John Millington
Wm. & Mary College
Williamsbg Va.—

Began this 2nd part 28th Mar 1845
finished same 5th May. do.—
In 1846 did not begin till 25th May—

A two volume manuscript chemistry text book prepared by John Millington for the chemical class at William and Mary College, beginning with the session 1844-5. Inserted between the pages actually written by Millington, are printed pages from Principles of Chemistry, by Daniel B. Smith. Approximately 559 pages, including the printed pages from Smith's text-book.

Vegetable Nutriment p 260
Ammonia begins p 270

SMITH'S CHEMISTRY.

The principles of Chemistry prepared for the use of Schools, Academies and Colleges, by Daniel B. Smith, second edition, revised and adapted to the present condition of the science.

RECOMMENDATIONS.

Philadelphia, Oct. 7, 1842.

URIAH HUNT, Esq.

Dear Sir—The Elements or Principles of Chemistry, prepared by Daniel B. Smith, is a work of very great merit, compiled with great care, as regards its facts, and highly philosophical as respects its principles. The style is chaste, perspicous and concise, the selection of Phenomena judicious, and the rationale is treated in the simplest and clearest manner. I must congratulate teachers and professors on the appearance of the second edition of this creditable work, so well suited to the learner, and so good a remembrancer for the instructor. Nothing old that is of value to the general student, and nothing new that is of use to a proper comprehension of principles are omitted. The whole work designates its author, as one who has studed thoroughly, digested philosophically, and written clearly and comprehensively.

Wishing your undertaking the success which it merits,

I am yours, &c.

J. K. MITCHEL, M. D.,
Professor of Practice of Medicine in Jefferson Medical College, in Philadelphia.

Philadelphia, Oct. 15, 1842.

URIAH HUNT,

Dear Sir—Feeling some interest in Chemical Text Books, I have examined Smith's Chemistry with care, and do not hesitate to pronounce it one of the best I

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istry

arket Street

1842.

have hitherto met with, as it embraces a general v of the science in its present state, in a condensed well digested form, which is far better adapted to the uninitiated, than a more ponderous volume.

Respectfully yours,

JAMES C. BOOTH,
Professor of Chemistry in the High School of Philadelphia.

URIAH HUNT,

Dear Sir—I have perused with great pleasure Smith's principles of Chemistry, published by you. It is an excellent compendium of the principles, and most important phenomena of the science, well digested, and explained in the simplest and shortest manner. It appears to me to be a very desirable addition to our list of American Chemical treatise, and to be admirably adapted to the purpose for which it is prepared—that of a text book for lectures.

With great respect, I remain yours,

JOHN F. FRAZER.
Professor of Chemistry in the Franklin Institute of the State of Pennsylvania.

PANORAMA

OF

PROFESSIONS AND TRADES;

OR,

EVERY MAN'S BOOK,

BY EDWARD HAZEN;

EMBELLISHED WITH EIGHTY-TWO ENGRAVINGS.

This work was written for the use of schools and families, as well as for miscellaneous readers of every age. The subjects are the trades and professions in which men are engaged with a view to honest subsistence. In educating the rising generation, this branch of learning has been greatly underrated or entirely overlooked, while the

The Principles of Chemistry

by

Daniel B Smith

Part the Second

Organic Chemistry

2nd Edit.

Uriah Hunt 101 Market Street

Philadelphia 1842.

That Portion of Chemistry we have so far been studying is called Inorganic Chemistry because it object is to examine into substances which possess no organs of secretion for supporting and carrying on life which in fact such things as the metals, salts sulphurs &c do not possess; and consequently we know not when they are generated or produced or how long they may last, since having no life they are incapable of that change called dying. — The study we now enter upon on the contrary has for its object an examin: of such things as have had, or which possess life and consequently the organs, parts or machinery by which life is carried on, the cessation of which produces death, and this branch is therefore called organic chemistry, or the chemistry of organized bodies, And this is always made the last or concluding branch of Chemical Study because notwithstanding there are but few elements entering into the composition of organic compounds yet they are distinguished generally by a much more complex and hidden mode of combining and which consequently requires a certain previous knowledge of ordinary or inorganic chemistry in order to understand them; — for the same laws which govern the union or decomposition of inorganic compounds also hold good in such as are organic and the same elements are found in both. Except only that a Red heat destroys, or rather decomposes every organic compound that has so far been discovered.

PART SECOND.

ORGANIC CHEMISTRY; OR, THE CHEMISTRY OF THE COMPOUND RADICALS.

CHAPTER I.

GENERAL VIEWS.

447. It is impossible to frame a perfect system of arrangement for the facts of a science which is imperfectly understood, or has been but partially explored. The progress of knowledge consists, in truth, in the gradual development of the arrangement of physical phenomena, according to their essential relations; and those imperfect attempts at effecting this one great end of philosophical research, which subsequent discoveries have compelled us to reject as inadequate, are not without their use; and may serve as temporary lights to guide our footsteps along an uncertain path, until we gain the solid ground and clear daylight of truth.

In no science is the force of these remarks more to be felt than in organic chemistry. The vast variety and complexity of substances of which it treats, have hitherto obliged its cultivators to submit to an arbitrary classification, from which we are not at present able to disengage the science.

448. Among the various arrangements that have been proposed for this part of our subject, perhaps there is none more convenient than to class together the compounds of carbon.

There is this peculiarity in this element, that although it is itself the most tasteless, inodorous, insoluble and infusible of all substances, its compounds are generally liquid or gaseous, or very easily fusible solids, odorous, and readily undergoing decomposition. With hydrogen and oxygen it forms the basis of all vegetable, and with hydrogen, oxygen, and nitrogen, that of all animal structures, producing, by the combinations and permutations of these few elements, the innumerable complex forms of organic products.

449. The compound substances examined in the preceding part of this treatise, are characterized by the variety of the elements of which they are composed, and the simplicity of their laws of combination. In organic chemistry, on the other hand, we find substances of peculiar and even opposite properties composed of the same three elements, slightly differing in their proportions, and apparently baffling all attempts at a just classification.

Even here, however, we may perceive the dawn of a clear light, which will probably enable us to bring these multitudinous compounds under the same general laws that govern inorganic matter. A considerable number of them have already been ascertained to be binary compounds, of radicals more or less complex, which unite in the same manner as the simple elements with other bodies, and are capable of separation from their combinations without themselves undergoing decomposition. We find in this department of chemistry, as in the other, acids, alkalies, and salts; and we also find a large class of compounds, the ethers and the essential oils, &c., of which inorganic chemistry furnishes few if any examples.

450. From a review of the various compounds which have passed under notice, it is evident that there are two great classes into which they may be divided; those namely, which are neutral or indif-

The Elements in the former part of our course, no less than 54 were enumerated, while all the organic substances we shall in future have to examine seldom amount to more than the 4 just mentd. viz: Carbon, Hydrogen, Oxygen and Nitrogen with an occasional sprinkling of a few other elements introduced in some case accidentally or at any rate not essential to the compound.—

+ which is the case with organic chemy which has only engaged the attention of Professors there the last few years

By radicals are meant roots, or principles like elements; except that they are not simple or single, but compounds which enter into the composition of substances as if they were elements, and thus form things.

A Binary compound of Radicals is therefore a substance formed by the combination of two only of such compound Elements. — Fownes calls them Quasi Elementary substances. — They evince a readiness on the one hand to combine with Hydrogen & the metals, when they are called Salt Radicals, and on the other with Chlorine Oxygen & Sodium when they are called organic Salt Basules.

ferent in their chemical relations, as the salts; and those which possess energetic affinities, as the acids and alkalies.

451. Viewed from another point, they admit of being divided into two great classes; namely, one of binary compounds, formed by the union, atom to atom, of two elements; and the other consisting of several atoms combined into a single group, which acts the part of an elementary body.

452. Sulphurous acid, SO_2, is a compound of the latter class; being the sole product of the direct union of sulphur and oxygen. The other oxides of sulphur are, as has been stated, conceived to be compounds of sulphurous acid, and not of sulphur itself. Thus hyposulphurous acid is SO_2+S, and is a true sulphur acid, which unites with sulphur bases to form sulphur salts. Hyposulphuric acid is $2SO_2+O$; sulphuric acid is SO_2+O; chlorosulphurous acid is SO_2+Cl; iodosulphurous acid SO_2+I; and nitrosulphurous acid SO_2+NO_2. By this mode of conceiving the nature of these bodies, we reconcile many seeming anomalies, and explain many phenomena not intelligible on the old view.

453. *Organic Radicals.*—There are numerous cases in which we are compelled to resort to similar suppositions respecting the constitution of compound bodies, in order to arrive at clear notions of the changes which they undergo, by the operation of chemical forces. There are, for example, several organic products which combine, amidst various changes of composition, with one or more atoms of most of the simple elements. When these various compounds are analyzed, the chemist perceives that there is a certain combination of atoms common to them all; and that if there were a substance so constituted, all the changes he has observed could readily be explained as so many combinations of that complex radical. Even if this substance cannot be sepa-

rated from its combinations and exhibited *per se*, the chemist has no hesitation in admitting its existence, and allowing it a place and a name in the list of organic elements.

454. Such an hypothetical radical is *benzule*. The essential oil of bitter almonds has long been a subject of interest and research to the chemist, on account of the powerful poison which it contains. Another organic product which has been subjected to frequent and accurate analysis, is the volatile acid obtained from gum benzoin. These substances have been subjected to the action of powerful reagents, and made to enter into combination with the simple elements. The result has been the full proof of the existence of the complex radical benzule, represented by $C_{14}H_4O_2$, although it has never yet been insulated. The protoxide of this substance is benzoic acid: with an atom of hydrogen it forms the oil of bitter almonds; and it enters into combination with chlorine, bromine, iodine, and sulphur, besides forming a great variety of other compounds with organic bodies.

455. It is evident that in these cases, the atoms which constitute benzule are held together by a stronger affinity than unites that radical to its several compounds, for it remains unchanged amidst a series of decompositions and recompositions.

