previous to her death. One of the mesenteric glands was enlarged and indurated.

It is worthy remark that there was not found, in any part of the alimentary canal, any thing resembling in the smallest degree the peculiar substances, which the patient had discharged so abundantly during life.

SOME ACCOUNT OF IODINE.

BY J. FREEMAN DANA, A. M.

THE following account of Iodine is collected from various notices, which have appeared in different foreign journals, and from experiments which I have had an opportunity to make on this curious substance. Many of the experiments which have been made by the European chemists, have been repeated with great interest. For a full history of iodine, I refer the reader to that able memoir of Gay Lussac, in the *Annales de Chimie*, for July, 1814, a translation of which may be found in Thompson's *Annals of Philosophy*, vols. 5 and 6, and to the papers of Sir H. Davy, in the *Philosophical Transactions* for 1814. As soon as the account of the discovery of this substance reached Boston, I endeavoured to procure materials for preparing it, and fortunately found some barilla at the glass-house, with enough of which, I was politely supplied by Mr. Thomas Chase, then clerk to that manufactory. From this some iodine was prepared, and was exhibited by Professor Gorham, to a society of philosophical gentlemen in Boston, and was probably the first ever prepared in the United States. Since June, 1814, I have employed every opportunity in some experiments on this body.

Iodine was discovered accidentally by M. Courtois, in 1811; this gentleman has an extensive manufactory of salt-petre in Paris, and found, in his process for procuring soda from the ashes of sea-weeds, that his metallic vessels were much corroded, and searching for the cause, made the discovery; he observed several of its properties, especially that of forming a fulminating compound when treated with ammonia; but from the attention required by his manufactory, he was unable to pro-

secute his inquiries, and therefore committed it to some of the French chemists, who pursued the examination of it, and have done honour to their undertaking.

Various methods for obtaining this substance were given in the *N. E. Journal* for July, 1814; the following processes will be found very simple and easy.

1. Dissolve the barilla or black-ash of commerce, in water, and gently evaporate until no more crystals appear; decant the liquid and evaporate to dryness in a bason of Wedgewood's ware; the salt thus procured should then be fused, and afterwards broken into coarse powder; introduce the powdered salt into a deep tubulated retort, with a short neck, and adapt a large receiver; pour over the salt highly concentrated sulphuric acid, and iodine immediately appears in the form of a beautiful violet coloured vapour; apply a gentle heat, and the iodine passes to the receiver, where it is condensed. A smell resembling hydrochloric (muriatic) acid is perceptible; this arises from a small portion of common salt, remaining attached to the mass in the retort, and from a peculiar acid (the hydroiodic) to be hereafter noticed.

2. Another method by which rather a larger quantity may be obtained, is given by the Dr. Wollaston. Dissolve kelp in water, concentrate the solution by evaporation, and separate all the crystals that can be obtained; pour the remaining liquid into a clean vessel, and mix with it sulphuric acid in excess, and boil it for some time; sulphur is precipitated and muriatic acid evolved; decant the clear liquid and strain it through wool; put it into a small flask and adapt a tube closed at one end, previously putting into it as much black oxide of manganese as you added before of sulphuric acid; apply a gentle heat, and iodine sublimes.

PROPERTIES OF IODINE.

Iodine in a solid state, is crystallized, having a colour and lustre similar to plumbago; the form of the crystals, as ascertained by his ingenious reflective goniometer, is that of an octahedron, whose axes are to each other in the ratio of 2, 3 and 4. This form, says Dr. W. most frequently appears in a section of the octohedron parallel to a plane of its greatest and least axes, presenting to view a rhombic plate, bevelled at each edge by two narrow planes, which are inclined to each other at an angle of

12½°. Its odour is similar to that of chlorine, but not so suffocating; taste very acid; water dissolves about one seven thousandth of its weight, and acquires a yellow colour; it stains the skin brown, but the colour is soon removed; it destroys vegetable colours, but not so rapidly as chlorine; specific gravity 4,948, at 62½°; it is a non-conductor of electricity; it possesses a negative electrical energy with respect to metals, inflammable and alkaline substances, but is positive with respect to chlorine; for when united to chlorine (as in an acid compound to be mentioned) it separates from it at the negative surface in Voltaic arrangements. At the temperature of 225° it melts, and under common pressure of the atmosphere is volatilized at about 340°; this was ascertained by Gay Lussac, by putting iodine in excess into sulphuric acid, and observing at what temperature the vapour passed through the acid. Iodine when mixed with water, may be distilled over with that liquid; its vapour mixes with that of water at 212°, and it may be distilled at a lower temperature even; the same thing happens to the essential oils, they boil at the temperature of 509°, but may be distilled with water at 212°.

