Syllabus of a course of lectures on the principles of chemistry, commencing at the Museum, Oxford, in Oct. 1831.

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Samuel Crompton
The gift of Dr Greenhill

SYLLABUS

OF A

COURSE OF LECTURES

ON THE PRINCIPLES OF

CHEMISTRY,

COMMENCING AT THE MUSEUM, OXFORD,
IN OCTOBER MDCCCXXXI.

Daubeny

SYLLABUS.

GENERAL plan of the course.

Chemistry distinguished from mechanical philosophy—Its office twofold—to ascertain the characteristic properties inherent in different kinds of matter—and to determine the changes that are produced in these properties in consequence of the action of one body upon another—As this may happen either by the agency of natural causes, or be brought about by artificial means, the facts of Chemistry are derived from two sources—observation and experiment. Whatever changes are induced in bodies may be referred to one of two causes, or to the operation of both united—these are Attraction and Heat—Hence a knowledge of the laws which regulate the action of these two forces constitutes in itself a principal part of Chemistry, and is essential to the due understanding of the remainder.

1. Attraction.

The attraction which comes more immediately under the consideration of the Chemist distinguished from other kinds, by its taking place at *insensible distances*, and subsisting between the particles of different kinds of matter; whereas that between the particles of the same body belongs to mechanical philosophy—Hence the former kind is designated by the name of Chemical, whilst the latter is called Cohesive.

Cohesive.

Cohesive attraction must be incidentally noticed as serving to modify the action of that denominated Chemical—It is possessed in a greater or less degree by all substances—the different states in which they exist arising not from the *absence* of this force, but from the more or less power-

ful influence of the antagonist power, heat—This proved by the late experiments of Mr. Faraday—It subsists only between the ultimate particles of matter—and therefore is exerted only at *insensible distances*—Unequal force with which it is supposed to act on the several faces of the same atom, thus giving rise to differences in crystalline form—Probability that every chemical compound possesses a certain crystalline arrangement, which is however modified by various causes.

Chemical or Elective.

Chemical attraction commonly called affinity—Causes two kinds of combination between bodies—in the first the ingredients of the compound remain unaltered; in the second the properties of both are destroyed or greatly modified—First kind of union may take place in any proportion—the second only in certain definite ones—Laws of the second kind of combination considered—relative proportion of the ingredients invariable in the same compound—where more than one combination of the two ingredients exists, the larger quantity in which one of them unites is always an exact multiple of the smaller—These facts have been explained on the doctrine of atoms, but are independant of the truth or falsehood of that theory.

Affinity of a body for the substances with which it combines shewn to be of unequal force—so that the presence of a third substance, having a stronger affinity for one of the ingredients of an existing compound than the latter possess for one another, will cause the destruction of the existing combination, and the production of a new one—hence chemical attraction is frequently called *elective*—Chemical analysis founded on the principle just stated.

Explanation of the terms *Single* and *Double* Elective Attraction.

Causes which interfere with the regular operation of the laws above stated.

2. Heat.

The term Heat restricted in chemical language to the *sensation*, the *cause* of that sensation being called caloric—

Caloric may be viewed as an antagonist power both to cohesive and chemical attraction—Whether to be viewed as a distinct substance, or as a vibration among the particles of matter that convey the sensation of heat—Distinction between caloric and light.

Light a chemical agent—Brief detail of its properties so far as they are connected with Chemistry—Chemical operation of the several rays unequal.

Properties of caloric—its tendency to an equilibrium—This equal distribution of caloric takes place in two ways; by being *conducted* and *radiated* from the body which possesses a surplus of it.

Conduction of caloric explained—Relative conducting power of bodies considered—Whether liquids conduct caloric—and airs—Other means by which caloric is transmitted in these two cases.

Radiation of caloric shewn to take place from all solid bodies—but in different degrees—Those bodies which radiate most reflect least, and vice versâ—Absorption of caloric in direct proportion to its radiation—Radiation of heat does not follow the same ratio as that of light—Application of the principles laid down respecting the radiation of caloric to various economical purposes—and to explain certain natural phænomena—as those of dew.

