+ The double voltaic Tube for decomposition shows this well – filling the Tubes & cistern with dilute solution of Ammonia ties of an alkali; it has an acrid taste, stains turmeric paper of a brown colour, and is a powerful base, neutralizing the strongest acids.

598. When a succession of electric sparks is passed through this gas, it is entirely decomposed; its volume is doubled, and the resulting gases are three volumes of hydrogen, and one of nitrogen; its formula may therefore be given as NH_3, and its equivalent, as 17.15.

599. A weak solution of ammonia is decomposed by the secondary action of the voltaic pile; hydrogen, from the decomposed water, being evolved at the negative, and nitrogen at the positive electrode. But if a portion of mercury form the negative electrode, no hydrogen is evolved, and the mercury is rapidly converted into a light porous substance, having the lustre and all the characters of an amalgam. So unstable however is its constitution that if the current of electricity ceases, it is at once resolved into mercury, two volumes of ammoniacal gas, and one volume of hydrogen. This decomposition is retarded by subjecting the amalgam to an intense cold before discontinuing the current. It may be preserved at zero, and is then found to crystallize in cubes, and to retain its metallic character. (Kane.)

600. *Ammonium.*—This amalgam must be regarded as a compound of mercury, and of these gases, in the above proportions; and as the metals do not form compounds possessing metallic properties, with any other bodies than metals, the existence of a compound metal which has not yet been insulated, and which must be represented by NH_4, is inferred. To this suppositious metal, Berzelius gives the name of *ammonium*. He supposes the volatile alkali to be the protoxide of ammonium, NH_4+O, which is resolved by decomposition into one atom of water, one of nitrogen, and three of hydrogen. This the-

ory places ammonia in the class of metallic protoxides, to which the other alkalies, potassa, soda, and lithia, belong, and is supported by many strong analogies.

601. If this view be correct, it is evident that the protoxide of ammonium is the hydrate of ammonia; such is in fact the constitution of the salts of ammonia with the oxygen acids, of which an atom of water is an essential element.

The real nature of ammonia is a question of much interest and difficulty, and there are other facts which seem to favour a theory that connects it with the series of organic radicals above described.

602. *Amide.*—When the oxalate of ammonia, $(C_2O_3+NH_4O)$ is heated, two atoms of water are disengaged, and a new substance, called *oxamide*, of which the formula is $C_2O_2+NH_2$, is evolved. So, likewise, chloride of mercury, (HgCl), and ammonia, (NH_3), produce chlorohydric acid, (HCl), and Hg, NH_2. One atom of bichloride of platinum, and two of ammonia, produce 2HCl, and $Pl+2NH_2$. It is evident, therefore, that the third atom of hydrogen is not so closely united to the nitrogen, as the remaining two; for the former is separated by the ordinary chemical reactions, but the latter are not disengaged till the ammonia is resolved into its ultimate elements. It is hence concluded, that the real base of ammonia is this bihydroguret of nitrogen, which has received the name of amide, and of which the formula is NH_2, the symbol, Ad, and the number, 16.15.

603. Although amide has not been insulated, it forms compounds with many of the metals and organic radicals. When potassium is heated in dry ammoniacal gas, an atom of water is disengaged, and a fusible olive green solid remains, which is K, NH_2, the amidide of potassium. The amidide

In this case both Nitrogen & Hydrogen must be considered as metals – which have never yet been seen in their separate or isolated state. and at some future day probably Oxygen will be found of the same family.

Amide the base or radicle of ammonia – NH_2 – its symbol Ad.

\+ further particulars of this oxyamide will be presently given

Ammonium

This is the same, or an analogous case to the before referred to, in the combination of sulphur with oxyg.n which it will be recollected will not by any direct process exceed SO_2 – consequently sulph.c acid it wo.d seem is SO_2+O & so of Amide which is the prime radicle consisting of NH_2

while ammonia is NH_2+H
and ammonium NH_2+2H.

+ Its pharmaceutic. name is Hydrargyrum ammoniatum, or ~~ammon~~ Ammoniated Mercury it is only used as an ointment.

of mercury forms compounds with the mercurial chlorides, oxides, and salts, some of which have been long known and used in the practice of medicine. The white precipitate of the shops is the chloride and amidide of mercury; HgAd+HgCl. +

604. Amide combines with many of the organic radicals: its combination with benzule is called benzamide, and with carbonic oxide, oxamide. These compounds differ, in their ultimate analysis, from the benzoate and oxalate of ammonia, in yielding one atom less of water; but they are entirely destitute of saline properties, and are formed by the same change which chlorohydric acid undergoes, when it acts upon a metallic oxide; that is to say, the ammonia parts with its third atom of hydrogen, and benzoic and oxalic acids, with that atom of oxygen which constitutes them acids, thus forming one atom of the new compound, and one of water.

Oxamide is a tasteless, inodorous, snow-white crystalline powder, almost insoluble in cold water, ether, and alcohol, and readily converted into oxalate of ammonia by acids or alkalies, and by heat.

605. *Double nature of Ammonia.*—The phenomena which ammonia presents, are in one respect of a very remarkable, and of what may be called a dimorphous character.‡ When it combines with oxygen acids, its salts, as has been stated, contain an atom of water as an essential element, and are isomorphous with the corresponding salts of potassium; and it exhibits in this respect all the properties of a highly basic metallic protoxide, as strongly as any of the class; and we are led to infer, that in these cases it is the hydrated protoxide of ammonium which enters into combination.

606. On the other hand, ammonia exhibits properties which bring it into close affinity with water, and which remove it entirely from the class of alkalies, with which, in other respects, it is so closely(+) connected.

before mentioned

‡ That is to say, it is almost impossible in our present state of knowledge to say whether ammonia is an oxyd of the Metal Ammonium, or whether it is an amidide of Hydrogen.

-vate & insoluble

Many of the metallic salts copiously absorb dry ammoniacal gas, and form definite compounds, in which ammonia appears to act the part of basic water, or water of crystallization. Thus dry sulphate of zinc is converted into a bulky white powder, perfectly soluble in water, and consisting of $2\,(ZnO, SO_3)+5AdH$. The sulphates of copper, of nickel, of cobalt, and of cadmium, combine with two and a half or three equivalents of ammonia, and form soluble compounds. From some of these the ammonia escapes by mere exposure to the air; in some the salt may be sublimed without change, while in others one portion of the ammonia is more strongly retained than the rest. In these cases, it seems probable that ammonia acts as the amidide of hydrogen, analogous to the protoxide of hydrogen, and not as the protoxide of ammonium.

