There may be a group of elements, say three, like iron, cobalt, and nickel; but there is no proof that this idea is correct, and the simplicity of the spectrum would be an argument against such a supposition. This substance, forming by far the larger part of the whole amount of the gas, must, in the present state of our knowledge, be regarded as pure helium.

On the other hand, the heavier residue is easily altered in density by re-diffusion, and this would imply that it consists of a small quantity of a heavy gas mixed with a large quantity of the light gas. Repeated re-diffusion convinced us that there was only a very small amount of the heavy gas present in the mixture. The portion which contained the largest amount of heavy gas was found to have the density 2.275, and its refractive index was found to be 0.1333. On re-diffusing this portion of gas until only a trace sufficient to fill a Plücker's tube was left, and then examining the spectrum, no unknown lines could be detected, but, on interposing a jar and spark gap, the well known blue lines of argon became visible; and even without the jar the red lines of argon, and the two green groups were distinctly visible. The amount of argon present, calculated from the density, was 1.64 per cent., and from the refractivity 1.14 per cent. The conclusion had therefore to be drawn that the heavy constituent of helium, as it comes off the minerals containing it, is nothing new, but so far as can be made out, merely a small amount of argon.

If, then, there is a new gas in what is generally termed helium, it is mixed with argon, and it must be present in extremely minute traces. As neither helium nor argon has been induced to form compounds, there does not appear to be any method other than diffusion, for isolating such a gas, if it exists, and that method has failed in our hands to give any evidence of the existence of such a gas. It by no means follows that the gas does not exist; the only conclusion to be drawn is that we have not yet stumbled upon the material which contains it. In fact, the haystack is too large and the needle too inconspicuous . Reference to the periodic table will show that between the elements aluminium and indium there occurs gallium, a substance occurring only in the minutest amount on the earth's surface; and following silicon, and preceding tin, appears the element germanium, a body which has as yet been recognised only in one of the rarest of minerals, argyrodite. Now, the amount of helium in fergusonite, one of the minerals which yields it in reasonable quantity, is only 33 parts by weight in 100,000 of the mineral; and it is not improbable that some other mineral may contain the new gas in even more minute proportion. If, however, it is accompanied in its still undiscovered source by argon and helium, it will be a work of extreme difficulty to effect a separation from these gases.

In these remarks it has been assumed that the new gas will resemble argon and helium in being indifferent to the action of reagents, and in not forming compounds. This supposition is worth examining. In considering it, the analogy with other elements is all that we have to guide us.

We have already paid some attention to several triads of elements. We have seen that the differences in atomic weights between the elements fluorine and manganese, oxygen and chromium, nitrogen and vanadium, carbon and titanium, is in each case approximately the same as that between helium and argon, viz. 36. If elements further back in the periodic table be examined, it is to be noticed that the differences grow less, the smaller the atomic weights. Thus, between boron and scandium, the difference is 33; between beryllium (glucinum) and calcium, 31; and between lithium and potassium, 32. At the same time, we may remark that the elements grow liker each other, the lower the atomic weights. Now, helium and argon are very like each other in physical properties. It may be fairly concluded, I think, that in so far they justify their position. Moreover, the pair of elements which show the smallest difference between their atomic weights is beryllium and calcium; there is a somewhat greater difference between lithium and potassium. And it is in accordance with this fragment of regularity that helium and argon show a greater difference. Then again, sodium, the middle element of the lithium triad, is very similar in properties both to lithium and potassium; and we might, therefore, expect that the unknown element of the helium series should closely resemble both helium and argon.

Leaving now the consideration of the new element, let us turn our attention to the more general question of the atomic weight of argon, and its anomalous position in the periodic scheme of the elements. The apparent difficulty is this: The atomic weight of argon is 40; it has no power to form compounds, and thus possesses no valency; it must follow chlorine in the periodic table, and precede potassium; but its atomic weight is greater than that of potassium, whereas it is generally contended that the elements should follow each other in the order of their atomic weights. If this contention is correct, argon should have an atomic weight smaller than 40.

Let us examine this contention. Taking the first row of elements, we have:

Li=7, Be=9.8, B=11, C=12, N=14, O=16, F=19, ?=20.

The differences are:

2.8, 1.2, 1.0, 2.0, 2.0, 3.0, 1.0.

It is obvious that they are irregular. The next row shows similar irregularities. Thus:

(?=20), Na=23, Mg=24.3, Al=27, Si=28, P=31, S=32, Cl=35.5, A=40.

And the differences:

3.0, 1.3, 2.7, 1.0, 3.0, 1.0, 3.5, 4.5.

The same irregularity might be illustrated by a consideration of each succeeding row. Between argon and the next in order, potassium, there is a difference of -0.9; that is to say, argon has a higher atomic weight than potassium by 0.9 unit; whereas it might be expected to have a lower one, seeing that potassium follows argon in the table. Further on in the table there is a similar discrepancy. The row is as follows:

Ag=108, Cd=112, In=114, Sn=119, Sb=120.5, Te=127.7, I=127.

The differences are:

4.0, 2.0, 5.0, 1.5, 7.2, -0.7.