Effects of caloric considered:—1st, in increasing the bulk of bodies—Relative expansion of different substances by equal increments of heat considered—Application of this property to determine the relative degree of caloric present—Construction of thermometers—Apparent exceptions to the universality of this law.

Effects of caloric in changing the condition of bodies—Proofs that in these cases it enters into combination with them, and becomes latent—General law laid down by Dr. Black on this subject—Explanation of the cold produced by evaporation, according to his principles.

Proofs that different substances in a solid and liquid state retain in combination different quantities of latent caloric—a knowledge of which fact has led to various attempts

at calculating the absolute quantities of caloric they may severally contain.

Applications of the theory of latent caloric to the improvement of the steam-engine, and to various other economical purposes.

Sources of heat:—1st, Radiation from the sun:—2dly, Friction:—3dly, Percussion:—4thly, Combustion.

On the atmosphere and its constituents. 1st, Its chemical properties.

Combustion dependent on the presence of atmospheric air—which is altered in its properties during that process—in what manner the change takes place, according to the hypothesis of Stahl, and that of Lavoisier—Reasons for preferring the latter explanation—Atmospheric air shewn to be composed of two ingredients.

Properties of the first of these—its fitness for supporting combustion—and for producing acids—hence called *oxygen*—Difference between what is called *oxydation* and *combustion*—Nature of Flame—Light and heat given out during combustion not always proportionate—Effect of the presence of certain fixed incombustible substances in increasing the luminousness of flame—such as lime—Drummond's application of this fact to telegraphs, &c.—The most combustible substances shewn to be capable of uniting with oxygen without the extrication of light.

Properties of the second constituent of the atmosphere—why called *azote*—how procured—whether elementary.

On water and its base.

Water not an element—one of its ingredients separated, and the other absorbed by certain metallic bodies—Substance absorbed shewn to be oxygen—Properties of the ingredient which is disengaged—why called *hydrogen*—its extreme lightness and inflammability—Proportion between the ingredients which form water—Properties of this liquid—enters into composition with various bodies, forming hydrats—The other compound of hydrogen and oxygen discovered by Mons. Thenard.

On the agency of

Subject of electricity would have been more in place under

the head of the general principles of Chemistry—Why more convenient to treat of it here. Electricity in the production of chemical changes.

General principles of common electricity stated—either resinous or vitreous—Bodies from which neither kind can be elicited are termed non-electrics—Property which the latter possess of transmitting the electric fluid when set in motion—Hence electrics and non-conductors, conductors and non-electrics are convertible terms.

Voltaic differs from common electricity, both in the mode of exciting it, and in the effects it produces—Description of the different kinds of apparatus used for generating it—Its effects on the electrometer—in exciting muscular and nervous irritability—in fusing and igniting metals—in producing chemical changes by altering the affinities of bodies—Sir H. Davy's discoveries on this subject—Speculations as to the cause of the differences existing between common and voltaic electricity.

Connection between electricity and magnetism—Experiments which prove that the latter may be induced by the former—Rotatory motion impressed by a current of electricity upon a body that has become magnetic—Mutual influence of discs of copper, and certain other bodies, when set in motion, upon magnets, and of magnets upon the discs—Magnetism also induced in certain bodies by heat.

Classification of bodies according to their electrical relations.

On acids in general—their peculiar properties—Division of them into such as contain oxygen—hydrogen—and other principles not yet considered. On primary compounds attracted to the positive pole of the Galvanic battery.

Nomenclature of acids and of salts explained.

Carbonic acid one of the constituents of the atmosphere—means of ascertaining its presence—its specific gravity—extinguishes flame and animal life—is absorbed by water—possesses acid qualities—how procured—proofs of its compound nature. 1st, Acids containing oxygen. Carbonic acid and base.