607. This double nature of ammonia is shown by the decomposition which takes place, when an excess of ammonia is added to a strong, hot solution of nitrate of copper. The ammoniacal nitrate of copper crystallizes in fine, purple, rhombic octohedrons. This salt deflagrates violently when heated to the melting point, and appears to consist of nitrate of ammonia, NH_4, NO_6, and of the amidide of copper, Cu Ad; one portion of the ammonia being resolved into amide, and the other into ammonium.

608. *Salts of Ammonium.*—Of the oxygen salts of ammonia, the nitrate is principally used for the preparation of protoxide of nitrogen. The sulphate is obtained from the liquid products of the distillation of coal, in making coal gas—and is used for the preparation of the chloride of ammonium—or crude sal ammoniac of commerce.

The phosphate of ammonia and magnesia is much used as a flux in blow pipe experiments, and was formerly called microcosmic salt.

The oxalate of ammonia is much used as a test of the presence of lime.

before mentioned

‡ That is to say, it is almost impossible in our present state of knowledge to say whether ammonia is an amide of the Metal Ammonium, or whether it is an amidide of Hydrogen.

⊕ Solutn. of Oxalate of Ammonia to drop into diluted Lime water to show excellent Test for presence of Lime, as oxalate of Lime is white opake & insoluble

+ This compound likewise presents the singular fact of a dense and heavy white crystalline salt, resulting from the mixture of two perfectly invisible gases. For when gaseous ammonia is brought into contact with perfectly dry carbonic acid gas, this solid is formed by 1 equiv.t of Carb.c acid uniting with 1 of Amm.a and is anhydrous, and if mixed with water is decomposed into ammonia, and the sesqui carbonate. —

What is generally called carbonate of ammonia is the ordinary smelling salts used in smelling bottles as a remedy against fainting; and this is now generally considered as a sesqui carbonate of Oxide of the metal Ammonium. It is formed by heating 1 part of Chloride Sal Ammon.c with 1½ part of well dried carbonate of Lime. when chloride of Calcium will remain in the retort, and hydrated sesqui carbonate of Ammon.a is sublimed. The Water in this case comes from the combination of the oxygen of the Lime with the Hydrogen of the Chlorohydric Acid. When recent it is hard compact, translucent, crystalline and very pungent in odour, but by keeping (if exposed to air) it loses ammonia & weight, & its pungent smell – it shake & pulverulent & is converted into Bi-Carbonate

From Count Cinchon of Peru, whose lady first used the Bark on recommend.n of Indians & he afterwards introduced it into Europe where it was administered by Jesuits & hence obtained their name. Quinia was Indian name for the Tree producing this Bark

Show this explosive compound by touching the filtering papers on which it is deposited, having been previously made

With carbonic acid, ammonia forms a neutral anhydrous carbonate, NH_3CO_2, and a bicarbonate. The constitution of the latter is NH_4O, CO_2+HO, CO_2. By the union of these in various proportions, several complex varieties of the carbonate are formed.

609. *Amide and the Salt Radicals.*—When ammonia is made to act on the salt radicals, and on some of the metallic oxides, certain compounds are formed of so unstable a constitution, that the slightest molecular agitation is sufficient to decompose them, with violent detonation. The extreme danger of examining and handling these preparations, has prevented their accurate analysis, but from the similarity of their properties, it is probable that the ammonia used in their preparation, undergoes the same change in all, and exists in the condition of amide, feebly combined with a salt radical, or a metallic oxide.

As traces of sal ammoniac are perceived when it is decomposed, it must contain hydrogen; and it is highly probable that it is a chloride of amide.

610. *Terchloride of Nitrogen.*—This compound is prepared by exposing a solution containing a 16th part of chlorohydrate of ammonia, to the action of chlorine gas. Minute yellow globules of the chloride soon begin to collect at the bottom. It is one of the most explosive compounds known. Its sp. gr. is 1.653. It does not congeal at zero of Fahrenheit; it may be distilled at 160°, and explodes with great violence at 212°, as well as by the mere contact of combustible substances.

With iodine and bromine, ammonia forms similar compounds; that with iodine is a brown powder, which explodes under water by friction.

611. *Fulminating Compounds with the Metals.* When the fresh prepared oxides of silver, gold, platinum, mercury, and copper, are digested in water of ammonia, an insoluble powder is formed, which

nothing but Morphia or Morphine remains in it & this can be taken without unpleasant consequences detonates with friction; and in the case of silver, and gold, with extreme violence. The composition of these bodies is uncertain. They yield hydrogen and nitrogen in the proportions to form ammonia, but it is evident that so stable a compound as ammonia, cannot, *as such*, enter into their composition.

SECTION IV.

THE ORGANIC ALKALIES.

612. The researches in organic chemistry have brought to light a multitude of proximate principles, which are secreted during the life of the plant or animal, and which are, in most cases, peculiar to the species or genus in which they exist. The most remarkable of these proximate principles is a series of organic alkalies, to which the plants that contain them owe their active medicinal properties. They all contain nitrogen, and all act as bases, neutralizing the strongest acids, and forming with them neutral crystalline salts, retaining the peculiar power over the animal system which the base itself possesses. The most remarkable of these alkalies are those found in the cinchonas, in the poppy, and the nux vomica. These alkalies exist naturally in combination with organic acids, peculiar, like themselves, to the plant.

613. Three distinct, but closely allied alkalies are obtained from the cinchonas.

Cinchonia, of which the formula is $NC_{20}H_{12}O$, exists in the red and gray bark; quinia or quinine, $NC_{20}H_{12}O_2$, in the yellow bark; and aricina, $NC_{20}H_{12}O_3$, in the aricara bark, a tree closely allied to cinchona. These alkalies are all soluble in alcohol, and nearly or altogether insoluble in cold water; their taste is intensely bitter, and they crystallize in brilliant needles or prisms. They appear to be the

+ This branch of Improvement in operative chemistry is <u>alone</u> sufficient to stamp a value upon chemical Science, even if it had done no more, for it has brought about a complete revolution in that branch of the Science of Medicine called Therapeutics, or the preparation & administration of medicines with a view of availing ourselves of their curative properties, which has not only proved highly important, but has contributed in no small degree to the relief and comfort of the invalid. – The Barks of certain trees which grow in Peru & other parts of South America were discovered to be highly beneficial in the cure of intermittent fevers, and were accordingly swallowed in large quantities under the name of powdered peruvian Bark, constituting a most nauseous & disagreeable draught, which is never now resorted to; because modern chemistry has discovered that the whole medicinal virtue of the Bark resides in a salt which can easily be extracted or separated from it, and which is called quinine, 3 grains of which can be swallowed in a pill without tasting it, and yet this small quantity produces the same effect on the animal frame as a whole ounce of the Bark as formerly administered. also <u>Salicine</u>