456. The discovery of numerous radicals of this kind has entirely changed the state of this department of chemistry, and thrown a clear and steady light upon some of its obscurest portions.

These compound radicals belong to all the various classes which have been found to exist among the simple elements in inorganic chemistry. Cyanogen, NC_2, is a genuine salt radical, belonging to the same class as chlorine and bromine; ethule, H_2C_4, may be regarded as a compound metal, for it forms a series of basic oxides, which neutralize acids, and benzule

νλη ule a principle; and
Stryx Benzoz an east Indian Plant
∴ the Principle of Benzoin

this is a Hydruret of Benzule or combin of Hydrogen with Benzule

Benzule see page 248

Binary compounds of 2 elements only

[illegible] constitute an important class of bodies in organic Chemy called compound Radicles

\+ For Hydrugen light as it is is now generally believed to have some unknown metal for its base.

belongs to the group which contains the electro-negative elements, among which are the bases of the principal acids.

457. *Dependence of Chemical Properties upon similarity of Atomic Constitution.*—The searching analysis to which these bodies have been subjected, has proved new and most remarkable laws to govern their composition. The radical ethule, for example, passes unchanged into combination with a vast variety of substances, without having yet been insulated. At a red heat, oxygen will entirely decompose it, as it does all other organic products, converting it into water and carbonic acid. So, likewise, by the action of heat alone, almost all organic products can be separated into new or simpler combinations of their elements. These organic radicals are also capable of a partial decomposition which has peculiar laws. They may be regarded as groups of atoms, having a certain physical or mechanical structure, which appears to exercise some influence upon their affinities, and to resist decomposition, or to modify the action of reagents.

458. Thus, there is a radical called acetule, C_4H_3, which forms a series of compounds with the simple elements; its hydrated oxide, C_4H_3, O+Aq, is the liquid called aldehyde, and its hydrated teroxide C_4H_3,O_3+Aq, is acetic acid. Under certain circumstances, the radical itself is decomposed by chlorine, with the complete substitution of chlorine for hydrogen, so that a new radical, C_4Cl_3, is obtained, which forms a series of combinations, parallel with those of acetule, and possessed of very analogous properties. Thus its hydrated oxide is the chloracetic acid, $C_4Cl_3O_3+Aq$, which forms a series of salts parallel with the acetates, and preserving throughout, the analogy of characters which has been mentioned.

459. So likewise a series of organic compounds has been discovered, of which alcohol may be re-

garded as the type. They all agree in their general chemical characters; they all contain carbon, and hydrogen in their atomic proportions, and combined with two atoms of water; the abstraction of an atom of water, converts them all into substances having the generic qualities of ether, and by the substitution of two atoms of oxygen for the Hydrogen of their water, they are all converted into acids.

	Alcohol.	Ether.	Acid.
Wine alcohol,	C_4H_4+2Aq,	C_4H_4+Aq,	$C_4H_4+O_4$.
Wood alcohol,	C_2H_2+2Aq,	C_2H_2+Aq,	$C_2H_2+O_4$.
Oil of potato spirits,	$C_{10}H_{10}+2Aq$,	$C_{10}H_{10}+Aq$,	$C_{10}H_{10}+O_4$.
Ethal,	$C_{32}H_{32}+2Aq$,	$C_{32}H_{32}+Aq$,	$C_{32}H_{32}+O_4$.

460. Upon a closer examination it will be found that these changes and substitutions are in perfect harmony with the laws of inorganic chemistry. Decomposition destroys nothing, it merely changes. An element leaves the combination in which it exists, for a new one, because it is solicited by a more powerful affinity; and if in any case it is disengaged in its elementary form, it is because the associated atoms have been drawn away by a stronger attraction than its own, or because its own repulsion of elasticity, or attraction of cohesion, is stronger than its affinity for any of the elements, or combinations, that are present.

When a bi-elementary compound is decomposed, one of the elements is almost always set free, and in proportion to its complexity of constitution, do the elements of a body, instead of being separately evolved, reunite into new combinations.

We can readily understand why it is, that water and carbonic acid are the most constant products of vegetable; and water, carbonic acid, and ammonia, of

animal decompositions; for they are the most stable compounds, which the respective elements are capable of forming with each other, and they are always produced when the elementary affinities have full play.

461. *Law of Substitution.*—The partial decomposition moreover, which these complex organic products frequently undergo, and which changes the character, but not the number, nor probably the arrangement of the atoms, by substituting an equivalent of another kind for the one which is removed, is an exemplification of the same law.

462. When acetule is subjected to the action of chlorine, six atoms of chlorine are engaged in the decomposition of a single atom of acetule. Three of these unite with the three atoms of hydrogen, which are displaced, and form chlorohydric acid, which is disengaged, while the other three replace the hydrogen which is removed.

Frequently there is a partial displacement by which a new radical is formed, which combines in its nascent state with other elements. Thus alcohol is the hydrated oxide of ethule, C_4H_3, O+HO. When it undergoes the acetous fermentation it absorbs four atoms of oxygen from the air; two of them combine with two atoms of its hydrogen to form water, thus converting the ethule, C_4H_3, into a new radical, acetule, C_4H_3, which seizes in its nascent state upon the other two atoms of oxygen, to form acetic acid, which is a teroxide of acetule, C_4H_3, O_3, and which retains the atom of water, originally contained in the alcohol, as it is incapable of existing except in combination with a base. So, likewise, when equal weights of acetate of potassa, and arsenious acid, are exposed to a dull red heat, a dense fuming liquid is obtained, which is the oxide of a new complex radical. This radical, which has received the barbarous name of *Kakodule*, is pro-

duced by the breaking up of the acetic acid, and is remarkable for containing metallic arsenic. Its formula is C_4H_6 As. It unites with the electro-negative elements, forms an acid and a salifiable base, and is distinguished from every other series of the kind, by the insupportable odour and deadly poison of all its compounds.

463. The impossibility under which many of these organic products labour of separate existence, is a frequent cause of their decomposition. When a substance is presented to them which abstracts the base with which they are combined, they are decomposed in the act of separation into simpler and more permanent combinations. Thus oxalic acid, C_2O_3, cannot be obtained in a purer form than its sesquihydrate; and when its crystals are heated with sulphuric acid, the water is abstracted, and the oxalic acid separates into carbonic oxide, CO, and carbonic acid, CO_2.

464. When these organic products are subjected to the action of highly oxygenated bodies, such as nitric or chloric acid, or the peroxide of lead, or manganese, they always combine with the oxygen, and are reduced to simpler forms containing fewer atoms.

The oxygen, according as the action is more or less intense, converts more or less of the hydrogen into water, sometimes replacing a portion of that which it abstracts, and sometimes combining directly with the body itself. Thus when gum, $C_{12}H_{10}O_{10}$, is subjected to the action of nitric acid, it first converts two atoms of the acid into deutoxide, and seizing upon the disengaged oxygen, is converted into mucic acid, $C_{12}H_{10}O_{16}$. By increasing the heat, an additional portion of nitric acid is decomposed, all the hydrogen is converted into water, two additional atoms of oxygen enter into combination, and

mucic acid is converted into six atoms of oxalic
, $6C_2O_3=C_{12}O_{18}$.

55. In other cases both bodies are decomposed
hanged, and the resulting compounds combine to
n a new product. Thus when olefiant gas, C_4H_4,
ubjected to the action of chlorine, an oily liquid
ormed, which contains $C_4H_4Cl_2$. In this case the
rine replaces an atom of hydrogen, which it con-
s into chlorohydric acid, and the two products
ibine, so that the true formula of the oily liquid is
I_2, Cl+HCl. So, likewise, when nitric acid acts
he substance called naphthaline, the composition
which is $C_{20}H_8$, it is decomposed into nitrous acid
oxygen; the latter abstracts an atom of hydro-
, which is replaced in the compound by the atom
itrous acid, and the product is $C_{20}H_7+NO_4$. At
same time another atom of naphthaline is divided
two, each containing $C_{10}H_4$, and the same
nge takes place in this new atom as in the old;
ortion of the naphthaline being resolved into the
r product, $C_{10}H_3+NO_4$.

66. *Spontaneous changes in Organic Products.*
he stability, equally with the chemical energy of
e organic products, varies greatly. Mere ex-
ure to warm and moist air is in a large number
ases sufficient to induce decomposition. Those
ies which are most liable to this spontaneous
nge are the immediate constituents of vegetables,
animals, such as sap, blood, milk, and animal
vegetable fibres. When the vital principle,
ch is capable of preserving these for a long course
of years, departs, the change at once begins. So
slight are the affinities which hold them together, that
the tendency of their elements to enter into simpler
combinations soon developes itself; the hydrogen
and nitrogen form ammonia; and the carbon and
hydrogen seize upon the oxygen of the air, and
form carbonic acid and water. A variety of fetid

gases, due to the presence of sulphur, phosphorus, &c., are disengaged, and the whole mass soon becomes putrid.

467. This putrefaction does not take place if the heat is sufficient to coagulate the albuminous fluids and to drive off the water, nor when the latter is congealed by cold. It is prevented also by the presence of salt, or of alcohol, which abstracts the water, and of reagents, such as corrosive sublimate, &c., which combine with the organic tissue, and render its affinities more stable.

468. This spontaneous change, which takes place rapidly under favourable circumstances, may be greatly prolonged by moderating its activity. It then becomes, in fact, a slow combustion, in which only the more combustible element is slowly consumed. Such is the mouldering decay which wood undergoes, in which the greater part of the hydrogen, and a portion of the carbon, are burnt out, while the organic texture is destroyed, and a pulverulent carbonaceous mass remains—the vegetable mould or *humus*, so fertilizing to the soil.