Of its base, carbon—Principal source of this substance—Mineral bodies which consist of it either wholly or princi-

pally. Combinations of carbon with oxygen, three, viz. *carbonic oxide, carbonic acid, and oxalic acid*—difference in the chemical nature of these bodies, according to the atomic theory. Carbon in combination with hydrogen forms two gases, *light carburetted hydrogen and olefiant gas*—Various methods of obtaining these two gases—Nature of the coal and oil gas used in illumination—Fire-damp—Sir H. Davy's lamp for preventing the explosions in mines which arise from the presence of this gas—Principle of its security explained. Carbon in union with hydrogen forms several compounds not gaseous, viz. Bitumen—Naphtha—Naphthaline—Bicarburet of hydrogen, and other products resulting from the distillation of coal, lately examined by Mr. Faraday. Carbon with nitrogen forms *cyanogen*—Properties of this gas—its combination with hydrogen possesses acid properties, although no oxygen be present—called *hydrocyanic*, or *Prussic acid*—its poisonous effects—Nature of *Prussian Blue* briefly explained.

Nitric acid. Nitric acid consists of the same ingredients as atmospheric air chemically combined—how obtained—its properties.

Other compounds of nitrogen and oxygen—*Nitrous gas*—its properties, and proofs of its composition—*Nitrous oxide*—how obtained—supports combustion—its singular effects upon the nervous system—Other compounds of oxygen and nitrogen, the existence of which seems more problematical.

Sulphuric acid and base. Sulphuric acid—how obtained—Theory of the changes that take place when the acid is procured by burning sulphur in close vessels with nitre—Properties of sulphuric acid, and of its base, sulphur—Other compounds of sulphur and oxygen described, viz. *sulphurous*, *hyposulphurous*, and *hyposulphuric acids*—compounds of sulphur and hydrogen, viz. *sulphuretted* and *bisulphuretted hydrogen*—Acid properties of these compounds, although no oxygen be present—the latter exists only in combination—Compound of sulphur and carbon—its singular properties.

Phosphoric acid and base. Phosphoric acid enters into the constitution of bones and other animal matters—proved to consist of oxygen, and a peculiar base called phosphorus—History of the discovery

of this body—Processes for obtaining it—Its properties and combinations with oxygen, viz. *phosphoric*, *phosphorous*, and *hypophosphorous acids*, &c. 2dly, with hydrogen, viz. *proto-phosphuretted* and *perphosphuretted hydrogen* gases.

Boracic acid—whence procured—sometimes a volcanic product—its properties and composition—process for separating its base, *boron*. Boracic acid and base.

On the acid disengaged by the action of sulphuric acid on common salt—why called muriatic—its properties—decomposed by electricity into hydrogen, and a peculiar gas of a yellowish-green colour termed chlorine—Properties of chlorine—Question as to whether this or muriatic acid be the simple substance. 2d, Acids not containing oxygen. Muriatic acid and its acidifying principle, chlorine.

Compounds of chlorine with oxygen: 1. Euchlorine: 2. Peroxide of chlorine: 3. Chloric acid: 4. Perchloric acid —compounds with carbon—with carbonic oxide, viz. *phosgene gas*—with phosphorus: 5. with olefiant gas: 6. with nitrogen.

Use of chlorine in bleaching, and in destroying animal effluvia—Nature of the *chlorurets of lime and of soda*, lately introduced for the latter purpose.

Fluoric acid obtained from the fluor spar of Derbyshire. —Difference in its properties when procured in glass and in silver vessels—reason of this difference—Properties of fluo-silicic gas—of pure fluoric acid—Decomposition of fluoric acid, and separation of its base, fluorine. Fluoric acid and its acidifying principle.

Iodine—whence procured—its properties—its combinations with hydrogen, viz. *hydriodic acid*—with oxygen, *iodic gas*—with chlorine, *chloriodic acid*—and with various metals and simple combustibles—Explosive compound formed by the union of iodine and nitrogen. Iodine and its compounds.

Brome a substance lately discovered, and considered as yet elementary—Its analogies with chlorine and iodine—forms acids with hydrogen, &c. Brome and its compounds.

Affinity between the last mentioned class of bodies and those attracted to the negative pole of the voltaic battery— On primary compounds attracted to

the negative pole of the voltaic battery.

Third class of bodies called salts, resulting from the union of the two former.

1. Alkalies and their bases.

Potass how obtained—occurs in nature combined usually with carbonic acid—Means of separating the latter, and thus obtaining pure potass—Properties of this substance—shewn to be a metallic body in union with oxygen—This base called potassium—Combinations of this body with oxygen, viz. *potass*, and *peroxide of potassium*.