So likewise with opium, which altho invaluable as a sedative, for relieving pain, yet on some constitutions it produced such dreadful consequences that the remedy proved worse than the disease & it can not therefore be used. – But chemistry has discovered that Opium contains two distinct principles called Morphia & Narcotine which are separable from it either in a separate or conjoined state so that Opium can be denarcotized or deprived of its narcotine, and then nothing but Morphia or Morphine remains in it & this can be taken without unpleasant consequences

‡ To make it (Kane p 624) Boil the bark in 9 or 10 times its weight of water to which 2 parts of muriatic acid had been previously added – When the liquor will dissolve no more, cool and strain it; Then add quick lime in very fine powder untill the whole has a decided alkaline reaction. A precipitate will fall & must be collected on a linen cloth & dried. – This precipitate is then boiled in Alcohol wh dissolves out all the Quinine & cinchonine – Add water & distill off the alcohol to save it – The residue is then rendered neutral by dilute Sulphc acid, and on evaporation Sulphate of Quinine will be left.

Describe what opium is & how obtained from Seed Capsules of white Poppy. Opium contains a Gum a Resin a fixed oil, extractive or colouring matter, besides several other proximate principles. One of the most common modes of administering it is in the form of a Tincture called Laudanum – (Explain difference of Tinctures & Infusions) Laudanum cannot be made of pure Alcohol, but requires it to be considerably diluted with water. (explain why) – The above proximate principles contain morphia – narcotin, meconia, meconic acid, of which morphia is the most important & valuable – In 1829 – 100*000 worth of opium entered this country from [illegible] alone.

+ The colouring matters here referred are those obtained from organic products, and therefore doth not include an examination of colours generally, such as are used in the several varieties of painting, for most of these are what are called mineral colours, being produced by [illegible] inorganic compounds, such as the Metalic Oxides, [illegible] as Red Lead white Lead, Chrome Yellow & Green, Vermillion Verdigris, Oxides of Iron &c including the Ochres – and most of these have what is called a body, or are solid & opake & therefore conceal the wood canvass or other substance on which they placed. – The Dyeing and printing of woven goods such as pieces of Linnen Cotton or Woollen Cloth & Silk on the contrary is brought about by Thin or Transparent Colours or Stains, and these are generally Vegetable colour matter, or combinations of organic & Inorganic Matter – Explain Dyeing & Callico printing – The Blocks or rollers – colours mixed with paste. The difference between ingrain & piece dyeing by Salvage &c –

East Indias & Sou

principles to which peruvian bark owes its febrifuge virtues, and the disulphate of quinine, Qu_2SO_3+8Aq, is extensively manufactured for medicinal purposes.

614. *Morphia*.—The narcotic virtues of opium are due to various alkaline principles, which have been obtained from it by the action of acids, and of alcohol. It seems probable that some of these are secondary products, and that they do not exist in the plant itself. The most important of these alkalies is morphia, the chief narcotic principle of the poppy. Morphia is almost insoluble in cold water, but dissolves freely in alcohol. Its solution is intensely bitter to the taste, and strongly alkaline. Morphia neutralizes the strongest acids, and forms soluble crystalline salts. It colours nitric acid red, forms a copious white precipitate with tannic acid, and a rich blue liquid with sesquichloride of iron. Its formula is $NC_{35}H_{20}O_6$. Its chlorohydrate, acetate, and sulphate, are much used in medicine as substitutes for opium.

615. *Strychnia*.—The nuts of the various species of the genus strychnos, are intensely poisonous, and owe their power to two alkalies, strychnia and brucia. Strychnia is the best known of these; it has an intensely bitter, somewhat metallic taste, and renders 700,000 parts of water strongly bitter. It is nearly insoluble in ether, absolute alcohol, and water, but dissolves readily in spirits of wine. It forms soluble crystalline salts, and is one of the most intense poisons known to us. Its formula is $N_2C_{44}H_{24}O_4$.

Nux Vomica

Nicotia or the active principle of Tobacco.

by some white Indigo
radicle and Blue
Dumas on the contrary

sulphate of arsenic in
and digest Indigo in
metallic sulph. attenu
comes green and is
out green, but
xygen of atmosphere
ly powdered & in the
then becomes soluble
t may be so for
tic effects of the

SECTION V.

COLOURING MATTERS.

616. *Indigo*.—One of the most remarkable nitrogenous products of vegetation, is indigo. It is se-

‡ To make it (Have f…
of water to which …
added – When this …
it; Then add quick…
has a decided al…
must be collected on…
then boiled in alcoho…
cinchonine – add…
it – The residue is …
acid, and on evap…

Describe what or…
Capsules of white…
a fixed oil, extrac…
other proximate …
modes of administ…
called Laudanum…
& Infusions) Laud…
Alcohol, but requ…
water. (explain why,…
morphia – narcotin,…
is the most impor…

+ The colouring m…
from organic pro…
an examination of…
the several varie…
what are called …
inorganic compoun…
as red lead white…
Verdigris, oxides of…
most of these …
solid & opake & …
other substance on…
printing of woven …
Woollen Cloth & Silk …
Thin or Transpare…
Generally Vegetable …

creted in the cellular tissue of various plants, and so long as the tissue remains perfect, it is colourless. But when the leaves begin to wither, the indigo absorbs oxygen, and acquires a blue colour. It is prepared by placing the leaves in large vats, in which they undergo a species of fermentation, and yield a yellow liquor, which contains the indigo. This is mixed with lime water, and the indigo slowly absorbs oxygen, becoming blue and insoluble. As thus prepared, indigo is a mixture of various bodies, from which it may be obtained by sublimation, as a rich purple vapour, which condenses into brilliant, purple, prismatic crystals, of a metallic lustre. The formula of this pure indigo is, $NC_{16}H_5O_2$. By the action of deoxidizing agents, indigo loses its blue colour, and becomes soluble in alkaline solutions.‡ This colourless indigo is a compound of blue indigo with an atom of hydrogen, and it recovers its blue colour and insolubility, by the absorption of an atom of oxygen from the air. It may be prepared by mixing $1\frac{1}{2}$ parts of indigo, $2\frac{1}{2}$ of slaked lime, and 2 of sulphate of iron, with 60 of water, in an air tight vessel. The oxide of iron decomposes the water, the hydrogen of which combines with the indigo, rendering it colourless and soluble. Chlorohydric acid precipitates the white indigo from this clear solution, as a crystalline white powder. When cloths are dipped in this solution, the colourless indigo is precipitated in the fibre, and regains its blue colour in the air.

