



LXVIII. On iodic æther

James F.W. Johnston M.A. F.R.S. E

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LXVIII. *On Iodic Æther.* By JAMES F. W. JOHNSTON, *M.A.*
*F.R.S. E. &c. &c.**

WHEN a saturated solution of iodine in alcohol is poured into hot nitric acid in a large flask, a violent action takes place with evolution of nitric æther, acetic acid and deutoxide of azote; and the colour of the iodic solution disappears. If the heat be kept up, and iodine in a solid state be gradually added as long as the action takes place, and the colour disappears, there is deposited on cooling a transparent yellowish oily-looking fluid, heavier than water, and possessing the following properties:—

1. It has a strong penetrating odour, very different from that of the hydriodic æther of Gay-Lussac, and a sharp burning taste, the effect of which remains upon the tongue for a considerable time.

2. When free from excess of iodine it is of a very pale yellow colour; a slight heat, however, discolours it by causing partial decomposition.

3. It is not easily inflammable. It cannot be volatilized without decomposition. The heat and light of the sun decompose it in close vessels; it becomes coloured and deposits iodine in regular crystals. Kept in contact with the acid liquid in which it was originally formed, it remains colourless for a great length of time. Left to spontaneous evaporation in the open air it thickens, becomes discoloured, and disappears very slowly. On the hand it volatilizes rapidly, and leaves a stain like iodine.

4. Its specific gravity at 60° Fahr. is about 1.34.

5. The boiling point of the compound is as high as 230° Fahr. When gradually heated in a small retort, a colourless fluid, having an æthereal odour, begins to distill over as low as 160°; while the æther in the retort gradually thickens and becomes dark coloured. At 380° this coloured liquid comes over very slowly in brownish red fumes, which condense in the beak of the retort into a dark brown solid, consisting chiefly of iodine. Over a spirit-lamp the distillation and decomposition are much more rapid; iodine is given off in copious violet-coloured vapours, and there remains a light shining charcoal, which in the flame of a candle burns away very slowly. The clear liquid which distills over by a gentle heat reddens litmus, but gives no æther by admixture with water.

In preparing this æther, if we continue the heat after the iodine has disappeared without adding more, the æther held in solution by the acid liquid is again decomposed, the solu-

* Communicated by the Author.

tion becomes coloured, iodine is deposited and volatilized, and olefiant gas is given off. If the experiment be made in a tubulated retort, the iodine condensed in the beak and in the receiver is gradually converted, by the absorption of the olefiant gas which comes over, into Faraday's iodide of carbo-hydrogen, which crystallizes in long white prisms of one or two inches, or forms an entire massive coating in the interior of the long beak.

6. It dissolves largely in alcohol, either cold or hot, giving a colourless solution, from which water precipitates a large quantity of it, but of a brown colour. The alcoholic solution when distilled gives a colourless neutral liquid not troubled by water, but which, mixed with caustic potash and placed in the light, becomes brown, showing that it contains iodine. In the retort there remains the brown opaque fluid. Æther mixes with it in all proportions, and by agitation separates it from the acid liquid in which it is formed. It might therefore be employed with advantage in the preparation of the iodic æther, were it not difficult again to separate the whole of it by water without decomposition. Water dissolves it in small quantity. When the yellow æther is washed with water it becomes less in quantity, less fluid, and of a brown colour, which by further washing gradually deepens to a dark brownish red. The aqueous solution is colourless, and slightly acid, due, as appears from its reactions, to the presence of a small quantity both of iodic and of hydriodic acid.

7. Sulphuric acid in the cold decomposes it, rendering it dark brown; when heated it becomes dirty black, and vapours of iodine are given off. A few minute prisms of a yellowish colour also condense in the upper part of the tube, which are probably iodide of carbo-hydrogen (iodide of ætherine). On muriatic acid it floats unchanged, but as the lighter parts evaporate or are dissolved it becomes brown and dense, and sinks to the bottom; the acid at the same time becomes yellow. Nitric acid in the cold does not act upon it. The acid solution in which it is formed retains it in solution only till it cools. When once separated by cooling, it cannot be redissolved by the application of heat.

8. When chlorine is passed over it, muriatic acid is formed, and the æther becomes red. This gas, however, does not seem to be capable of decomposing it entirely; for when gently heated after long exposure to an atmosphere of chlorine, it gives off chlorine and muriatic acid vapour, and sinks apparently unchanged, except in colour, when put into water.

9. When obtained by decantation from the acid liquid in which it is formed, the æther reddens litmus; and from the

ease with which water and the caustic and carbonated alkalies discolour and partially decompose it, and the impossibility of distilling it, I have not hitherto obtained it in a state, in which, in the air at least, it does not possess this property in a slight degree. A weak solution of caustic potash or soda acts upon it like water, discolouring it and diminishing its volume; but after washing again with water to remove the alkali a slight action upon litmus is still observable. This is to be ascribed solely, I believe, to partial decomposition. A concentrated solution of a caustic fixed alkali acts upon it, with the evolution of heat and some gas; and when allowed to subside after agitation the alkaline solution is of a red colour, and the æther, much diminished in quantity, is colourless, or nearly so. Agitated with pure water the æther again becomes coloured and tinges litmus. With a sufficient excess of caustic alkali it appears, like muriatic æther, to be resolvable into a colourless oil containing only carbon and hydrogen.

The alkaline solution evaporated to dryness, and the dry salt redissolved gives no trace of iodic acid. It precipitates lead of the well-known yellow colour, but it does not precipitate muriate of barytes. Nitric acid separates iodine from the solution.