469. *Starch, Gum, Sugar.*—The most abundant products of vegetable secretion, are starch, gum, and sugar. Their composition is nearly the same, being twelve atoms of carbon united with varying quantities of oxygen and hydrogen in their atomic proportions. Thus the composition of starch, and of gum, is $C_{12}H_{10}O_{10}$, of sugar from the sugar cane, $C_{12}H_{11}O_{11}$, or $C_{12}H_{10}O_{10}+Aq$, and of sugar from grapes, $C_{12}H_{12}O_{12}$, or $C_{12}H_{10}O_{10}+2Aq$. The forces which hold these atoms together, are so nearly balanced by the divellent affinities, that slight causes are sufficient to effect their transformation into new compounds, and the conversion of all the others into sugar of grapes.

470. *Ferments.*—The transformation which grape sugar itself, in certain circumstances, undergoes, is

Coagulation – white of Eggs in Boiling

Mexico & West Indias no joints of Meat but
cut into Ribbands & hung on Trees to dry – Pistachio

Salting Bacon Beef Mutton – Alcar at [illegible]
keeping dry & in alcohol –

the Term

Sugar of Grapes used as a Type –
Raisons – Prunes – Grocers Figs

& distillant , tendency to disperse or separate

one of the most remarkable phenomena in chemistry. When the air is entirely excluded, its solution remains without change; but with the free access of the air, it obeys the ordinary law of organic decay, loses its sweetness, and becomes discoloured, sour, and fetid. There is a substance well known by the name of yeast or *ferment*, which is the scum that collects on the surface of fermenting beer. Let a small portion of yeast be added to the solution of sugar, kept at a temperature of 70° or 80° in a close glass vessel, and let a tube pass from the vessel to a pneumatic apparatus containing mercury, so that all the gaseous products can be collected. In a short time the mixture becomes turbid; minute bubbles of gas begin to collect; the temperature and the internal agitation increase, and then gradually subside, and the solution again becomes cool and clear.

471. If we now examine the products, we shall find that a quantity of carbonic acid gas has been collected over the mercury, and that the liquid has lost all the properties of sugar, and is converted into a new substance, *alcohol*. The change which has thus taken place, is a mere transformation of the elements of the sugar. Grape sugar consists of C_{12} H_{12} O_{12}, alcohol of C_4 H_6 O_2, and carbonic acid of C O_2; so that each atom of sugar has been converted into two of alcohol and four of carbonic acid.

472. Although nothing has been either gained or lost in this process, the presence of ferment is essential to the change. What then is the nature of its agency?

Yeast consists chiefly of gluten—a vegetable principle containing much nitrogen; and it is efficacious as a ferment only when it is itself in an active state of decomposition. The internal agitation of its particles is then sufficient, when it is diffused throughout the saccharine liquid, to overcome the vis-inertiæ of the forces by which the elements are held to-

gether as sugar, and to induce new arrangements by which stronger affinities come into play. This molecular agitation is propagated from the yeast to the adjoining particles of sugar, and from these, particle by particle, throughout the whole mass, till the decomposition is complete.

473. This force, by means of which the presence of one body brings about, in the chemical arrangements of another, a change altogether disproportioned to the relative quantities and ordinary reaction of the bodies, has received the name of *catalysis*, and has been supposed, without sufficient foundation, to be a new and anomalous power. In the present case, the principle on which the change takes place, is precisely like that which governs the cases before noticed, in which a decomposition, begun in a single particle, is propagated throughout the whole mass, by the disturbance of the equilibrium of forces which had maintained the atoms of the compound in a quiescent state.

474. This power, which bodies in a state of decomposition possess, of inducing the same state in those with which they come in contact, is the cause of many of the transformations which occur among organic products.

CHAPTER II.

THE COMPOUNDS OF CARBON WITH ELECTRO-NEGATIVE ELEMENTS.

SECTION I.

CARBON AND OXYGEN.

475. *Carbonic Oxide.* CO; 6.12+8=14.12. This oxide may be prepared by heating to a red heat in a gun-barrel, a mixture of two parts of well dried

† The precise mode in which yeast acts has been long an object of enquiry with men who have been fairly developed. – Yeast may be kept a long time in a dry place, and seems like the seed of plants to be called into action by heat & moisture, seeming to imply that it partakes of Vegetable nature; a circumstance corroborated by M. Latour of Paris who in 1837 discovered by the Microscope that yeast is an organized vegetable endowed with a principle of Vitality, and that it grows & operates by its vital action instead of its chemical effects as formerly supposed, and this is now generally believed to be true.

Mouldiness on Books – surface of Paste, also Meat

– Berzelius calls it catalytic force

and branches – and the Surgeon cuts away, or even amputates a mortified and dead member.

Carbon itself is Electro Neg

Carburet of Iron

† It is always produced in Burning charcoal and Anthracite & Stove are sometimes found unpleasant & unhealthy although they have good draft.

common means of suicide in France

Show Oxalic Acid —

Carbonic Acid/gas

over leaf

chalk (carbonate of lime) and one part of pure iron filings. The gas which is evolved must be collected over water, and will be found to be a mixture of carbonic acid and carbonic oxide. The former is readily absorbed by the water, leaving the latter pure. Carbonic oxide may also be prepared by heating in a glass retort, one part of binoxalate of potassa, oxalate of ammonia, or oxalic acid itself, with five or six times its weight of sulphuric acid. In the former process the iron is oxidated by the abstraction of an atom of oxygen from the carbonic acid which is thus resolved into carbonic oxide. The carbonic acid gas which comes over is evolved by the decomposition of the carbonate of lime. In the latter case the oxalic acid is resolved into carbonic acid and carbonic oxide, by the action of the sulphuric acid.

Carbonic oxide is a colourless, tasteless, inflammable gas, which is sparingly absorbed by water, and has no action on earths or alkalies.

When a lighted taper is plunged into a jar full of this gas, the taper is extinguished after setting fire to the gas, which burns quietly with a pale blue flame. Carbonic oxide gas is highly deleterious to the animal system; taken into the lungs it occasions headache, and when breathed pure, almost instantly produces stupor.

The specific gravity of carbonic oxide gas is .9727. A mixture of 100 measures of this gas and 50 measures of oxygen explodes by the electric spark, and is converted into 100 measures of carbonic acid.

476. *Oxalic Acid.* C_3O_3; 12.24+24=36.24. This acid is evolved in the process of vegetation, and exists in combination with potassa, in the rumex acetosa, and the oxalis acetosella, or sorrel, from which last plant it has derived its name. It also exists in combination with lime in several species of lichen. Oxalic acid may be prepared artificially by

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digesting sugar in five or six times its weight of nitric acid, and distilling off the excess of acid; the residue, on cooling, yields crystals of oxalic acid which amount to about one half the weight of the sugar. The acid may be prepared from many other organic substances, as gum, starch, wool, hair, and silk.

Oxalic acid has a very sour taste, reddens vegetable blues, and forms neutral salts. It crystallizes in slender flattened four or six sided prisms, with di-hedral summits, the primary form of which is an oblique rhombic prism. These crystals are a compound of one atom of acid, and three atoms of water, two of which escape when they are heated to 212°; they are permanent at common temperatures, but effloresce in a higher temperature, fuse in their own water of crystallization at 209°, and dissolve in 15.5 times their weight of water at 50°. They are also soluble in alcohol. Oxalic acid evaporates very slowly at common temperatures, and when heated to 330° it sublimes rapidly and condenses in transparent acicular crystals, which contain one atom of water.

Oxalic acid is a rapid and fatal poison, the proper antidote for which is a mixture of chalk and water.

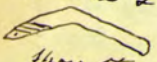
Oxalic acid may be distinguished from all other acids by its form of crystallization, and by its forming with lime a white precipitate insoluble in an excess of acid.

477. *Carbonic Acid.* CO_2; 6.12+16=22.12.—Carbonic acid may be prepared by decomposing fragments of marble, (carbonate of lime,) with diluted chlorohydric acid, and collecting the gas over mercury. Carbonic acid is an invisible inodorous gas, which is condensed beneath a pressure of 36 atmospheres into a transparent colourless fluid. This fluid is the most expansible body known; at 32° its sp. gr. is .83, and its expansion is nearly

† Carbonic acid gas was discovered by Dr. Black of Edinburg in 1757 and not then knowing its properties or that it had any acid quality about it, he called it Fixed air - a name often applied to it at present day. (State his reasons for this name Dig. Every cubic yard of natural limestone on the earths surface contains very nearly 171 cubic feet (170.92) of this gas in a hidden or latent state) - Who occasionally it is evolved spontaneously in limestone rocks & caverns as in the Grotto del Cane near Naples, Italy

No notion existed of its having any connection with or containing Carbon until this was discovered by Lavoisier, and then found out by experiments on combustion of the diamond in oxygen gas in apparatus like this

one of Faradays experiments with Bent tube sealed hermetically after the lime & acid in the end



Show the mask to be used in making those appli

This is a new and interesting experiment first made on a large scale by Thillorier of Paris and publicly reported by him in Decr 1835 The apparatus which is of great weight and enormous strength is minutely described in the 3rd Edit: of Websters chemy (1839) the Plate representing it being the frontispiece to the Book. But it is very slightly noticed in Kanes chemy – expensive & dangerous apparatus

Explain it by my Diagram from Pamphlet

It burst & killed 2 assistants just before the class assembled.

Show is incombustible & extinguishes flame

⊕ 1½ as heavy as atmosp: air & can therefore be poured from one vessel to anot: without Pneumatic trough. In this age when produced it spreads itself over the grass & land where it is speedily absorbed – It gets into Wells caverns & low places

Nov: 40 – see the Pamphlet
the Vessel burst under 50 atm
& killed 2 assists [illegible]
been in room in few minutes

use of a Candle

The Grotto del Cane near Naples explained

one per cent for each degree of Fahrenheit, which is four times that of air. If a jet of the liquid acid be directed into a small cylindrical vessel, the cold produced by the sudden conversion of one part into gas, will be sufficient to congeal the remainder into a soft snow-like mass, which evaporates very slowly.