617. Indigo dissolves in sulphuric acid;+ and the solution retains the brilliant colour of the indigo, and this is much used in dying by the name of Saxon blue. There appear to be two acid sulphates thus formed, one of which, called the *sulphopurpuric acid*, contains two atoms of each of its elements; and the other, the *sulphindylic acid*, is a bisulphate of indi-

& Inorganic Matter – Explain dyeing & Callico printing. The Blocks or rollers – colours mixed with paste. The difference between ingrain & piece dyeing by Salvage &c.–

‡ show … Show this … + by …

several Plants - the Indigofera of East Indias & Sou Am^n. but it will grow here

‡ when it is called Indigogene or by some white Indigo Liebig considers this as the radicle and Blue Indigo as its oxide; but Dumas on the contrary asserts that

Show this prepare

For dying woollen cloth, Dissolve sulph^t. of arsenic in hot solut^n. of Caustic potassa, and digest Indigo in fine powder in the solutn - the metallic sulph^t. attracts oxygen from the Indigo which becomes green and is dissolved - Cloth dipped in this comes out green, but soon turns blue by exposure to oxygen of atmosphere

+ by heat and long digestion, being previously powdered & in the proportion of 1 to 8, and it then becomes soluble in water, and in this state it may be so far diluted as to destroy the caustic effects of the acid while

‡ Liebeg says Indigo in small fragments is heated with 10 times its weight of strong nitric acid - It evolves much nitrous acid vapor & is dissolved - It is boiled and Nitric acid added as long as any red vapors are disengaged. On cooling a large quantity of semi transparent yellow crystals is deposited - Wash them in cold water & redissolve in hot to purify

+ One important colouring matter in the vegetable Kingdom is passed unnoticed - This has been called Chlorophyle, and it gives the green colour to the leaves and other parts of plants - It becomes yellow and red in Autumn by absorbing oxygen and becoming acid, thus producing the change that occurs in the fall of the year - This is proved by the red leaves becoming green again by the action of an alkali strong enough to neutralize the acid go; both of these acids form neutral salts with a single atom of alkali.

618. *Carbazotic Acid.*—By the action of acids and alkalies, indigo is resolved into several new compounds, the most important of which is the picric, or carbazotic acid. This acid is formed by the action of nitric acid on indigo; it crystallizes in brillant yellow prisms, explodes by the action of heat, and forms detonating salts. Its taste is intensely bitter, and it forms an almost insoluble salt with potassa, which renders it one of the most delicate tests of that alkali. The formula of carbazotic acid is $C_{14}H_4NO_9+Aq$.

619. *Red Colouring Matters.*—The principal red dyes are those obtained from the cochineal insect, brazil wood, log-wood, the roots of the madder, the flowers of the carthamus, and the resin of the lac insect. The colouring matter of all these substances is obtained in a solid form by dissolving them in a solution of alum, and precipitating the alumina by means of an alkali. The colouring matter falls in combination with it, and the precipitate when dried is known by the name of lake. These lakes are also obtained by means of chloride of tin, which forms richly coloured solutions, from which the colouring matter may be precipitated in combination with oxide of tin, by an alkali.

620. All the tints of the dyers may be produced by the combination of four principal colours, black, red, yellow, and blue.

The chief yellow dyes are the quercitron, or black oak bark, turmeric, fustic, and saffron. Black is produced by the pergallate and pertannate of iron.

621. *Mordants.*—Many of these colouring matters have so strong an affinity for wool, silk, and flaxen, and cotton fibre, that they do not wash out from the cloths that have been died with them.

Others again have so little affinity for organic fibre, that they readily wash out. These colours can be made fast colours, by first dipping the material to be dyed, in a solution of alum, or some other salt, the base of which has an affinity both for the fibre and colouring matter, which are thus made to enter into a permanent combination. A salt of this kind is called a *mordant* or basis; colours which adhere to cloth without a basis, are called *fast* or *substantive colours;* those which require one, *adjective* colours.

Section VI.

NEUTRAL NITROGENOUS COMPOUNDS.

A few colourless substances, possessing neither acid nor basic properties, are here grouped together.

622. *Asparagine.*—This proximate principle is contained in asparagus, the marsh mallow, and liquorice. It crystallizes in a rectangular octohedron, and in hexahedral prisms, is inodorous, and has a slightly cool, nauseous taste. It is soluble in water, but insoluble in ether and alcohol, and has no affinity for either acids or alkalies. Asparagine is resolved into a peculiar acid, termed the aspartic acid, and into ammonia, by being boiled with hydrated oxide of lead or magnesia, and it bears the same relation to this acid, that urea bears to cyanic acid. Anhydrous asparagine consists of $C_8H_8N_2O_6$, and aspartic acid of $C_8H_5N_1O_6$, so that the former is isomeric with aspartate of ammonia, $C_8H_5N_1O_6 + H_3N_1$, yet alkalies do not evolve ammonia, nor acids, aspartic acid, from asparagin. Crystallized asparagin, contains two atoms of water.

623. *Caffeine, Theine.*—One of the most remark-

+ The mordaunt not only thus fixes the colour, but frequently heightens it and makes it more beautiful. The usual mordaunts are ~~[illegible]~~ Aluminous earths and oxide of Iron. As an instance of elevating the colour, Scarlet and ~~[illegible]~~ madder red may be noticed. Dip a piece of cotton cloth into decoction of Madder & it will come out of a dirty red colour neither handsome or permanent - But wet the cloth with weak acetate of Alumina & dry it at a high temperature & then washed (strong) a portion of the Alumina will be retained in chemical combination with the fibres of the cotton - and if now introduced into Hot decoction of Madder, & again washed, it will be found of a beautiful & permanent red colour owing to the chemical combination that will have taken place between the alumina & the colouring mat of the Madder. If oxide of Iron had been used as the mordaunt instead of alumina, the cloth wo^d have been dyed purple

Cochineal Insect
carmine is from it.
Lac Insect color only from Stick or Seed Lac
madder Rubia Tinctoria
Brazil wood Cæsalpina of West Indies
Log wood Hæmatoxylon Campechiana
Carthamus or Safflower Dyers Saffron is different from Crocus or True Saff^n
Saffron Rouge Stick

Fustic - Morus Tinctoria of West Indies & S Am^a
Turmeric root of Curcuma Longa of E Indies

⋕ Litmus, chemical Test from Litchen Rocella

^ viz 29 per cent or nearly 1/3rd

+ It is singular that Piperine is both Tasteless and Inodorous, and it is destitute both of Acid and Basic properties.

able coincidences, which the researches in organic chemistry have brought to light, is the absolute identity of the active principle of the tea plant, and the coffee berry; two plants, which, although natives of countries remote from each other, and brought into use by nations of the most opposite habits, have become, from a sort of instinctive relish, the favourite beverage, and almost a necessary of life, with civilized man in all climates. *Caffeine* crystallizes in long brilliant needles, of a rich satiny lustre. It has a purely bitter taste, is soluble in water, has neither acid nor basic reaction, and contains more nitrogen than any other vegetable product. Its formula is $N_2C_8H_5O_2+Aq$.