Salts of potass—with carbonic acid two—with nitric acid, Saltpetre—use of this salt in the manufacture of gunpowder—Process for fabricating this mixture—Theory of its explosive effects—Period of its invention—Use of nitre in the process of forming sulphuric acid—Mode in which nitre is obtained from decomposing vegetable and animal matter—Question as to whether the ingredients of the salt preexisted in the latter, or were produced during the process of their decay—Nature of the compound called *liver of sulphur*, formed by bringing sulphur and potass in contact with the assistance of heat—and of the analogous compounds formed by the same body with the other alkalies—the earths—and the metals.

Soda proved like potass to be the oxide of a peculiar metal—Uses of this alkali in soap-making, &c. Its compounds with carbonic acid two: viz. 1st, containing the least proportion of carbonic acid, procured from sea plants: 2dly, containing twice as much acid as the former, found in a rock in Tripoli, and called *Trona*. Muriate of soda—whence obtained—its uses—processes for decomposing it: 1st, by means of carbonate of lime—This process probably goes on extensively in nature, giving rise to the production of natron lakes:—2dly, by means of oxide of lead:—3dly, by sulphate of soda:—4thly, by passing steam through heated salt and clay.

Sulphate or Glauber salt—Its properties and uses.

Borate of soda already noticed under boracic acid.

Phosphate of soda—Phosphorus readily obtained from it.

Methods of distinguishing the salts of soda from those of potass.

Lithion—discovered lately in a peculiar mineral—The principal distinction between it and the other fixed alkalies.

Ammonia—how procured—its properties—Carbonate and bicarbonate of ammonia—Muriate of ditto—Modes of obtaining this salt employed formerly in Egypt, and at present in Europe—Its economical uses—Nitrate of ammonia.

Decomposition of this alkali by heat, and by electricity—Curious effect of the action of Galvanism upon an ammoniacal salt in contact with mercury.

2. Earths and their bases.

Division of the earths into alkaline and proper.

1. Alkaline.

Lime an alkaline earth, found in nature combined with carbonic acid—Method of obtaining quick-lime—Slacked lime, an hydrate—Use of lime in making mortar—difference in the composition of this, according as it is intended for land or water-works—Use of lime as a manure—Its salts—Carbonate of lime—Its properties—Sir James Hall's experiments on the fusion of this substance.

Sulphate of lime—nature of selenite—and of plaster of Paris. Phosphate of lime found in the bones of animals.

Fluate of lime, or fluor spar—Chloride of calcium and muriate of lime—their difference explained—nature of the substance called *chloride of lime*—Oxalate of lime an insoluble salt—hence oxalic acid is a test of lime.

Magnesia found in combination with carbonic acid—its properties when separated—its uses—its salts—The sulphate or Epsom salt—the muriate—present in sea-water—Phosphate of magnesia and ammonia—Remarks on the tendency of this earth to form triple salts, and if combined with an acid, to part with a portion of it when heated—Best method of separating lime from magnesia.

Barytes—Found united with the carbonic and sulphuric acids—Properties of these salts and of the earth when separated—Muriate and nitrate of barytes.

Strontites—where found—its properties—Analogies to barytes, and modes of distinguishing the two earths.

General remarks on the above four alkaline earths—they agree in containing a metallic base separable by the joint

agency of electricity and potassium—Other properties in which they resemble the alkalies.

II. Earths proper.

Alumina obtained pure from alum—its properties—and uses, particularly in agriculture—Sulphate of alumina not the same as alum—Modes of preparing the latter salt—Its various economical uses—Theory of its application in dying.

Silica—its properties—its affinities seem stronger for the negatively than the positively electrical bodies—hence classed by Berzelius among the acids—Its supposed base *silicon*—Its combinations with fluoric acid—with the alkalies and earths—Its uses in glass-making, &c.

The remaining earths zircon, glucine, yttria, and thorina, of rare occurrence—Brief detail of their properties.