478. Carbonic acid gas is incombustible; it extinguishes all burning bodies except potassium, and destroys animal life when it forms only a fourth part of the atmosphere. When an attempt is made to breathe carbonic acid it causes a violent spasm of the glottis which prevents the air from entering the lungs. If the gas be so much diluted with common air that it can be breathed, it acts as a narcotic poison and proves speedily fatal to life. Its sp. gr. is 1.524.

479. The liquid differs from the gaseous carbonic acid in a very remarkable circumstance. The former mingles in all proportions with ether and alcohol, but not with water, on the surface of which it floats like oil. On the other hand carbonic acid gas is readily diffused through water, which will take up its own bulk at the common atmospheric pressure. The quantity of the air compressed into the water is in exact proportion to the pressure, and the gas escapes as soon as that pressure is removed. These phenomena closely resemble those caused by the mutual indifference and penetration of the gases. Carbonic acid and water are mutually indifferent, and the presence of the latter, like that of a gas, is no obstacle to the diffusion throughout its mass and between its particles, of the former. When both materials are in a liquid state, the attraction of gravitation separates them, and the lighter fluid floats above the heavier.

480. The artificial Seltzer waters sold in the

shops, are prepared by forcing into a strong metallic vessel, containing water, six or eight times its volume of carbonic acid gas. The effervescence of these waters, and their pleasant acidulous taste, are owing to the presence and escape of the acid. It is to the presence of the same acid, evolved during the vinous fermentation, that beer, cider, and sparkling wines, owe their agreeable pungency.

Water, holding carbonic acid in solution, reddens litmus paper; the acid is expelled by boiling, or by removing the atmospheric pressure. Carbonic acid may be distinguished from other acids by forming a precipitate with lime water, which effervesces when mixed with any other acid.

Carbonic acid is extensively diffused throughout nature. It always exists in the atmosphere, and in natural waters; it is evolved in the process of respiration, vegetation, and fermentation; it is discharged in great quantities from fissures in the earth, and from springs of water in certain volcanic regions; and in combination with lime and other metallic oxides, it forms a large portion of the earthy and rocky crust of the globe.

481. *The Carbonates.*—The carbonates are decomposed with effervescence by nearly all the acids. Most of them part with their acid when heated to dull redness; the carbonates of lime and magnesia are decomposed at a full red heat, those of baryta and strontia at an intense white heat, and those of potassa, soda, and lithia, are unalterable in the fire. When the carbonate of lime is subjected to an intense heat, under a very great pressure, it fuses, without decomposition, into a crystalline mass. Excepting those of the alkalies, the carbonates are sparingly soluble in water.

482. The carbonate of potassa is procured from the ashes of vegetables by lixiviation and evapora-

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482. The carbonate of potassa is procured from the ashes of vegetables by lixiviation and evapora-

To Bottle Champaigne Cyder &c. —

Bottles Champaigne Cyder &c. or

& Bottles effervescent —

No difference between Soda Lime

or any thing else used

cause of the effervescence when we add an acid to

Alcaline alkali &c. —

Breath or Blow thro tube into Lime water

Pure lime Soluble in Water not so Caustic as

lime — known theory of

take in MS sheet Mortar

— or bases combined with carbonic acid

hence Lime Kilns, and calcined Magnesia

All the alkaline salts, even if kept

in close stopper Bottles become Carbonats

Carbonate of Potassa

+ Salt of Tartar because also obtained by burning Tartar of Wine, Bi-Tartrate of Potassa –
also Kali ppt.^um –
Salt of Wormwood – Sal Æratus of Bi Carb^te

tion, and is known by the names of potash and pearlash. In this state it always contains other salts, chiefly the sulphate of potassa and chloride of potassium. A pure carbonate of potassa is obtained by heating the bitartrate of potassa to redness. A mixture of charcoal and pure carbonate is left, from which the latter may readily be obtained by solution in water. It may thus be obtained in crystalline grains, and in this state it is called salt of tartar.

Pure carbonate of potassa has a strong alkaline taste, turns vegetable blues green, and is slightly caustic. It is highly deliquescent, dissolves in less than its weight of water at 60°, and crystallizes with difficulty from its solution. It fuses at a full red heat, and is insoluble in alcohol. Its principal uses in the arts are in the manufacture of soap and glass.

When a current of carbonic acid gas is passed through a solution of the carbonate of potassa, a bicarbonate is formed, which crystallizes in octohedral prisms, requires four times its weight of water at 60° to dissolve it, and does not deliquesce.

483. The carbonate of soda is obtained by lixiviating the ashes of sea weeds, and when thus made is called kelp and barilla. It is also prepared by decomposing the sulphate of soda at a red heat by a mixture of sawdust and lime. Sulphuret of calcium and carbonate of soda are formed, and the latter is obtained by lixiviation and crystallization. Carbonate of soda has an alkaline taste, and turns vegetable blues green; it crystallizes in octohedrons with a rhombic base, containing either 7 or 10 atoms of water. Its crystals effloresce in the air; when heated they fuse in their own water of crystallization, and dissolve in about two parts of cold water.

484. A sesquicarbonate of soda is found native in central Africa, being contained in the waters of certain lakes which become dry in summer. It is called

trona, whence one of the names of soda, *natron*, is derived.

By passing carbonic acid gas through its solution, the carbonate is converted into a bicarbonate, a less soluble and less alkaline salt.

The carbonate of lime is one of the most abundant salts in nature. Chalk, marble, limestone, are carbonates of lime; and it is the principal material of the shells of molluscous animals. The form of its primitive crystal is a rhomboid, and the number of its secondary forms exceeds two hundred. The protocarbonate of lead is the common pigment called white lead.

The bicarbonate of lime and magnesia is a native crystalline limestone rock, known by the name of dolomite.

485. Carbon forms three other acids with oxygen, the rhodizonic, which is a tribasic acid, its composition being C_7O_7+3Aq, or $C_7O_{10}+H_3$; the croconic acid, C_5O_4+Aq, or C_5O_5+H; and the mellitic acid, C_4O_3+Aq, or C_4O_4+H. It is highly probable that carbonic oxide is the real base of all these compounds. In this case oxalic acid will be represented by $2CO+O$, and carbonic acid by $CO+O$.

Carbonic oxide also unites as a base with chlorine to form what is called the chlorocarbonic acid, $CO+Cl$, the phosgene gas of Davy.

Section II.

CARBON AND THE SALT RADICALS.

486. The chloride, bromide, and iodide of carbon, are volatile, aromatic, crystalline solids, or transparent liquids, analogous to camphor and the essential oils in their properties.

Why lime must be burnt before fit for Mortar

Chalk Excellent beds said to have been discov? in N W part of State of Arkansas – The only chalk yet known in America – Sylvester reports a N York Packet & Tirier current of 6th Oct. 1845 from Little Rock Gazette

White Lead

or bi Carbonate

Mineral Coal described p 245.–

Chloride of Carbon a volat Liquor highly explosive } intricate & of no importance in arts Medicine or to the Chemical Student

× discovered by Lampadius in 1796 who called it the alcohol of sulphur. Is singular being a clear transparent fluid out of 2 opake bodies
Its refractive power exceeds flint glass as shewn by Dr Brewster in 1813 - who first noticed its use for making reflecting Telescopes, which has been tried by Barlow of Woolwich
The difficulty is its confinement owing to its being so very volatile & expansive

‡ It was stated in the French Journals a few years ago, that if Phosph is put into this fluid and is there kept for several Months, it will combine with the sulphur, thus leaving the pure carbon alone, when it will crystallize and form real diamonds. (Comstocks Chemy p 196)

Section III.

CARBON AND SULPHUR.

487. *Sulphocarbonic Acid. Bisulphuret of Carbon.* — $C S_2$; 6.12+32.2=38.32. This acid may be prepared by passing the vapour of sulphur over fragments of red-hot charcoal, in a porcelain tube, and collecting the vapour under water. It is a transparent, colourless liquid, remarkable for its high refractive power. Its sp. gr. is 1.272; it has an acid, pungent, slightly aromatic taste, and a highly fetid smell, resembling that of putrid cabbages. It is very volatile, boils at 110°, and produces intense cold during its evaporation. It is very inflammable, and burns with a pale blue flame. It is soluble in alcohol and ether, and dissolves sulphur, phosphorus, and iodine, forming a beautiful pink solution with the latter.

488. This acid forms true sulphur salts with the metallic protosulphurets; and their composition is such, that if the sulphur be replaced by oxygen, the corresponding carbonates will be formed.

CHAPTER III.

THE NON-NITROGENOUS COMPOUNDS OF CARBON AND HYDROGEN.

489. We shall gain a clearer view of the subject of organic chemistry, by tracing its products from their more complex to their simpler forms, as we shall thus follow the progress of discovery, and throw into natural groups a variety of compounds, of which the theoretical relations are not well understood.

The organic radicals are conveniently divided into two classes, the nitrogenous and non-nitrogenous—the latter embracing most vegetable, and the former most animal products. The only ones which contain no carbon are amide, and its derivatives.

SECTION I.

THE ALCOHOLIC SERIES.

490. *Starch, Lignine, Gum, and Sugar.*—These substances are the most important and abundant vegetable secretions. They are formed in all plants, and may be regarded as the stores laid apart by the plant itself for its own future nutriment. They are classed together on account of their close resemblance in constitution and properties, being all formed of twelve atoms of carbon, combined with oxygen and hydrogen in the proportions to form water; and being easily convertible into the same product.

491. Starch and lignine possess an organic structure, which they retain until decomposed. Starch is imbedded in the cellular tissue of plants, as small white grains of an irregular form. Each grain consists of concentric layers, the outer ones of which are the most hard and insoluble, so that when the grain is crushed, it becomes a soft mass. It is readily procured from plants which contain it, by reducing them to a powder, and washing away the soluble parts with cold water. The fecula subsides in the form of a white powder. It is insipid, inodorous, and insoluble in alcohol, ether, and cold water. When, however, the grains of fecula are triturated in a mortar, so as to bruise and break the outer covering, the inner portion, which is soluble, being exposed, a partial solution in cold water may be effected. Boiling water readily dissolves fecula, con-

…ns containing Nitrogen, & those that are without it.