A nitrogenous resinous product, called *piperine*, is extracted from the various species of pepper. Its formula is $NC_{34}H_{19}O_6$.

Section VII.

THE ANIMAL FLUIDS.

624. The principal elements of the animal fluids have been stated to be fibrine, caseine, and albumen. They form the materials from which the tissues and skeleton of the living being are supplied with new matter. These, in conjunction with gelatine, and various earthy and alkaline salts, compose the animal structure.

625. *Blood.*—If fresh drawn blood be made to trickle over a plate of silver heated to 140°, it dries to a red, glossy, brittle mass, which yields by analysis, precisely the same proportions of nitrogen and hydrogen, carbon and oxygen, as proteine, so that the blood contains in a liquid form the identical constituents of flesh and cellular tissue. The specific gravity of blood is 1.055. When it is allowed to rest

it separates into a yellow liquid, called the serum, and a gelatinous red mass, called the clot or cruor. If it be examined under a microscope, blood will be found to consist of a multitude of red globules, floating in a nearly colourless liquor. These globules are circular or oval flattened discs, varying in different animals from $\frac{1}{5000}$ to $\frac{1}{1000}$ of an inch in diameter. They consist of a central colourless albuminous nucleus, surrounded by a membrane, which is coloured red by a peculiar principle, called *hæmatosine.* These red globules, along with the fibrine and a large portion of the albumen, form the coagulated mass, called the cruor. Lecanu found the blood to contain 13.3 per cent. of blood globules, .21 of fibrine, 6.51 of albumen, .67 of fatty and extractive matters, 1.05 of alkaline and earthy salts, and 78.26 of water and loss. Hæmatosine is a dark brown, tasteless, inodorous mass, which is insoluble in ether, alcohol, and water, but which forms blood red solutions with alkalies, and a rich permanent dye with bichloride of mercury. It constitutes but 4 or 5 per cent. of the red globules; and its formula, according to Mulder, is C_{44} H_{22} N_3O_6Fe.

+ It is singu
Inodorous,
Basic pro

626. *Milk.*—This fluid, in addition to caseine, contains sugar and oils, which like the analogous vegetable secretions, are destitute of nitrogen. The caseine exists in milk in two conditions, soluble and insoluble; the former remains in the milk, the latter separates with the cream. By contact with caseine, sugar of milk is converted into lactic acid. Berzelius found cream from cow's milk to consist of 4.5 per cent. of butter, 3.5 of caseine, and 92 of whey. Skimmed milk contains 2.6 per cent. of caseine and butter, 3.5 of sugar of milk, .6 of extractive and lactic acid, .17 chloride of potassium, .255 of earthy and alkaline phosphates, and 92.875 of water.

627. *Mucus and Gastric Juice.*—The internal surface of the alimentary canal, is kept constantly

it separates into a yellow liquid, called the serum, and a gelatinous red mass, called the clot or cruor. If it be examined under a microscope, blood will be found to consist of a multitude of red globules, floating in a nearly colourless liquor. These globules are circular or oval flattened discs, varying in different animals from $\frac{1}{3000}$ to $\frac{1}{1000}$ of an inch in diameter. They consist of a central colourless albuminous nucleus, surrounded by a membrane, which is coloured red by a peculiar principle, called *hæmatosine*. These red globules, along with the fibrine and a large portion of the albumen, form the coagulated mass, called the cruor. Lecanu found the blood to contain 13.3 per cent. of blood globules, .21 of fibrine, 6.51 of albumen, .67 of fatty and extractive matters, 1.05 of alkaline and earthy salts, and 78.26 of water and loss. Hæmatosine is a dark brown, tasteless, inodorous mass, which is insoluble in ether, alcohol, and water, but which forms blood red solutions with alkalies, and a rich permanent dye with bichloride of mercury. It constitutes but 4 or 5 per cent. of the red globules; and its formula, according to Mulder, is $C_{44}\ H_{22}\ N_3 O_6 Fe$.

+ It is singu… Inodorous, Basic pro…

626. *Milk.*—This fluid, in addition to caseine, contains sugar and oils, which like the analogous vegetable secretions, are destitute of nitrogen. The caseine exists in milk in two conditions, soluble and insoluble; the former remains in the milk, the latter separates with the cream. By contact with caseine, sugar of milk is converted into lactic acid. Berzelius found cream from cow's milk to consist of 4.5 per cent. of butter, 3.5 of caseine, and 92 of whey. Skimmed milk contains 2.6 per cent. of caseine and butter, 3.5 of sugar of milk, .6 of extractive and lactic acid, .17 chloride of potassium, .255 of earthy and alkaline phosphates, and 92.875 of water.

627. *Mucus and Gastric Juice.*—The internal surface of the alimentary canal, is kept constantly

Lacteals Lymphatics Thoracic Duct

Describe how Blood formed & what becomes of it, or how distributed thro' system & its several purifications

abt. 1650
Describe Harveys discovery of circulation & what occurs in Lungs

The heart with its Ventricles & Auricles

The thoracic duct &c.

moist, by a thick tenacious mucus, closely resembling the solution of *cerasine,* but containing nitrogen. When any substance is introduced into the stomach, there is copiously secreted, in addition to the mucus, a ~~colourless~~ pale yellow liquid called the *gastric juice.* This fluid contains about two per cent. of common salt and sal ammoniac, and a portion of free chlorohydric acid, and possesses the remarkable property of softening the food, and converting it into an uniform gray pulp, called *chyme,* from which the absorbent vessels take up the nutritious portions. It owes this property to the presence of an organic principle, called *pepsine,* which excites, in the food that enters the stomach, a true fermentation, converting it into chyme, by communicating to it the molecular change which its own particles are undergoing, in the same manner as ordinary ferment gives rise to the changes which convert sugar into alcohol.