From all the experiments made on this substance, it is considered as an undecomposed body, as a supporter of combustion, and analogous to oxygen and chlorine.

OF THE COMPOUND OF IODINE AND OXYGENE.

This compound was first obtained in a separate state, by Sir H. Davy; he formed it by causing a current of *euchlorine* to act on iodine, a combination took place, and a solid body formed, which consisted of a compound of iodine with oxygen, and of chlorine with iodine, called *chloride*, which will be noticed below; when the substances formed by this action were exposed to a gentle heat the *chloride* was driven off, and the *oxide* remained behind; it has the following properties; it is a solid of a white colour; of considerable specific gravity, as it sinks in sulphuric acid; astringent taste; dissolves rapidly in water, forming a colourless solution, which has acid properties; when exposed to heat oxygen is evolved, and iodine remains; it first reddens vegetable blues and then destroys them. The name *iodic*, or rather *axiodic acid*, has been given to it, and it is probably composed of one proportion of iodine, and five of oxygen.

The compounds formed by this substance with different bases, were discovered by Gay Lussac, although he failed in his attempts to procure it in a separate state; he however calculated the composition of it with great accuracy, and inferred from his experiments, that it consisted of 100 iodine combined with 32,0085 oxygene, that is to say oxiodic acid contains five proportions of oxygene. Oxiodic acid has the property of combining with different bases, and of forming with them a peculiar class of salts, called iodates or oxiodes; it also possesses the property of combining with various acids, and forming solid compounds, which for the most part are susceptible of crystallization. When dropped into sulphuric acid, a solid substance falls, which melts when heated, and on cooling crystallizes into rhombs of a yellow colour; according to Davy it is composed of twenty oxide, and eight sulphuric acid, he considers it as a hydrate; one proportion of iodine, one sulphuric acid and two water. The two acids of phosphorus, nitric and oxalic acids also form peculiar compounds with the oxiodic acids. Oxiodic acid dissolves gold and platinum; no other compound of oxygene and iodine have yet been discovered.

OF IODINE COMBINED WITH CHLORINE.

When chlorine is brought into contact with dry iodine, it is rapidly absorbed, producing a temperature equal to boiling water. There appear to be two compounds of chlorine and iodine, the one of a yellow, and the other of an orange red, to these Gay Lussac has given the name of chloruret and sub-chloruret of iodine; there does not appear any evidence, that they are two distinct compounds, since the sub-chloruret may be easily formed by the addition of iodine to the chloruret, and may be again precipitated by an alkali, so it is probable that this compound of chlorine and iodine, called *chlorionic acid*, may hold a variable quantity of iodine in solution, and thus the colour of the supposed "sub-chloruret" may become deep, according to the quantity of iodine it contains.

Chlorionic acid rapidly deliquesces in the air, forming a colourless solution, which becomes coloured on exposure to strong light, or to a gentle heat, chlorine being evolved, and iodine being dissolved by the remaining liquid.

Chlorionic acid discharges the colour from a sulphuric solution of indigo; when acted on by an alkali it suffers decompo-

sition; oxiodic and hydrochloric acids are formed, which combine with the alkali.

When we wish to obtain it free from iodine, we pass a current through a dilute solution of iodine in the acid, and exposing it for some time freely to the sun; the product is a very acid colourless liquid, from which iodine is abundantly precipitated by ammonia.

Is it not probable that the liquid acid may be a mixture of oxiodic and hydrochloric acids, and that water may suffer decomposition when the solid chlorionic acid is added to it? Since we obtain an acid of precisely similar characters, when we mix oxiodic and hydrochloric acids, and moreover the latter are much more stable compounds than the former, and *ceteris paribus*, strong compounds are formed in preference to weak.

Chlorionic acid is very volatile, but in consequence of its rapid action on mercury, the elastic force of its vapour has not been ascertained; iodine absorbs less than one third its weight of chlorine, and chlorionic acid probably consists of one proportion of iodine and one of chlorine.

OF THE COMPOUND OF IODINE AND HYDROGENE.