× Base of Ammonia

† Starch called Fecula Technically

& Lignine from Lignum & idos.

…their words into each other

‡‡ when magnified like an onion

o To make starch of wheat flour Potatoes
Horse Chesnut – Cassava root called arrow
root

FROM THE BALTIMORE AMERICAN.

We have received the following note from Mr. GEORGE W. ANDREWS, one of the best practical chemists in this city, giving the mode pursued by him in manufacturing the explosive cotton recently discovered in Germany. It will be seen that the process of Mr. A. differs from the recipe recently published. We have tried the cotton thus prepared and found it to act precisely like gunpowder.

Perhaps it may be proper to add that the cotton thus prepared is more dangerous than ordinary gunpowder, as it will explode by exposing it to too great a heat when drying by a stove. The nature of gunpowder is so well known that all who use it are very careful. The appearance of the prepared cotton is so similar to the article in its raw state that persons are very apt to become careless in handling it. Hence we should not be surprised to hear of serious accidents from its use; we hope these hints, which we throw out by way of caution, will induce all who use the explosive article to be duly careful. The following is Mr. Andrews's recipe:

"GUN COTTON.—After repeated experiments in relation to this recently discovered *explosive*, having prepared it with acids of various strengths, I have, from the results obtained, arrived at this conclusion, viz: That the *nitric* acid employed must be in the most concentrated form. The acid used by me most successfully was of the specific gravity 1.522. This was mixed with an equal quantity (by measure) of commercial sulphuric acid, specific gravity 1.834. Having washed the cotton in a weak alkaline solution, and subsequently in pure water, it was dried and then immersed for *one* minute in the above mentioned mixture of nitric and sulphuric acids. Having pressed from the cotton as much as possible of the acid absorbed by it, (between plates of glass,) I washed it repeatedly in water until no acid taste remained: then having separated the fibres, it was dried with gentle heat.

"Cotton thus prepared resembles much in appearance wool of fine quality, and leaves no residuum when burnt upon paper.

"Having loaded a pistol with *two* grains of the above, a ball was projected with such force as to pass through an inch board, burying itself three-fourths of an inch deep in another; while the same pistol loaded with *six* grains of ordinary *gunpowder*, the ball barely entered the first board.

"To ensure success the washings in both instances must be repeated frequently, to free it in the first place from the alkali, and in the latter from the acids.

"GEO. W. ANDREWS.

"BALTIMORE, Nov. 19, 1846."

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der may also be identified
& the noise it makes when
Dextrine is soluble Starch

& British Gum
why British - Gum from
arabia - & Tragacanth
from Greece & Turkey

Sunline or soluble part
of Starch

verting it into a tenacious, bulky jelly, which forms when dry a solid of a horn-like transparency, which retains its solubility in cold water.

Starch, like sugar, forms definite soluble compounds with the alkalies, and insoluble ones with the alkaline earths and oxide of lead. It is decomposed by the action of sulphuric and nitric acid, being converted by the latter into oxalic and malic acids. The most delicate test of the presence of starch is iodine, which colours its solution blue.

When heated a little above 212°, fecula acquires a slightly red tint, the odour of burnt bread, and becomes soluble in cold water. The term amidine is applied to starch which has, either thus, or by being dissolved in hot water, been rendered soluble in cold water.

When starch is heated still higher it assumes a dark colour, swells and softens, and becomes very similar to gum in its properties. In this state it is employed by calico printers, under the name of British gum.

492. Fecula is readily converted into sugar. This change takes place in the germination of seeds, and may be effected by frost and by the action of dilute sulphuric acid. If starch is boiled for a considerable time in water, acidulated with $\frac{1}{12}$th of its weight of sulphuric acid, it is wholly converted into sugar, identical with the sugar of grapes. 100 parts of starch yield 110 of sugar, and the only difference in their composition is, that sugar contains a greater proportion of the elements of water. The agency of sulphuric acid in effecting this change appears to consist in furnishing the required water; for it does not itself suffer any diminution in the process.

The composition of fecula, or starch, is $C_{12}H_{10}O_{10}$.

493. A variety of starch called *Inuline*, is obtained in the same manner as common starch from the roots

of the Elecampane, Dahlia, &c. Its solution in hot water does not gelatinize as it cools, but deposites its inuline unchanged. Another variety is found in the Iceland moss, which is soluble in cold water. Their composition is the same as common starch.

494. Lignine, or woody fibre, constitutes the fibrous structure of vegetable substances, and is the most abundant principle in plants. It is prepared by digesting sawdust in alcohol, water, and dilute chlorohydric acid, until it ceases to yield any soluble matter to these menstrua.

Lignine has neither taste nor odour, is unalterable in the air, and is insoluble in alcohol, water, and the dilute acids. By the action of strong sulphuric acid, it is converted into gum, which is again changed by long boiling into a saccharine substance, identical with sugar of grapes.

Lignine has a strong affinity for alumina, oxide of iron, and of tin, and will separate them from their combinations. When precipitated upon the vegetable fibre, these compounds can be combined with various colouring matters, which may thus be fixed permanently on the fibre. When paper, which is pure lignine, is immersed in strong nitric acid, and immediately well washed, it becomes thick and tough like parchment, and so combustible as to serve for tinder. The composition of lignine is called Xyloïdine $C_{12}H_8O_8$.

495. Gum is a concrete juice, which exudes principally from the bark of many trees, and also from other parts of the plant.

Pure gum is colourless, transparent, inodorous, insipid, brittle, and breaks with a vitreous fracture. It has a strong affinity for water, and forms in that liquid a clammy, adhesive solution. It is insoluble in ether and alcohol, and is precipitated by the former from its solution in opaque white flakes. Its solubility is increased by acids and alkalies, and it is

A Inula helenium is the Botanic
name of the Plant Elecampane
So likewise Arrow root – or starch of Maranta Arundinacea
in Bermuda, & several other roots – [illegible] Potatoe Starch
is used

– Prepared from Sawdust

B Ass paper is made from Rags and consists of the fibres
which originally formed the Flax cotton Straw or other
vegetable substance from which the Cloth that produced
the Rags was originally spun & woven, of course Paper
is Lignine, and I cannot offer you a purer Sample
of its nature & appearance than a Sheet of pure white Paper

X Hence dyeing and Calico printing which are similar
processes differently conducted – Dyeing is dipping the whole
piece in colouring fluid to give it one uniform colour.
printing on the contrary is applying the Colours by engraved
Blocks so as to produce patterns. – Very few colouring Matters
will impart their colours permanently to vegetable fibre so
as not to wash out or fade without previous preparation.
Those that do so are called Substantive Colours & are very
few in Number. Most colours require the previous use of a
base or Mordant
which possess a
strong affinity for
the vegetable fibre &
at same time for
the colouring Matter.
These Mordants are
chiefly acetate of
Alumina & the
chlorides of Iron
Tin which not only
fix the colour but
often improve its tint

Gum Acacia called Gum Arabic is
the best type. Show Specimen
of this & other Gums, Tragacanth
Cerasine Bassorine – British Gum &c

O called Mucilage of Gums or Gum water
used for sticking things together, and
for glazing them, & prep.d for oily
Varnishes – Sizing of Paper to
prevent Ink running –

Decoction of Madder (Rad Rubia Tinctoria) gives a dirty red dye
to Calico which easily washes out. – But first steep the Cloth
in Acetate of Alumina & dry it by heat sufficient to drive off the
Acetic acid & the alumina will fix upon the Lignine – now dip
it in Hot decoction of madder the colour rises of such strength as
for alumina & it will come out a bright red, that will not wash out

Dia acetate of Lead is most delicate test for Gums.

λ Tragacanth much used as a Varnish for Book makers & Book Binders does not crack, but albumenized

Ø Rock Candy —

Describe sugar Making
Jarmin Bullock's Blood
L 9 88

converted, when heated with strong nitric acid, into a peculiar acid, called the mucic acid. Gum forms definite insoluble compounds with several of the metallic oxides, especially that of lead. The solution of the dinacetate of lead is therefore the most delicate test of the presence of gum.

The purest specimen of gum is gum-arabic, the concrete juice of the mimosa, an African tree. It is soluble in cold water; and the name of *Arabine* has been proposed for this species. Another species of gum exudes from the bark of the cherry, peach, and apricot. It is insoluble in cold water, but soluble in boiling water, and is identical in composition with arabine. It is distinguished by the name of *Cerasine.* A third species, Bassora gum, is called *Bassorine;* it swells into a jelly in hot water, but does not dissolve. The mucilage of flaxseed, and that from the bark of the slippery-elm, appear to form another species or variety of gum. Gum tragacanth is a combination of arabine and bassorine.

The composition of gum is $C_{12}H_{10}O_{10}$.

496. *Cane Sugar.*—Cane sugar exists abundantly in the sap of certain vegetables, more especially in that of the sugar cane, the sugar maple, and the root of the beet, from all which it is extensively manufactured.

Pure sugar is white, hard, brittle, inodorous, and intensely sweet. Its sp. gr. is 1.6, and it fuses at 350° into a clear yellow liquid. It crystallizes in four or six sided prisms, which are bevelled on their edges. It is soluble in its own weight of cold, and to almost any extent in hot water, and in four times its weight of boiling alcohol. It forms definite crystalline soluble compounds with alkalies and alkaline earths and common salt, and an insoluble one with oxide of lead, thus acting the part of a feeble acid.

497. Sugar is inflammable, and is much altered by exposure to heat, acquiring a dark colour and an

empyreumatic taste. It is then called *caramel*. The composition of cane sugar is $C_{12}H_{11}O_{11}$. Strong nitric acid converts it into oxalic acid; by the action of dilute nitric acid, it is converted into a pentebasic acid—the saccharic acid, the crystals of which consist of $C_{12}H_5O_{11}+5HO$, and its constitution must be regarded as $C_{12}H_5O_{16}+H_5$.