628. *Bile.*—As soon asthe *chyme* has passed from the stomach, it receives the addition of *bile,* a liquid which distils drop by drop from the gall bladder into the intestinal canal, and which converts the chyme into *chyle.* This is an opaque, white, milky fluid which contains the same elements as blood, and is collected from the innumerable vessels, at the extremity of which it is taken up from the intestines, and poured into the venous blood before the latter returns to the heart. The bile, which thus converts the digested food into *chyle,* is secreted by the liver from the venous blood which passes through it in the course of circulation. It is a fluid of a greenish yellow colour, which contains 91.5 per cent. of water, united with resins, a fatty acid, soda and common salt. The principal element of bile is the *choleic acid,* which is a bitter, yellowish white, brittle mass, soluble in ether and alcohol, and forming soaps with alkalies. It exists in the bile in combination with

soda, and its formula, according to Liebig, is $C_{76}N_2 H_{66}O_{22}$.

629. *Urine.*—As it is the office of the liver to abstract from the venous blood, in the shape of bile, all excess of carbon which it contains, so it is the function of the kidneys, to separate from the arterial blood, all the products which are rendered unfit for circulation by containing an excess of nitrogen. None of the animal fluids is subject to such changes in its constitution, from age and disease, as the urine. In a healthy person it contains 93.3 per cent. of water, 3 of urea, 1.7 of lactic acid, .1 of uric acid, and nearly 2 per cent. of alkaline and earthy phosphates and sulphates, and common salt.

630. *Urea.*—Urea is obtained in brilliant white quadrangular prisms. It is an inodorous, neutral substance, of a nitrous taste, soluble in water, and producing great cold during its solution. Its formula is $N_2C_2H_4O_2$. The solution of urea in pure water continues long unaltered; but if any ferment is present, a change of constitution takes place, it appropriates to itself four atoms of water, and is converted into 2 atoms of carbonate of ammonia; $N_2C_2H_4 O_2+H_4O_4$, becoming $2(CO_2+NH_4O)$. Urea is isomeric with cyanate of ammonia, NC_2O+NH_4O; and may be artificially prepared by mixing solutions of cyanate of silver, and chlorohydrate of ammonia. Chloride of silver is precipitated, the remaining solution does not yield cyanic acid with acids, nor ammonia with alkalies, but crystallizes into quadrangular prisms identical with urea.

631. *Uric Acid.*—This acid is found in the urine of carnivorous animals, and in the dry white excrement of serpents. The latter consists chiefly of urate of ammonia. Pure uric acid is white, tasteless, inodorous, and very sparingly soluble in water. It reddens litmus paper and forms crystalline salts. Its

Having thus gone thro the subject of Chemistry it now only remains to show how the principles already taught may be applied to the examination of different substances which is called analysing them, and to examine into the nature of analysis and what things can and what cannot be analysed.

formula is $N_4C_{10}H_4O_6$. The bony concretions, which are formed in the joints in gouty patients, consist of urate of soda.

By the action of nitric acid, uric acid undergoes a series of very remarkable changes, giving rise to compounds of great interest in a theoretical point of view, and some of them possessing singular beauty of colour.

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PART THIRD.

THE HISTORY OF CHEMICAL PHILOSOPHY.

CHAPTER I.

THE CHEMICAL KNOWLEDGE OF THE ANCIENTS.

632. Although the science of chemistry bears every mark of being upon the eve of great changes, which will separate its future from its present, by even a wider interval, than separates its present from its past conditon, there is perhaps no example in the whole range of science, of clearly demonstrated doctrines, more contradictory in appearance to all our ordinary conceptions, than are to be found in its domain. The present is separated from the past, the scientific view, from the popular notions, by so wide a gulf, that the study of chemistry would be deficient in some of its most instructive lessons, if we were to omit the history of its rise and progress.

633. This science being the developement of the laws which govern the mutual action of bodies, and the changes consequent upon their intermixture, the elements of a rude chemistry must have existed in the earliest ages, as soon as men began to explore the material world around them, and to apply to their own use the qualities which they thus discovered. We must suppose that many of the early

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Why must a certain rude chemistry have existed, even without its being known to exist from the beginning of society.?

Murex
Tyrian Purple of Romans from Murex
Staining of Glass

ancients ignorant of Theory

Difficulty of identifying Ancient names

Aurum Argentum Cuprum Ferrum
Plumbum Stannum & Hydrargyrium
also Stibium or antimony

discoveries were the result of accidental combinations; and yet the knowledge which the fathers of mankind acquired, and the arts they practised, seem more like the results of a wisely directed instinct, which is but another name for the inspiration of superior power, than the slow and irregular advances of blind chance and necessity; so greatly are they superior to the arts known to those branches of our race, who having lost the traces of that original knowledge, and sunk into a barbarous ignorance, have been compelled to toil up the steep and almost inaccessible paths, which lead back to industry and civilization.

634. It is difficult, perhaps impossible, to ascertain the exact extent to which the ancients practised the chemical arts. Of chemical theory they were absolutely ignorant; but they could not fail to become acquainted with the more common and useful metals, to discover many of the salts which exist in a state of nature, and to apply their properties in some of the various processes and manufactures with which they were acquainted.

635. We cannot, in many cases, determine the substances designated by names which we now apply to familiar and well known objects; objects, which, we are apt to think, have always been so called, while in fact the names are of far greater antiquity than the discovery of the substances themselves, and have been variously applied according to the state of the arts and civilization. In the ancient languages, moreover, there are many terms for which we have no modern equivalents, or of which the only translation that can be given is conjectural; so that at every stage of the inquiry into the arts and knowledge of the ancients we meet with doubts and difficulties not easily to be resolved.

636. Seven metals were known to the Greeks and Romans, viz. gold, silver, copper, iron, lead, tin, and

mercury. Of these, the first five appear to have been known to mankind in the earliest ages. There seems little doubt that gold was the first of these metals which attracted the attention of man. Being found in masses of sufficient magnitude to exhibit its properties of fusibility, malleability, and ductility; its beauty of colour, its brilliancy, and unalterability by the air and by fire, rendered it an object of universal admiration and eager desire. Its discovery must be regarded as an era in the history of the arts, for it possesses properties so peculiar, and so useful, so different from most of the rude materials which met their gaze, that men must have had their curiosity strongly excited, to learn whether there were any other substances possessing similar qualities of fusibility, ductility, and malleability. The discovery of silver, of copper, and of iron, metals which are occasionally found native, was probably the first fruits of this search; if indeed it was not accidental, and contemporaneous with that of gold, for we know that these metals were in use before the flood. It is not an unlikely conjecture, that the accidental presence of some of the ores of these metals in the vessels in which the operation of melting was performed, or in the ground where a great fire had been kindled, led the way to the knowledge, that there were stony substances from which these precious materials could be extracted. The presence of native silver and copper in frequent association with stones of certain characters, was a sufficient indication of their existence in these ores. As no mineral substance was more likely to excite their attention from its weight and metallic lustre, or would sooner reward their labour by yielding up its metal, than galena, it is a very natural conjecture, that the discovery of lead was one of the first fruits of these rude investigations. The frequent union of the ores of iron with those of copper, would soon lead to the discovery of

Gold found in metallic State

Found native ? explain

Galena ? explain – used by Galen

Tubal Cain taught the art of working in Iron

24 Mistake of author copper will not harden by fire, but by Hammering & compression. —

In all relics of ancient metals, no Iron found

Q? may not this be from its very perishable nature the art of obtaining that metal, if its accidental production by fire in the way pointed out, be not more probable.