This compound may be obtained, in a gaseous form, by various methods, by the action of hydrophosphoric acid on the iodate of potash, or by the action of phosphorus on moistened iodine, or by moistening the ioduret of phosphorus; the gas evolved may be condensed in water. The most eligible method of procuring it in a liquid state is, to dissolve iodine in water, and pass a current of sulphuretted hydrogen through the solution, sulphur is precipitated, and the hydrogen combined with the iodine; or dissolve the ioduret of phosphorus in water, and separate the compound of hydrogen and iodine from the phosphoric acid by distillation. It is called *hydroionic gas* or *acid*; when the gas comes in contact with mercury it is decomposed, and if a volume of it be agitated over mercury a few minutes, a solid body of mercury and iodine is formed, and if the gas was pure, half a volume of a gas remains, which is hydrogen.

When hydroionic gas is made to act on potassium or zinc, the same results are obtained, viz. a solid compound of the metal with iodine, and half the volume employed, of hydrogen; hence the composition is evident, and it consists of one proportion of iodine, united to one of hydrogen.

Its odour is similar to that of hydrochloric gas ; its specific gravity is 4,429.

The effect of chlorine on this gas is very striking, as it instantly deprives it of hydrogen, and the dense, beautiful violet colour of the iodine appears, while hydrochloric acid is formed.

It is partially decomposed by a red heat, and completely, if oxygen be present ; water is formed and iodine evolved.

This gas is abundantly soluble in water ; when dissolved in large quantity it renders the water smoking, and of great density ; the liquid acid may be concentrated by evaporation, and obtained of a sp. gr. equal to 1,7. Though colourless when recently prepared, it absorbs oxygen when freely exposed to the air, water is formed and iodine precipitated, which being dissolved, renders the acid of a chocolate colour or brown red, nor can this colour be discharged by boiling. From this power of absorbing oxygen without evolving any gas, it may be a good eudiometric substance.

Sulphuric and nitric acids, and chlorine decompose hydroiodic acid, and the iodine is precipitated or exhaled in violet vapours, and indeed chlorine when cautiously added, is a delicate test of the presence of this acid.

Hydrogen cannot be made to act directly on iodine at common temperatures, but exposed to a red heat they unite.

OF IODINE AND NITROGENE.

These two bodies cannot be made to unite directly, but only through the medium of ammoniacal gas dissolved in water ; when ammonia is passed over iodine, a viscid brown, shining liquid, a true ioduret of ammonia is formed ; and iodine in proportion as it is saturated with ammonia loses its lustre ; when ioduret of ammonia is dissolved in water, the alkali suffers decomposition, hydroiodate of ammonia is formed, and the compound of azote and iodine ; the ioduret of azote may more easily be obtained by putting iodine in fine powder, into a strong solution of ammonia in water, and the compound will be obtained in the form of powder, of a blackish brown appearance. Great caution is requisite in preparing ioduret of azote, it explodes with ease, either by gentle friction or slight elevation of temperature ; it will even, when well prepared, explode spontaneously ; the explosion is attended with a faint violet coloured light, and is very loud, being instantaneous. The com-

pound was discovered by M. Calin, and consists of one of iodine and one of azote.

OF IODINE WITH THE SOLID INFLAMMABLES.

Sulphur forms with iodine a compound of a dark greyish colour, crystallized and radiated like sulphuret of antimony; its elements are held together by a weak affinity, for iodine is separated when distilled with water.

Carbon has no action on iodine in any circumstances, under which they have been placed.

Phosphorus combines with iodine, producing, during their action, heat without light; there are at least two distinct compounds of phosphorus and iodine, the one is of a greyish black colour, of a crystalline appearance, easily fusible; when brought into contact with water, hydroiodic acid and phosphorous acids are formed; it doubtless consists of one proportion of phosphorus united with one of iodine. The other compound is a black substance, difficultly fusible, and consists of one phosphorus and two iodine; this as well as the former compound, exhales vapours of hydroiodic acid when slightly moistened.

Boron has no action on iodine; boracic acid when fused with ioduret of potassium, is decomposed, the iodine is evolved, and oxygene separated from the boron; the latter may be obtained by dissolving the glass formed by the fusion, filtrating and washing the boron, which remains on the filter.

OF IODINE WITH SOME OF THE METALS.