498. *Glucose—Sugar of Grapes.*—This species of sugar is the saccharine principle of grapes, and of most sweet fruits. It is also copiously secreted in certain diseases, such as diabetes, and is formed from starch in the process of germination, and from all the preceding compounds by artificial processes. It crystallizes in cubes, or in flat quadrangular tables, or in minute needles. Its sp. gr. is 1.38, and it is less sweet and soluble than cane sugar. It is converted into caramel by heat, and forms definite compounds with metallic oxides. Its composition when crystallized is $C_{12}H_{11}O_{11}+3Aq$, and when fused at 212°, $C_{12}H_{11}O_{11}+Aq$, or $C_{12}H_{12}O_{12}$. As the above compounds differ from each other only in the quantity of the elements of water, we can readily understand the ease with which they are converted into sugar of grapes.

499. Lignine is converted into grape sugar by macerating in the cold, 12 parts of linen or paper shreds, with 5 of oil of vitriol, and one of water. After 24 hours the mass is dissolved in a large quantity of water, and boiled for ten hours. It is then neutralized with chalk, and evaporated.

500. Starch is converted into grape sugar by moistening its paste with a solution of pale malt, and keeping the mixture at 160° or 170° for several hours. Six parts of malt will produce 2.5 of sugar. This change is effected by the action of a peculiar ferment, namely, the substance called *diastase*, which is formed in barley in the process of malting, and which can be obtained from it in the form of a gum-

Burnt sugar is the colouring of Brandy,

or Molasses

+ Thus wholesome rendered poisonous.

x such as Raisons Figs currants &c. which when bruised are never mixed with sugar, but from stones &c

& Thus Sugar may be obtained from cotton or linen rags or Paper which is pure ligneus, and that is prepared from Wood saw dust. and this saw dust Braude says (Dicty Liquid) if pure when carefully roasted like coffee becomes partly soluble and inter mediate between starch & sugar, and when mixed with a little flour & Baked, produces very palatable bread

dia through ιστημι istemi I set

Dextrine, because it reflects and depolarizes light to the right side

Grape sugar is $C_{12}H_{12}O_{12}$

alcohol $C_4H_6O_2$ p. 219 back

8 6 10

absolute alcohol

Prop. 38

my, tasteless, white mass. It acts only when in a state of active decomposition, and disturbs the equilibrium, so as to induce a new arrangement of the particles of the starch. One part of diastase is sufficient to convert in a few hours 2000 parts of starch into sugar, if the temperature do not exceed 168°.

This change is also effected by boiling one part of starch with four parts of water, and $\frac{1}{100}$th of sulphuric acid, during 36 or 40 hours; taking care to renew the water as it evaporates. It is not easy to point out the manner in which the sulphuric acid acts; but the change is evidently due to the fixation in the gum and cane sugar of one atom, in starch of two, and in lignine of four additional atoms of water.

501. Before being converted into grape sugar, starch is converted into a species of gum called dextrine, which is isomeric with itself, and which is speedily changed into sugar.

502. *The Vinous Fermentation.*—The changes which take place in the solution of grape sugar when it undergoes the vinous fermentation, have already been detailed. There is reason to believe that it is the only substance capable of that change, and that cane sugar becomes converted into it before fermentation takes place. The substances which excite the vinous fermentation all agree in containing a large portion of nitrogen, and in entering readily into that state of decomposition, which they communicate to sugar. Ripe saccharine fruits contain this principle, and their juices, therefore, spontaneously enter into the vinous fermentation whenever the temperature is favourable.

503. *Alcohol.*—$C_4H_6O_2$=46.48. The alcohol which is the product of this fermentation, may be separated from the water, gum, sugar, and other principles, with which it is usually associated, by repeated distillations; the last of which must be from dry carbonate of potassa, or chloride of calcium.

Pure or absolute alcohol is a colourless, limpid fluid of a penetrating odour, and hot, burning taste. It is highly volatile, of the sp. gr. of .795, boils at 168°, and has never been congealed. It is very inflammable, and burns with a lambent, yellowish-blue flame, without smoke. It unites with water in every proportion, heat is evolved, and the mixture occupies less space than did the alcohol and water it contains. Alcohol dissolves the resins, the essential oils, the alkalies, and the deliquescent salts. The latter crystallize from their alcoholic, in the same manner as from their aqueous solution, in combination with alcohol of crystallization. The term alcoate, is applied to these definite crystalline compounds.

From its greater affinity for water, alcohol precipitates gum, and the efflorescent salts, from their aqueous solution.

504. *Ether.*—C_4H_5O. This substance differs from alcohol by containing one atom less of water, and may be prepared from it by any process which will deprive it of that atom. It is usually obtained by the action of oil of vitriol on its own weight of alcohol. The mixture is quickly raised to the temperature of 260°, when it boils, and the ether distils over, mingled with water and alcohol, from which it is freed by a second distillation. In this process the oil of vitriol, and alcohol, both part with their water, and anhydrous sulphuric acid combines with ether to form sulphate of ether. This sulphate combines with another atom of oil of vitriol, and forms the bisulphate of ether, or sulphovinic acid, $C_4H_5O+SO_3+\overline{SO_3+Aq}$. When this product is heated to 260° it is decomposed; the ether escapes in the form of vapour, and the sulphuric acid re-combines with water.

505. Pure ether is a colourless, limpid fluid, of a hot, pungent taste, and fragrant odour. Its spe-

+ producing Varnishes

‡ spirits – Spirit of Peppermint – of Vanilla – Lavender & Perfumes

Alcoate

Sulphr acid & equal weight of Alcohol distilled

Sulpho vinic

is then called

Alcohol of Potash – describe degrees – common alcohol – rectified – Proof Spirit – double rectified concentrated by Potash or Lime & absolute by freezing

Describe improvements in Scotch Distilleries

The [illegible] or flameless lamp with Platin. coil is my improvement upon alcohol lamps.

cific gravity is .7; it is very volatile, boiling at 96°, and at —40° in a vacuum. At —46° it congeals, and its evaporation in a cool atmosphere is sufficient to freeze mercury. It combines with alcohol in all proportions, but is sparingly soluble in water. It is highly inflammable, and burns with a bright white flame. It dissolves the essential oils, resins, and fatty matters, but the fixed alkalies are insoluble in it. When a coil of platinum wire is heated to redness, and suspended over the surface of ether in an open vessel, it sets fire to the stratum of vapour immediately around it, and is kept at a red heat by the combustion until the ether is consumed.

Phosphoric acid acts on alcohol in the same manner as sulphuric, forming a phosphovinic acid, which is subsequently decomposed; and the ethers which the two acids form, are identical in composition and properties.

506. Ether combines with almost all the acids, forming compounds which constitute a very natural and distinct group of the family of salts. These ethereal salts are generally volatile, aromatic fluids, freely soluble in oil and alcohol, and more or less in water, although some of them are crystalline solids. The hyponitrite of ethule is the nitrous ether, and its alcoholic solution, the sweet spirits of nitre of the shops, a highly fragrant, sweet, volatile fluid, much used in medicine.

507. The salt radicals displace the oxygen of the protoxide of ethule, and form compounds possessing all the generic properties of the ethers. These phenomena are to be explained by regarding ether as the protoxide of an organic radical, C_4H_5, which has received the name of ethule, and which acts the part in composition of an electro-positive element. According to this view, the composition of ether is C_4H_5, O, and of alcohol $C_4H_5, O+HO$.

Ethule, ether, and alcohol, are the types of seve-

ral series of organic compounds in which the oxides, and the hydrated oxides of compound radicals, possess properties closely allied to those of ether and alcohol.

508. *Other products of the decomposition of Alcohol.*—When six measures of oil of vitriol are strongly heated with two of alcohol, the mass becomes dark, boils rapidly, and finally swells and blackens, and a mixture of various vapours and gases is copiously evolved. By agitation with water, the condensible products, which are sulphurous acid, ether, and vapour, are removed, and a gas remains which is colourless, of an ethereal odour, highly inflammable, and burning with a brilliant white flame and with much smoke. This gas is the olefiant gas, or heavy carbureted hydrogen gas of chemists. It detonates violently by means of the electric spark, when mixed with three or four times its volume of oxygen gas. For each measure of olefiant gas, three measures of oxygen disappear, water is deposited and two measures of carbonic acid gas are formed. These two measures of carbonic acid consist of two of oxygen and two of vapour of carbon. The remaining volume of oxygen combines with two volumes of hydrogen to form water; so that olefiant gas contains two volumes of vapour of carbon and two of hydrogen condensed into one, and its sp. gr. is therefore .9868. Its atomic constitution is C_2H_2=14.24, or according to others, C_2H_4=28.48.

509. If a jar of olefiant gas be inverted in a pneumatic trough, and bubbles of chlorine be passed up into it, both gases disappear, and a heavy oily liquid is formed, which may be collected in a cup beneath the mouth of the jar. When pure, this liquid is colourless, of a sweet ethereal odour, and inflammable. It consists of $C_2H_4Cl_2$, and is decomposed by an alcoholic solution of potassa, which

Olefiant Gas – Shall not make it now
But refer it to page 243 where
its natural production is noticed.

Fluid Salts before referred
to in 1st part p. 183.

Ethuret the base or
principle of Ethers is
C4 H5 Brande

or in other words Ether
is protoxide of Ethule
and alcohol the same
with 1 equiv.t of Water
or Hydrated per oxide

† It is from the formation of this oily substance that the gas has been called Oleiant or Oleafiant Gas. a term introduced by the Dutch chemists who discovered it.

Aldehyde

‡ Its name aldehyde is expressive of its modeof formation being an abbreviation of Alcohol dehydro-genatum, or alcohol deprived of Hydrogen (Graham) or rather of 1/3 of its Hydrogen; for Alcohol is $C_4 H_6 O_2$ while Aldehyde is $C_4 H_4 O_2$.

abstracts an atom of chlorohydric acid, forming chloride of potassium, and a gas having a garlic odour, and burning with a smoky red flame. The composition of this gas is C_4H_3Cl; so that the oily liquid is the chlorohydrate of this substance, and must be represented by $C_4H_3Cl+HCl$.