637. Gold and silver were melted, and cast, and hammered, into various forms; and were also beaten into thin plates, which were used in covering wood and other materials. The extreme thinness which has been given to those metals by modern goldbeaters, is, however, an art of recent date.

638. The Egyptians, before the time of Moses, knew the process for hardening iron, so as to render it fit for axes and other cutting tools. Five hundred years later, however, the use of copper for these purposes still continued among the Greeks, who had no other swords, at the time of the Trojan war, than those made of copper hardened by fire.

They afterwards learned the property which iron possesses, of being welded, and knew the art of converting that metal into steel. But it is a remarkable proof of the looseness of their habits of observation, that both the Greeks and Romans attributed the hardening of soft iron by sudden cooling, to a peculiar property of certain waters, which acquired thereby extraordinary celebrity. Like most of the arts and learning of the age, the knowledge of iron was brought from the East, and the word Chalybs was the name of a tribe on the Euxine, from whom the Greeks learned the use of the metal, just as our term for all the finer kinds of pottery, is an acknowledgment that we derived the art of making them from the Chinese.

639. The name Stannum, which we translate Tin, and which was, without doubt, subsequently applied by the ancients to that metal, appears to have originally denoted an alloy of lead and silver, from which the art of separating the more precious metal was unknown. The tin of ancient commerce was procured by the Phenicians from Spain and Britain,

welding
making Iron into the
Steel not being an
original metal

Process of hardening

Chalybeate Spring
& Medicine,

the inexhaustible mineral riches of the latter country having been thus early known.

The ancients alloyed copper with lead and tin, and carried to great perfection the art of casting statues of bronze, which was an alloy of these metals in various proportions.

640. Although ignorant of the existence of zinc as a peculiar metal, they were well acquainted with the alloy of that metal and copper, and with the ore of zinc, called calamine, which was used then, as it is now, for obtaining brass.

641. Lead was in common use among the Egyptians in the time of Moses. Like tin, it was chiefly furnished by the Phenicians, who obtained it from Spain and Britain. It was beaten into thin sheets, as at present, and was cast into pipes for the conveyance of water.

642. Mercury was found in the mines in its native state, and was also obtained from cinnabar. It is not mentioned by Moses, or by Herodotus, so that its discovery is probably of later date than that of the other metals, of which we have been speaking. The ancients knew that it dissolved gold and silver, lead, copper, and tin, and applied it to the purpose of gilding, in the same manner as is now done.

643. It seems probable that Bismuth was occasionally seen by the ancients, but that it was not distinguished by them from tin or lead.

644. The sulphuret of antimony was used by the Asiatics, as it is to this day, for blackening the eye brows, and what is not a little singular, the term alcohol, now used only for spirits of wine, was originally applied to this powder. The red and yellow sulphurets of arsenic were known as pigments. The black oxide of manganese was employed, as now, by the ancient potters, without its being known, however, that it contained a distinct metal.

645. The ancients were acquainted with many

Bronze Statues

Cinnabar ?'

Metal gilding will be
hereafter explained

read

welding
making Iron into Steel
Steel not being an
original Metal

Process of hardening

Chalybeate Springs
& Medicines

other pigments prepared from the metals, such as red and white lead, cinnabar, the ochres, and the blue and green carbonates of copper. They were acquainted with alum, and copperas, and knew their use in dying. The Egyptians knew the art of calico printing, and the nature of mordants, for Pliny describes with great clearness the process still employed in India for printing in colours. "There exists in Egypt," says he, "a wonderful method of dyeing. The white cloth is stained in various places, not with dye stuffs, but with substances which have the property of absorbing colours. These applications are not visible upon the cloth; but when they are dipped into the hot caldron of the dye, they are drawn out, an instant after, dyed. The remarkable circumstance is, that though there be only one dye in the vat, yet different colours appear upon the cloth; nor can the colour be afterwards removed."—*Plinii Hist: Nat.* xxxv. 11.

So great a degree of skill implies a considerable knowledge of dyeing materials, and of mordants.

646. Nitre was discovered in India and China, and the explosive mixture which it forms with sulphur and charcoal was known in the latter country before the Christian era, although it was not applied to the purposes of war. It is altogether uncertain when this salt was introduced into Europe, but the nitre of the Greeks and Romans was natron, the mineral alkali, and they knew nothing of the modern nitre. Natron was used by them in the manufacture of glass.

647. This material was known to the ancient Egyptians, and was probably an accidental and often made discovery, for the chance to which it is attributed must often have happened. Some Phenician merchants, it is said, landing near Berytus in Syria, with a cargo of natron, and having nothing wherewith to support their kettles, while they were dressing their

Ochres Yellow
red - umber
Terra De Sienna

- Mordaunts?

or Salt Petre, because obtained from Stones or πετρα

Natron now called Soda

how was Glass discovered?

food, took lumps of the natron for that purpose; the fire melted the salt, and fused it and the sand of the shore into glass. The Egyptians coloured their glass with various metallic oxides, and formed it into vessels, and vases, and beads. The principal use made of it by the Phenicians, was for plates to line the walls and ceilings of their apartments.

648. The art of making soap was practised by the ancient Germans and Gauls, but was known neither to the Greeks nor Romans till the time of the Roman emperors, when soap came into use as a pomatum.

The only acid known to the ancients, was the acetic, as obtained by fermentation.

They manufactured stone and earthen ware, and porcelain of a fine quality. They knew the use of calcined plaister of Paris in taking moulds, and prepared a mortar which hardened under water.

Wine was universally known, and the Egyptians made a fermented liquor of barley. Beer was the favourite national drink of the Gauls and Germans. There is, however, no evidence that the ancients had any knowledge of the art of distillation.