3. Ores and the metals they contain.

Arsenic first treated of, as being one of those metals which approach nearest to the simple combustibles—combines with oxygen in several proportions, and becomes acidified—with sulphur forming *realgar* and *orpiment*—with hydrogen in two proportions—*White* arsenic how obtained—reduction of it to a metallic state—Tests of arsenic when taken into the stomach, and cautions necessary in deciding upon the indications afforded.

Selenium, whence obtained—peculiar smell by which it may be recognised—Whether to be viewed as a metal.

Tellurium found alloying gold—Process for obtaining it in a metallic form—its properties, and combinations with oxygen, hydrogen, &c.

Bismuth—its properties and uses—remarkable fusibility it possesses when united with tin and antimony.

Antimony—reason assigned for its name—known at an early period—Medicinal preparations and salts—Ready test of this metal—Agreement of the metals above noticed in being brittle and readily fused.

Cobalt—its properties—Uses in colouring glass and porcelain—Its solution in several of the acids forms sympathetic inks.

Manganese—Chemical nature of its three principal ores explained—Ease with which the oxides of this metal absorb

and give out oxygen—furnishing a ready method of procuring the latter gas—Chamœlion mineral—Other uses of manganese—Mode of separating it from iron.

Chrome—its combinations with lead and iron—its presence imparts a rich colour to the substances with which it is combined—*Chloro-chromic acid* of Thomson—Compound gas composed of chromic and fluoric acids.

Molybdenum—Uranium—Tungsten—their properties briefly detailed.

Titanium—occurs united with iron—discovered in a metallic state in the slag from the copper furnaces of South Wales.

Tantalum—Cerium—Wodanium—their properties briefly noticed—The four last mentioned differ from the preceding in having never been reduced.

Zinc till lately classed among the brittle metals, the mode of rendering it malleable being a recent discovery—Its affinity for oxygen, and other properties—Its ores, viz. 1. *Blende*, 2. *Calamine common*, and, 3. *Electric*, 4. *Red oxide* —Chemical differences of these ores—Salts of zinc—Its uses in making brass and various other alloys.

Cadmium—hitherto found only in the ores of zinc—mode of separating it—and its properties.

Tin—where found—its properties—and uses combined with various metals—Aurum musivum—Test of the presence of this metal.

Lead—its properties—its most important combinations, viz. *massicot—minium—litharge*—Peculiar property of the oxides of lead to combine with every other metal except gold and silver—Its salts—those commonly called *sugar of lead*, and *Goulard's extract* particularly noticed—Tests of this metal—Its principal ores and alloys.

Copper—its properties—two oxides—Its salts, particularly *verdigris*—Ammonia a test of copper—Alloys of this metal employed in the arts—its ores—Modes of reducing them—Poisonous quality of the fumes given out—Plan of purifying the smoke from its noxious ingredients. Sir H.

Davy's method of preserving the copper sheeting of ships from corrosion.

Nickel—whence obtained—its colour, malleability, and ductility—found in all meteoric stones.

Iron—its affinity for oxygen, and other properties—yet occurs in nature in a metallic form—Meteoric iron—This probably the form in which it was first used—Mode of reducing iron from its ores at present adopted—Combinations of iron with carbon and sulphur particularly noticed—Its alloys with various metals.

Mercury—its ores—properties and uses—Chemical difference between *calomel* and *corrosive sublimate*—Its combinations with sulphur—other salts and medicinal preparations.

Silver—in what respect it differs from all the preceding metals—its strong affinity for chlorine—Test founded on this property—Combines readily with sulphur—Its salts and ores—Uses of this metal.

Platinum—Mode of separating it from its ore—Properties of the other metals with which it is alloyed—Properties of platinum—Its uses in the arts—Power which it possesses of inflaming hydrogen by promoting its union with oxygen gas.

Gold, why considered the most perfect metal—its oxides—salts—and alloys—Its principal ores, and the methods of reducing them by expellation—Uses of gold in the arts.

General remarks on the preceding metals—They agree in possessing malleability and ductility.

The subjects comprehended under the heads of Animal and Vegetable Chemistry, as well as certain other parts omitted in the present Syllabus, will be noticed in a subsequent Course of Lectures.

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