510. The chlorine has therefore in decomposing the olefiant gas, formed a new radical, C_4H_3, with which it has combined, forming the chloride, C_4H_3+Cl. This radical has received the name of *acetule*, and is formed from alcohol by other processes.

511. *Aldehyde.*—When alcohol is exposed to the action of substances which enable it to combine with oxygen, it parts with two atoms of its hydrogen, and is converted into a liquid called aldehyde, a neutral, inflammable, aromatic fluid, which mixes with water, alcohol, and ether. The composition of aldehyde is $C_4H_4+O_2$, and it bears the same relation to acetule that alcohol does to ethule; that is to say, it is its hydrated oxide, and its composition is represented by the formula $C_4H_3, O+Aq$.

512. *Acetic acid.*—If the oxidizing process be continued, aldehyde combines with two additional atoms of oxygen, and is converted into acetic acid, of which the formula is $C_4H_3O_3+HO$.

When any fermented liquor is exposed to the free access of air at the temperature of 60° or 80°, an intestine motion of the particles takes place, the liquid becomes turbid, absorbs oxygen, and in the end, all the alcohol is found to be converted into acetic acid. This acetous fermentation takes place with a rapidity proportioned to the free access of air; and the changes through which the alcohol passes are those which have been recited above; aldehyde being always a product intermediate between the alcohol and the acetic acid. The change is due, in all cases, to the presence of a decomposing ferment, which disturbs the equilibrium of the par-

ticles of the alcohol so as to bring new affinities into play.

The most concentrated acetic acid which can be prepared is the hydrated acid, $C_4H_3O_3+HO$. It crystallizes at 50° and boils at 240°; it has a peculiar aromatic pungent odour, and a caustic taste; it blisters the skin, mixes with water, alcohol, and ether, and dissolves camphor and the essential oils. Its specific gravity is 1.063; by diluting with water it acquires the sp. gr. of 1.078, and is then a definite compound of the acid, with two additional atoms of water. Further dilution reduces its specific gravity so that an acid containing 64 per cent. of water has the same specific gravity as the most concentrated.

513. *The Acetates.*—Acetic acid forms salts which are all soluble in hot, and most of them in cold water, and which are decomposed by sulphuric acid with the evolution of acetic acid. The acetate of copper is the pigment called verdigris; the acetate of lead, the well known salt, sugar of lead.

514. *Pyroligneous Acid.*—A pure acetic acid known by this name is prepared in considerable quantities by the destructive distillation of wood in close vessels. It is obtained mingled with tar, empyreumatic oils, water, pyroxylic spirit, &c., from which it is freed by being neutralized by carbonate of lime; the acetate of lime precipitates and is decomposed by sulphate of soda; the acetate of soda which is thus formed, is fused to free it from empyreumatic oils, and is then redissolved and crystallized, and decomposed by oil of vitriol.

515. *Pyroxylic Spirit.*—If the liquid from which the acetic acid in the above process, has been separated by carbonate of lime, be distilled, a spirituous liquid, termed pyroxylic spirit, is obtained, which closely resembles alcohol. Pure pyroxylic spirit is a colourless aromatic liquid, resembling in smell

This is usually called Henry Acromatic Vinegar, or formerly Vinegar of 3 Thieves in Prague in London – Vinegar is strongly antiputrescent and possesses strong preservative qualities – Hence its use in pickling Wet fruit – Salmon &c – – Fumigating Sick rooms at Guys Hosp.l Quick time in Vinegar – Dried and bottled – when wanted, throw in

Acetule the base or radicle of acetic acid, and all Vinegars is $C_4 H_3$

dilute Sulph.ic acid on it.

Acetates.

Verdigris
Sugar of Lead

Pyroligneous acid, fire & wood acid is that which affects our eyes, lungs & Mortals in wood smoak – It is this acid that is produced in our smoak Houses & wch preserves our Bacon.

Describe Iron cylinder for obtaining it – and shew it when obtained & when purified – Is now kept by carried on – See in future that same effect on Meat as smoaking but if purified, it perfect Vinegar.

Vinegar or acetic acid is therefore a Hydrated oxide of Aldehyde

Acetous fermentation

Methule base of wine μεθυ wine is $C_2 H_3$.

ξυλον Xylon Wood

From Formica Latin for Ant

and taste both alcohol and acetic ether. It burns with a paler flame than alcohol, its sp. gr. is .798; it boils at 140°, mixes perfectly with water, alcohol, and ether, dissolves the resins and essential oils, and is a true alcohol. When treated with sulphuric acid it produces an ether, an acid, and a heavy ethereal oil, in the same manner as alcohol.

516. *Methule.*—These phenomena are explained by the supposition of an organic radical called methule, the formula of which is C_2H_3.

Methylic ether will be represented by C_2H_3+O. It is a colourless gas of an ethereal odour, highly inflammable, and burning with a blue flame. It is eagerly absorbed by water, and is isomeric with alcohol, but having half its atomic weight.

Pyroxylic spirit is the hydrated oxide of methule, and is represented by C_2H_3O+HO. Methule combines with the electro-negative elements, and its oxide, with the acids, forming a series of compounds perfectly analogous to those of ethule.

517. *Formic Acid.*—If the vapour of pyroxylic spirit be brought into contact with oxygen gas by means of spongy platinum, four atoms of oxygen are absorbed; two of them enter into combination with two of hydrogen, which the other two atoms of oxygen replace, and the pyroxylic spirit, $C_2H_4O_2$, is thus converted into two atoms of water and an atom of formic acid, $C_2H_2O_4$. This acid derives its name from existing in a very concentrated state in the common ant. It may be obtained by distilling a mixture of one part of starch, sugar, or tartaric acid, with four of black oxide of manganese, four of water, and four of oil of vitriol. Pure hydrated formic acid is a limpid colourless slightly fuming liquid, of the sp. gr. of 1.235. It boils at 212°, and congeals below 32°. In its most concentrated state it is exceedingly caustic. It forms crys-

talline salts, and when the formiates of many of the metals are heated, they are decomposed and the metal is revived.

518. *Formule.*—Formic acid is the ~~per~~ ter oxide of a radical called formule, C_2H; and its composition is C_2H, O_3+HO. This radical bears the same relation to methule which acetule does to ethule.

519. *Oil of Potato Spirit.*—There are many secondary products of the vinous fermentation of great interest to the chemist. Thus the peculiar flavour of wine is due to a species of ether, which is the only one that is a natural product. The flavour of spirit from grain is owing to a peculiar essential oil. From the spirit distilled from potatoes, an oil, which bears the name of oil of potato spirit, has been separated. This oil, like the pyroxylic spirit, is a genuine alcohol.

It is a colourless oily liquid, with an acrid taste, and an aromatic yet nauseous odour, soluble in ether and alcohol, and sparingly so in water, burning with a blue flame, having a specific gravity of .812, congealing at 4°, and boiling at 294°.

520. *Amule.*—The composition of this oil is $C_{10}H_{12}O_2$. Sulphuric acid forms with it an ethereal oil, and it is evidently the alcohol of a radical of which the formula is $C_{10}H_{11}$, and to which the name of amyle, or amule, has been given. This radical combines with chlorine, and its oxide with acids ~~acids~~, to form true ethers. Its hydrated oxide is the oil above described, the proper name of which is *amylic alcohol.* By exposure to air this alcohol absorbs four atoms of oxygen, and loses two of hydrogen, being converted into an acid, $C_{10}H_{10}O_4$, identical with the valerianic acid, which exists naturally in the valeriana officinalis. This is an oily volatile acid, lighter than water, and forms soluble sweet-tasted salts.

521. *Cetule.*—There is a fourth radical of the

Jany 29. 1848 Saty Cousin

A new Anaesthetic Agent having none of the Evil or disagreeable effects of Ether for suspending pain

Perchloride of formyl, called Chloroform $C_2HCl_3 = FoCl_3$

‡ a colorless oily liquid – agreeable ethereal smell sweetish taste – density 1.48 @ 64° – boiling point 141.°44 – inflames with great difficulty – but burns green in flame of a candle – Mode of making Grahams chemy by Bridges p 566 also ment.d & described in Kane p 646 –

Dr H Wells committed Suicide Jany 1848

Sir H Davy hoped nitrous oxide wo.d produce this effect; but it failed – Dr. Horace Wells of Hartfd Ct a dentist tried it with success in 1st case but not afterwards this was in 1842 – In autumn of 1846 Dr. Chas Jackson of Boston suggested to Dr. Morton a dentist ~~that~~ vapor of sulph.c Ether wo.d ans.r the purpose – he tried it and claimed the discovery but they jointly took out a patent for it under the title of Letheon The N. Yk Physicians set faces ag.t it – Dr. Simpson commun.d 1st acct of it to Med.o Chirg.l Socty of Edinburg 10 Nov.r 1847 & to him belongs the discovery of its Anaesthetic properties – Spoonful on a Handkerchief applied to mouth & nostrils produces sleep in few minutes.

+ Amyl ~~or fousel oil~~ in Graham, and Amilic alcohol in Kane is the hypothetical radicle of a series of compounds of which the hydrate of the oxide as long been known as fousel oil, or oil of grain Spirits or of Potatoes – It consists of $C_{10}H_{11} = Ayl$ –
It is produced in the fermentation of unmalted grain & Potatoes along with alcohol & distills over with it, & gives it a bad taste & odour – The most striking analogy exists between oil of Potatoes & ordinary alcohol, and it is no doubt an alcohol.

Cetule is the base of Spermaceti from κητος whale it is $C_{32}H_{33} = Ct$. but has never been isolated.