649. Such seems to have been the amount of knowledge possessed by the ancients in these particulars. That knowledge remained for a long time nearly stationary, and it was not till the conquests of the Saracens overturned the old, and laid the foundation of a new order of society, that it began to advance. These conquests, by infusing new vigour into the decaying institutions of Europe, and mingling the learning of the east with that of the west, revivified industry and commerce, and created anew the chemic arts.

Ochres yellow
red - Umber
Terra De Sienna

- Mordaunts?

} Soap when discovered
& known

Acetic or Vinegar

Beer used

Ancients unacquainted
with distillation

or Salt Petre, because
obtained from Stone
or πέτρα

Influence of the
Crusades

Natron now called
Soda

how was Glass
discovered?

The Moorish dynasty in Spain was enlightened – 70 pubn Libraries

6000 Students at Bagdad.

CHAPTER II.

THE ALCHYMISTS.

650. The Saracen caliphs of Bagdad and Spain, were the great patrons and restorers of the learning of the middle ages. The caliphs of Cordova, from the eighth to the tenth century, and more especially the three Abdalrahmans, and Alhakem, carried the splendour of their monarchy to the highest pitch. They were probably the best and wisest sovereigns that ever sat on the throne of Spain. Alhakem established an academy at Cordova, which was for several years the most celebrated in the world. In the tenth century it contained a library of two hundred and eighty thousand volumes. In the twelfth century, there were no less than seventy public libraries in Mahometan Spain. Cordova produced one hundred and fifty authors, Almeria fifty-two, and Murcia sixty-two.

The caliphate of Bagdad was the great centre of learning in the east, as that of Cordova was in the west. In the middle of the eighth century, Almanzor founded the celebrated school of Bagdad, which numbered at one time more than six thousand scholars, who thronged thither from all parts of the civilized world. He established public hospitals for the sick, and laboratories for the preparation of medicines. These institutions gradually fell into decay, but were resuscitated in the thirteenth century by Mostanser; and Haroun al Raschid, Almamon, and their successors, patronized science with a zeal and liberality not inferior to that which animated the monarchs of Cordova.

Under the genial protection of these caliphs, learning of every kind flourished. The Arabs eagerly cultivated the Greek philosophy and mathematics, but the sciences to which they directed their principal attention, were those connected with the healing art. We find accordingly that they laboured incessantly to discover the effects upon the human frame, not only of all the plants which gave promise of medicinal efficacy, but that they explored for this end, with the greatest eagerness, the almost unopened mine of chemistry. Every thing here was to be begun anew; the sensible properties of chemical substances, and the manner in which they acted upon each other, had to be examined; and the novelty of the research, and the inexhaustible field of observation which was thus opened, drew crowds of votaries into these hitherto untrodden paths.

651. They went on for ages groping in the dark, pursuing their way, they knew not whither, following every accidental gleam of light, wasting the strength of giants, and the acuteness of the greatest genius, in barren and almost useless labours. Yet they were unconsciously preparing the soil for the rich harvest which their successors reaped, and it will well repay the curiosity of philosophical research, to trace the steps by which the science has advanced, from the ignorance of the Greeks and Romans, through the absurdities and follies of alchemy, to the sober and patient research which has led to the brilliant discoveries of our own times.

652. The Arabians had brought from the east the idle hope of being able to transmute the common metals into gold. Snatching at the similarity of properties of many of those bodies, they fancied that tin, and lead, and copper, only differed from silver and gold in the addition of some ingredients, which rendered them less ductile and unalterable, and that there must be some means of separating the perfect metals from the dross and impurities that thus debased them.

Great application to Therapeutics or the Healing art - Trial of Virtues of all plants

Alchemy -

principles of transmutation

How the term spirit was originally used, & how now used

The success which attended their rude attempts in the healing art, led them to suppose that behind the curtain which veiled the secrets of nature, must be concealed remedies of greater and of universal power, able to drive pain, and disease, and death, from the earth.

These vain expectations set in motion the two most powerful springs of action, the love of life, and the love of wealth, which impelled men in the search after new processes and combinations in chemistry, with a zeal and devotion which could not probably have been supplied by any other motives.

653. The writings of Geber are the earliest records, now extant, of the progress which chemical knowledge had made between the Christian era and the middle ages. Geber was the assumed name of a native of Harran in Mesopotamia, who lived in the eighth century, and of whose personal history little or nothing is known. He was acquainted with metallic arsenic, in addition to the metals known to the ancients, and he regarded them all as compounds of mercury and sulphur. Of these gold and silver are perfect metals: gold consists of the most subtile substance of mercury, as is proved by the ease with which the latter metal dissolves it; for mercury can dissolve nothing that is not of its own nature. Silver, like gold, consists of much mercury with little sulphur; but its sulphur is white, while that of gold is red. The other metals were composed of earthy mercury and fixed sulphur; and they were all capable of being converted into gold and silver by altering the nature and proportions of their sulphur and mercury. This change could be effected by the philosopher's stone, or the medicine, as he more commonly called it.

Geber was acquainted with the process of distillation, by which he purified vinegar, and he applied the term spirit, to sulphur, arsenic, and other volatile solids. He is the first writer who gives an account of nitre, and he prepared what he called dissolving water, by subjecting to distillation a mixture of sulphate of iron, nitre, and alum. He noticed the red fumes which are disengaged in the process, and used the liquid for dissolving silver. He was acquainted with crude sal ammoniac, and used its solution in his dissolving water for liquefying gold. He was acquainted with potash, soda, and alum; and by exposing the latter to a red heat in a glass retort, he obtained a weak sulphuric acid, which he preserved as a valuable menstruum. Geber mentions copperas, the sulphate of iron, which, as well as alum and nitre, he purified by solution and recrystallization. He made corrosive sublimate, cinnabar, and red precipitate; he prepared precipitated sulphur by dissolving sulphur in caustic alkali, and pouring distilled vinegar into the solution. He knew the combustibility and volatility of metallic arsenic.

654. When we compare the knowledge possessed by Geber, with that of the Romans, it is evident that very important additions had been made to the stock of chemical facts. The discovery of sulphuric, nitric, and nitromuriatic acids, of arsenic, of the mercurial salts, and of the solubility of sulphur in the alkalies, mark an era in the science, and whether or not they were the discoveries of Geber, entitle him to the epithet of the patriarch of chemistry, although he veiled his descriptions in the mystical jargon of the alchemists, so as to render them almost unintelligible.

655. From the time of Geber to the beginning o the twelfth century, there are few changes in the state of chemical knowledge of sufficient importance to attract attention. But the returning wave of the Crusades, wafted back to Europe the knowledge and the arts of the East, and greatly multiplied the number of the searchers after the Universal Medi-

crude – explain

menstruum explain

caustic, burning from Caustiens
erodens.