Here, again, there is a negative difference between tellurium and iodine. And this apparent discrepancy has led to many and careful redeterminations of the atomic weight of tellurium. Prof. Brauner, indeed, has submitted tellurium to methodical fractionation, with no positive results. All the recent determinations of its atomic weight give practically the same number, 127.7.

Again, there have been almost innumerable attempts to reduce the differences between the atomic weights to regularity, by contriving some formula which will express the numbers which represent the atomic weights, with all their irregularities. Needless to say, such attempts have in no case been successful. Apparent success is always attained at the expense of accuracy, and the numbers reproduced are not those accepted as the true atomic weights. Such attempts, in my opinion, are futile. Still, the human mind does not rest contented in merely chronicling such an irregularity; it strives to understand why such an irregularity should exist. And, in connection with this, there are two matters which call for our consideration. These are: Does some circumstance modify these "combining proportions" which we term "atomic weights"? And is there any reason to suppose that we can modify them at our will? Are they true "constants of nature," unchangeable, and once for all determined? Or are they constant merely so long as other circumstances, a change in which would modify them, remain unchanged?

In order to understand the real scope of such questions, it is necessary to consider the relation of the "atomic weights" to other magnitudes, and especially to the important quantity termed "energy."

It is known that energy manifests itself under different forms, and that one form of energy is quantitatively convertible into another form, without loss. It is also known that each form of energy is expressible as the product of two factors, one of which has been termed the "intensity factor," and the other the "capacity factor." Prof. Ostwald, in the last edition of his "Allgemeine Chemie," classifies some of these forms of energy as follows:

Kinetic	energy is the product of	Mass into the square of velocity.
Linear	" "	Length into force.
Surface	" "	Surface into surface tension.
Volume	" "	Volume into pressure.
Heat	" "	Heat capacity (entropy) into temperature.
Electrical	" "	Electrical capacity into potential.
Chemical	" "	"Atomic weight" into affinity.

In each statement of factors, the "capacity factor" is placed first, and the "intensity factor" second.

In considering the "capacity factors," it is noticeable that they may be divided into two classes. The two first kinds of energy, kinetic and linear, are independent of the nature of the material which is subject to the energy. A mass of lead offers as much resistance to a given force, or, in other words, possesses as great inertia as an equal mass of hydrogen. A mass of iridium, the densest solid, counterbalances an equal mass of lithium, the lightest known solid. On the other hand, surface energy deals with molecules, and not with masses. So does volume energy. The volume energy of two grammes of hydrogen, contained in a vessel of one litre capacity, is equal to that of thirty-two grammes of oxygen at the same temperature, and contained in a vessel of equal size. Equal masses of tin and lead have not equal capacity for heat; but 119 grammes of tin has the same capacity as 207 grammes of lead; that is, equal atomic masses have the same heat capacity. The quantity of electricity conveyed through an electrolyte under equal difference of potential is proportional, not to the mass of the dissolved body, but to its equivalent; that is, to some simple fraction of its atomic weight. And the capacity factor of chemical energy is the atomic weight of the substance subjected to the energy. We see, therefore, that while mass or inertia are important adjuncts of kinetic and linear energies, all other kinds of energy are connect with atomic weights, either directly or indirectly.

Such considerations draw attention to the fact that quantity of matter (assuming that there exists such a carrier of properties as we term "matter") need not necessarily be measured by its inertia, or by gravitational attraction. In fact the word "mass" has two totally distinct significations. Because we adopt the convention to measure quantity of matter by its mass, the word "mass" has come to denote "quantity of matter." But it is open to any one to measure a quantity of matter by any other of its energy factors. I may, if I choose, state that those quantities of matter which possess equal capacities for heat are equal; or that "equal numbers of atoms" represent equal quantities of matter. Indeed, we regard the value of material as due rather to what it can do, than to its mass; and we buy food, in the main, on an atomic, or perhaps, a molecular basis, according to its content of albumen. And most articles depend for their value on the amount of food required by the producer or the manufacturer.

The various forms of energy may therefore be classified as those which can be referred to an "atomic" factor, and those which possess a "mass" factor. The former are in the majority. And the periodic law is the bridge between them; and yet, an imperfect connection. For the atomic factors, arranged in the order of their masses, display only a partial regularity. It is undoubtedly one of the main problems of physics and chemistry to solve this mystery. What the solution will be is beyond my power of prophecy; whether it is to be found in the influence of some circumstance on the atomic weights, hitherto regarded as among the most certain "constants of nature"; or whether it will turn out that mass and gravitational attraction are influenced by temperature, or by electrical charge, I cannot tell. But that some means will ultimately be found of reconciling these apparent discrepancies, I firmly believe. Such a reconciliation is necessary, whatever view be taken of the nature of the universe and of its mode of action; whatever units we may choose to regard as fundamental among those which lie at our disposal.

In this address I have endeavoured to fulfil my promise to combine a little history, a little actuality, and a little prophecy. The history belongs to the Old World; I have endeavoured to share passing events with the New; and I will ask you to join with me in the hope that much of the prophecy may meet with its fulfilment on this side of the ocean.