Potassium, when introduced into vapour of iodine, burns with a faint bluish light, and much heat; the compound melts and sublimates at a red heat; on cooling assumes a white crystalline appearance; taste acrid; soluble in water; composed of one of iodine and one of potassium.

Zinc combines with iodine without violence, producing heat without light; the compound is white; one zinc and one iodine.

Tin combines with iodine; when in powder the compound is of a dirty yellow colour; it decomposes water, hydroiodic acid is formed and oxide of tin precipitated, or in part dissolved; hence probably originated the idea that iodine forms an acid with tin.

Iron combines with iodine, forming a brown substance fusible at a gentle heat, and volatile at a higher temperature; its solution in water is of a light green colour.

Lead, Bismuth, Copper, Mercury, and Silver, form compounds with iodine, of various shades of red, brown and orange; they are insoluble in water, while the iodurets of very oxidable metals are soluble.

Mercury forms two distinct compounds with iodine, the one yellow and the other red; the latter when crystallised is of a bright crimson; the one contains half as much iodine as the other, the mercury being the same in both.

All the metallic iodurets are decomposed by strong sulphuric and nitric acids, the metal oxidated and iodine disengaged with hydrogen; all of them which have been subjected to the action of oxygen at a red heat, have been decomposed, except those of potassium, sodium, lead, and bismuth. Iodurets are decomposed by chlorine, and sulphurets and phosphurets by iodine.

OF THE ACTION OF IODINE ON OXIDES.

When iodine is made to act on metallic oxides, the result is very different, depending on the presence or absence of water; thus when vapour of iodine is made to act on dry potassa, procured from potassium, oxygen is evolved, and an ioduret of potassium formed; but when iodine is added to a moderately strong solution of potash, the action which ensues is analogous to that which takes place when chlorine is passed through a solution of potash, two compounds are formed, the one consisting of potassium and iodine, and the other of potassium, iodine and oxygen. When iodine is added to a solution of potassa, the triple compound falls down in the form of fine granular crystals, and may be obtained pure, and free from the double compound, by digestion in alcohol, which dissolves the latter, and has little if any action on the former. The double compounds have all the properties of the iodurets obtained by the direct combination of the base with iodine; the triple compounds are analogous to the hyperoxymuriates, and are called oxyiodes, or oxyiodates.

The oxyiodates of potassium and sodium are similar to the hyperoxymuriates of those bases; their crystals are of a cubic form nearly; they scintillate when thrown on burning coals, like nitre; form a deflagrating mixture with charcoal; detonate by percussion with sulphur; when fused, give off an abundance of oxygen gas; are not altered on exposure to the

air; their composition is also analogous to the hyperoxymuriates. Oxyiodate of potassium is composed of one proportion of potassium, one of iodine and six of oxygene, hyperoxymuriate of potash, one of potassium, one of chlorine, and six of oxygene. Oxyiodate of ammonia is in the form of small granular crystals, and detonates when thrown on burning coals. The other oxyiodates have no interesting properties.

Hydroionic acid combines with the alkalis and earths, forming a class of salts called hydriodates, which are very analogous to the hydrochlorates, (*muriates*) and their properties are uninteresting. This acid also, when mixed with alcohol, forms a peculiar substance called hydroionic æther, which is very little soluble; has a strong and peculiar odour; is not inflammable; potassium may be preserved in it unaltered; exhales purple vapours when thrown on burning coals. Its specific gravity is about 1.92; boils at 148°; is composed of 100 acid and 18.55 of alcohol according to Gay Lussac.

Iodine when combined may be detected in the minutest portions by a paste made of starch in water. I have frequently taken a cork employed to close a phial containing iodine, and made traces with it on clean white paper, and when a paste brush or a little moistened starch is rubbed over it, the traces instantly become of a dense indigo blue. From this circumstance, and the fact that a beautiful violet or purple vapour arose from indigo when exposed to a gentle heat, I imagined that "Indigene" might be analogous to iodine, but after a great many experiments made on that substance, in conjunction with professor Gorham, no resemblance in chemical properties could be traced.

Water, when it contains less than one thousandth of its weight of the double or triple alkaline compounds of iodine, tarnishes polished silver; this effect produced by the compounds of iodine may be distinguished from that produced by sulphurets or sulphuretted hydrogen, by this circumstance, that solutions of sulphurets, or of sulphuretted hydrogen, by being boiled with a little muriatic acid, no longer tarnish silver; whereas solutions containing iodine still retain that power.

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