10. After being treated with caustic potash in a concentrated solution, potassium has a very slight action upon it, becoming tarnished, evolving minute bubbles of gas, and making the liquid slightly brownish. If potassium be dropped into the æther as first obtained, much action and evolution of heat takes place, æther and an iodide are formed, and charcoal remains behind.

11. When dry phosphorus is thrown upon it considerable action takes place, with evolution of heat, and an iodide of phosphorus is formed. The same takes place under water, and the supernatant liquid contains hydriodic acid, from which nitric acid precipitates the iodine. On sulphur it has no action.

12. Mercury does not act upon it in the cold, unless the æther have become discoloured by partial decomposition, when the mercury removes the free iodine to which the colour is due. When slightly heated a greenish pellicle is formed on the mercury, and the colour developed in the æther by heat disappears. This greenish pellicle dried and heated becomes red, showing that some iodide had been formed. The decomposition, however, is due to the heat and not to the action of the mercury.

This æther may also be prepared by the substitution of sulphuric æther for alcohol, in which case, after the violence of the action has ceased, the bottle may be placed in the sun

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for several days, and a little more iodine added as the colour slowly disappears. The addition of a little sulphuric æther will at any time by agitation give a solution of the iodic in common æther, which floating on the top may easily be separated.

The supernatant acid liquid in the first process contains a large quantity of iodine in solution, partly in the state of æther, partly, probably, as Faraday's iodide of ætherine, and partly as Serullas's periodide of carbon. The æther is not wholly separated by subsidence on cooling; a further portion is thrown down by the addition of water, and a second portion by saturation with an alkali, though in both cases slightly coloured. Agitation with sulphuric æther separates it most completely. Saturated with soda the supernatant liquid becomes dark coloured, and by evaporation may be brought to a treacly consistence, but does not crystallize. The dark colour is not due alone to free iodine, for it does not disappear by long exposure to the air, nor by heating, but to carbon, which exists either in a peculiar state of combination with iodine, or as ulmic or azulmic acid. By evaporation to a syrup, and subsequent dilution with cold water, a carbonaceous matter is separated, which is soluble in hot water, and in solution throws down a yellow iodide from the salts of lead. Alcohol does not separate the iodine from this carbonaceous matter, but it may be driven off by the heat of a spirit-lamp, leaving a spongy charcoal.

When the acid liquid is diluted and supersaturated with ammonia a yellow precipitate falls, which is chiefly Serullas's periodide of carbon. This compound is sometimes obtained also on decomposing the æther by dry caustic potash. Nitric acid throws down iodine from the filtered ammoniacal solution, and by evaporation it becomes dark coloured as above stated. The saturated supernatant liquid does not precipitate chloride of barium.

What is the true constitution of this interesting compound, it is difficult to decide. From the mode in which it is formed by the aid of nitric acid we should be led to infer the presence of oxygen; while, on the other hand, its properties and the absence of iodic acid, both in the caustic alkaline solution by which it has been decomposed, and in the supernatant liquid, which even when saturated gives no precipitate with muriate of barytes, lead to a contrary conclusion. When iodic acid is heated in alcohol decomposition takes place, and by distillation the whole of the iodine passes over, the odour of hydriodic æther, which is perceptible, showing that a small quantity of that compound has also been formed. The presence of alcohol, therefore, in a hot solution, seems incompatible with an

oxide of iodine; and if such be the case it will easily account for the absence of oxygen in the iodic æther, though formed by the agency of nitric acid. It is probable that nitric æther is formed first, and that from its decomposition the new compound containing iodine results. It seems to me, therefore, most likely that the æther described in this paper is a compound of iodine and ætherine ($4\text{C} + 4\text{H}$), belonging probably to the same class of compounds as the solid iodide of Mr. Faraday. Indeed in one experiment, instead of the æther subsiding as I expected, I obtained a group of large crystals of the solid iodide of carbo-hydrogen*.

Portobello, April 22, 1833.

LXIX. *Remarks on Sir David Brewster's Paper "On the Absorption of Specific Rays, &c."* By G. B. AIRY, Esq. M.A. Plumian Professor of Astronomy and Experimental Philosophy in the University of Cambridge. In a Letter to Sir David Brewster, K.H. LL.D. F.R.S. &c. &c.

My dear Sir David,

IN commenting upon your paper in the last Number of the Philosophical Magazine, I cannot but feel that I am undertaking an invidious task. That you will misinterpret my motives or feelings I am not afraid; but to others it may appear presumptuous in me to criticize the remarks of one whom I revere as the author of nearly all our experimental knowledge in the most important parts of optics. But science is public property: it is the right of all, and may be the duty of some, to expose what they conceive to be erroneous; and the obligation is at least not lessened when such seeming error is backed by the highest scientific character.

I commence with your remarks on the test of theory. "The power of a theory to explain and predict facts is by no means a test of its truth; and in support of this observation we have only to appeal to the Newtonian Theory of Fits, and to Biot's beautiful and profound Theory of the Oscillation of Luminous Molecules." I must surely have misinterpreted this sentence. That theories essentially and fundamentally different can apply equally to the explanation of phenomena embracing so many classes as the phenomena of optics, is, I conceive, quite impossible. What test, then, can there be for the truth of a theory but the power which it gives us of calculating old observations

* The colourless transparent prismatic crystals described in this paper as Faraday's iodide, differ from that compound, as generally described, in being slightly soluble in water, from which they may be again volatilized in beautiful prisms by a very gentle heat.