† Its name Ethal is formed of the first syllables of Ether & alcohol and must not be confounded with Ethyle or the base of Ether (p 235) This Ethal is the hydrate of the oxide of Cetene

‡ It is obtained by vaporating ther whey of milk to a syrupy consistency then setting it aside to work for a crystallization, and purifying the first product by animal charcoal, and then vaporating slowly and obtaining a 2nd crystallizn (Graham p 515) when

((particularly Fraxinus ornus a species of Ash

△ Lac (Latin) Milk ther acid being originally derived from sour Milk. It exists also in Male Urine, in Sour Kraut &c

same family which forms an ether, an alcohol, a compound isomeric with olefiant gas, and an acid, precisely as in the above cases. This radical is called cetule; its constitution is $C_{32}H_{33}$; that of its ether $C_{32}H_{33}$, O, of its alcohol $C_{32}H_{33}$, $O+HO$, of its olefiant gas $C_{32}H_{32}$, and of its acid $C_{32}H_{31}O_3+HO$. This cetylic alcohol is obtained by the action of alkalies on spermaceti, and is known by the name of *Ethal*. It is a tasteless, inodorous, white crystalline solid, which melts at 119°, and volatilizes at 250°, is insoluble in water, burns like wax, and forms with sulphuric acid a compound analogous to sulphovinic acid.

The perfect parallelism of the compounds of these radicals, methule, ethule, acetule, and cetule, is one of the most remarkable and instructive facts, which the recent researches into organic chemistry have brought to light.

522. *Lactine—Sugar of Milk.*—There are other species of sugar which naturally belong under this head of the alcoholic series. Of these, lactine and mannite are the only ones necessary to be noticed.

Lactine, or sugar of milk, is a secretion found only in the milk of animals. It crystallizes in white semi-transparent square prisms—of a highly sweet taste, slowly soluble in water, and forming a very sweet syrup. These crystals contain $C_{24}H_{19}O_{19}+5Aq$, and are therefore isomeric with grape sugar, having double its atomic number. When heated to 300°, the sugar of milk fuses, and the 5 atoms of water are driven off. Dilute sulphuric acid converts it into grape sugar.

523. *Mannite.*—Mannite is a secretion from the inner bark of many trees. It is obtained from manna by the action of boiling alcohol, and crystallizes in shining acicular crystals. Its taste is sweet, it does not combine with bases, and its formula is $C_6H_7O_6$.

524. *Lactic Acid.*—When the juice of the beet,

or of the carrot root, which contains much sugar, is kept for some time at 100°, a genuine fermentation takes place, which is termed the viscous or mucous fermentation. Alcohol is not formed in this process, but all the sugar disappears, and gum, mannite, and lactic acid, are found in its place. The lactic acid which is thus formed, is copiously secreted in the living animal, and plays an important part in the changes which take place in the vital fluids. Pure concentrated lactic acid is a syrupy liquid of a strongly acid taste, the formula of which is $C_6H_5O_5+HO$, and which is therefore isomeric with sugar of grapes, having half its atomic number. When heated to 480°, it parts with the elements of two atoms of water, and crystallizes in brilliant white plates, which may be purified by solution and crystallization from alcohol. Their constitution is $C_6H_3O_4$. Lactic acid is monobasic, and forms crystalline and soluble salts.

525. *Products of the decay of Lignine.*—When lignine is exposed to the action of air and moisture, its hydrogen slowly consumes, the vegetable structure becomes disintegrated, the proportion of carbon continually increases, and it is at last converted into vegetable mould, or into turf. The principal element of mould was originally obtained from the decomposition of the elm, and received the name of ulmine. It is also called humus, and geine, and the acid into which it passes by the action of alkalies, the ulmic, humic, and geic acid. These products are the elements which impart to vegetable mould its fertilizing qualities. Products closely allied to them are evolved by the action of cold dilute sulphuric acid upon starch, sugar, and lignine, and have received the names of sacchulmine, and sacchulmic acid. The formula of the former is $C_{40}H_{16}O_{14}$, and of the latter, $C_{40}H_{14}O_{12}$. A still longer action of a stronger acid converts these products into saccharohumine, $C_{40}H_{15}O_{15}$, and saccharohumic acid, $C_{40}H_{12}O_{12}$.

+ This fermentation is quite different from the viscous because

‡ as in Diabetes or sweet Urine

wine Ether Vineg.r Spirit

— Ulmin from the Elm — Humus Ground
& Geine from Earth

Ulmic, humic or geic acid is $C_{40} H_{12} O_{12}$.

These are dark brown, or black substances, resembling ulmine and ulmic acid. If four atoms of lignine, $C_{48}H_{32}O_{32}$, combine with fourteen of oxygen, there will be given out $8CO_2$, and 18HO; and an atom of ulmine or geine, $C_{40}H_{14}O_{12}$, will remain. The formula of the ulmic or humic or geic acid is $C_{40}H_{12}O_{12}$, being isomeric with the saccharohumic acid. This acid is insoluble in water, has a strong affinity for ammonia, and other alkaline and earthy bases with which it is combined in the soil. It is the opinion of Liebig, that it does not enter into the circulation of plants, but that its fertilizing properties are due to the ease with which it is decomposed, and the copious supply of carbonic acid it thereby furnishes.

526. *Light Carburetted Hydrogen Gas.*—When this decay of woody fibre takes place in shallow waters, a peculiar inflammable gas is disengaged, which consists of CH_2, and is called light carburetted hydrogen, or marsh gas. It results from the decomposition of lignine by water, one atom of the former, $C_{12}H_8O_8$, combines with four of the latter, and yields $6CO_2$, and $6CH_2$. This gas may also be formed by heating to redness in a glass retort equal parts of acetate of potassa and caustic potassa. The acid and water are simultaneously decomposed, $C_4H_3O_3$, and HO, producing $2CO_2$, and $2CH_2$; the carbonic acid is absorbed by the potassa, and pure light carburetted hydrogen is evolved. It is a colourless, transparent, inflammable gas, burning with a yellow flame, and forming, with oxygen, a highly explosive mixture. It consists of 100 measures of vapour of carbon, and 200 of hydrogen, condensed into 100, and its sp. gr. is .5593.

527. This gas is occasionally disengaged in vast quantities in coal mines, and forms a highly explosive mixture by mingling with the atmospheric air. It constitutes the fire-damp of the miners, and has

The heavy Gas, see back page 236. is made by 6 measures oil vitriol & 2 of alcohol in retort over water & is olefiant gas - requires a powerful [illegible] & comes over very [illegible] when it begins - [illegible] with Gallons [illegible] enough to throw the Burner - this & a quart [illegible] damp & [illegible] to it burns is enough [illegible] out of about a [illegible] & 4 or 5 oz oil Vitl

Fire damp in coal mines

occasioned the most disastrous accidents to those engaged in mining for coal. The frequent occurrence of the most melancholy disasters, drew the attention of Sir Humphrey Davy to the investigation of their cause, and the result of his experiments forms one of the proudest triumphs in the annals of science.

Sir Humphrey commenced his inquiries by determining the best proportions of air and of light carburetted hydrogen for forming an explosive mixture. This he found to be one of the latter to seven or eight of the former. In proportion as the relative quantity of either is increased, the mixture detonates more feebly, and ceases to explode when the air does not form more than three or four times the volume of the inflammable gas. On the other hand, the mixture continues to be feebly explosive when the volume of the air is increased to fourteen times that of the gas; while, if the proportion be still further increased, a taper burns in it with only an enlarged flame.

528. Davy next ascertained the temperature required for causing an explosion. He found that the strongest explosive mixture may be brought into contact with iron, and other solid bodies, heated to a red and even to a white heat, without detonating, provided the solid body is not in a state of combustion, whereas the smallest point of flame instantly causes an explosion. The cause of this difference is, that the temperature necessary to produce flame is far higher than the white heat of solid bodies; for flame is gaseous matter, heated so intensely as to be luminous.

Such being the nature of flame, it follows that rapid cooling will immediately extinguish it. Davy observed that flame is always extinguished in the passage through a narrow tube. He found that the narrower the tube, the shorter it may be to produce

1/4 past 10 to 11 1/2

1 of Carbur^d. Hyd^n. to 7 or 8 of air
is the most explosive mixture

22 pp
preface of Sect^n.
of Chap 3 the
alcoholic series
p 228 to Camphene
series Sect 2 p 246

for acc of the Black residuum
which is Thiomelanic Acid see
Kane p 557

Equals vols of Olefiant Gas &
Sulph^s Acid Gas come over
the latter being absorbed by
the water leaves Olef^t Gas

The heavy Gas, see
back page 236. is
made by 6 measures
oil vitriol & 2 of alcohol
in retort over water
& is olefiant gas –
It requires a powerful Spts
Lamp & comes over very
rapidly when it begins –
The Bell rec^t. with Gallons (some)
hold quite enough to show the
argand Burner – this & a quart
for Davy's Lamp & 1/2 pint to
show how it burns is enough &
this is got out of about a full
oz of alcohol & 4 or 5 oz oil Vit^l

Fire damp in Coal
mines

June 1847 Portobello Mary Johnston

No Private Examinations recorded

Public D^o. page 38

Sen^r. Math —	Wed 23^rd June
Pol Econ	Thur } 24^th to 11½
Metaphy —	} from 11½
Nat Phil	Frid – 25
Law —	Saty 26
Greek Sen^r & Jun^r. —	Mon 28
Belles Lees L^t. —	} Tue 29 to 11½
Nat^l. Law —	} — from 11½
Latin Sen^r. & Jun^r.	Wed 30^th
Junior Math^s.	Thur 1^st July
Chemistry —	Fri 2^nd
Histy —	Saty 3^rd –

10 days –

Private exam^ts June 1846 page 444

✓ Jun^r. Math —	Wed 17 June
✓ Jun^r & Sen^r. Greek	Thur 18
✓ Sen^r. Math^s —	Fri 19
✓ Nat Philo	Saty 20
Governm^t. —	Mond 22
✓ Latin Classes	Tue 23
✓ Chemistry	Wed – 24