

III. "On the Union of Ammonia Nitrate with Ammonia." By
EDWARD DIVERS, M.D. Communicated by Professor ODLING,
M.B., F.R.S. Received October 29, 1872.

(Abstract.)

Ammonia nitrate deliquesces in ammonia gas at ordinary temperatures and pressures, forming a solution of the salt in liquefied ammonia. To prepare the product, it is only requisite to pass dry ammonia gas into a flask containing the dry nitrate; but the condensation proceeds more rapidly if the flask is surrounded with ice.

The liquid obtained varies in composition according to the temperature and pressure. At a temperature of 23° and the pressure of the atmosphere, it consists of about four parts of nitrate to one of ammonia by weight; but under greater pressure, or at lower temperatures, much more ammonia can be condensed by the nitrate. At 0° and the pressure of the atmosphere, two parts of nitrate can condense one part of ammonia. Like an aqueous solution, the liquid boils when heated, and, when nearly saturated with the nitrate, deposits crystals of it when cooled. It can also, like an aqueous solution, be heated above its boiling-point without boiling, and become supersaturated with the salt without crystallizing. When poured out into an open vessel, it becomes almost instantly gelatinous in appearance—may, indeed, become so as it falls in a stream from the flask containing it. This effect is due to evaporation of ammonia and solidification of nitrate at the surface of the liquid: on breaking the crust of nitrate, the compound flows out as liquid as ever. It is not caustic to the dry skin. During its decomposition cold is manifested, and during its formation heat is evolved, but not to a great extent, because the heat given out by the liquefaction of the ammonia is nearly all used up in the liquefaction of the nitrate.

The specific gravity of the liquid varies, of course, with its composition. When it consists of two of nitrate to one of ammonia, it has a specific gravity of 1072.5; when it consists of four of nitrate to one of ammonia, it has a specific gravity of nearly 1200. Its specific gravity can be calculated from its composition, by taking for the purpose 1524.5 as the specific gravity of the nitrate, and 671 as that of the ammonia. The number 1524.5 is much less than that expressing the actual density of the nitrate in the solid state, but it does not differ very much from its apparent specific gravity in aqueous solution.

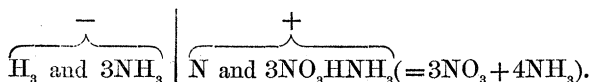
In its rate of expansion by heat, the liquid resembles others that exist as such at ordinary temperatures, rather than those that, like ammonia itself, are only retained as such by great pressure. Its expansivity increases with the quantity of ammonia present.

The volume of a mixture of the liquid with water is much less than the sum of the volumes of the liquid and the water, and yet a marked

absorption of heat occurs during the admixture. The same thing happens when a concentrated aqueous solution of the nitrate is poured into water, as was first pointed out by Gay-Lussac. Other examples of this remarkable phenomenon have been observed by different chemists, and have received various explanations. F. Mohr considers that heat is used up in the depression of the freezing-point of the water which the salt produces. As this depression of the freezing-point is probably attended by an increase in the latent heat of the water, his explanation appears to be the correct one. Thomsen finds the specific heat of the mixture to be less than the mean of the specific heats of its components.

Its action upon a great number of substances, principally inorganic, has been tried, and found to be for the most part like the actions of dry ammonia and ammonia nitrate conjoined. The nitrate appears to undergo double decomposition with most salts, and the ammonia to unite with nearly all, including the salt of magnesium, aluminium, iron, and manganese. The ammoniated chromium salts possess considerable stability. The ammoniated mercuric iodide is resolved by washing into ammonia and mercuric iodide again. The ammoniated compounds which do not dissolve in the liquid are very bulky, as observed by Gore in his experiments upon ammonia liquefied by pressure. Nitrates, chlorides, iodides, and bromides are either soluble, as Gore has found them to be, in ammonia alone, or else are decomposed into soluble chlorides &c. of ammonium, and insoluble ammoniated compounds of the metals. Sulphates, oxalates, chromates, and arsenites are insoluble, and phosphates are nearly so. Phosphoric and chromic anhydrides do not act upon the liquid with the energy that might be expected, but combine with the ammonia. Iodine dissolves freely, as it does in ammonia alone (Gore). Bromine generates nitrogen. Lead salts, including sulphate, chloride, iodide, and oxide, are freely soluble as ammoniated compounds. Platinous chloride dissolves freely as tetra-ammonio-platinous chloride. Potassium salts are very sparingly soluble. Alkalis and their carbonates decompose the nitrate; so do litharge, lime, and baryta. Calomel is converted into metallic mercury and a soluble ammoniated mercuric compound. Potassium, sodium, zinc, and cadmium dissolve without liberating gas, by reducing the nitrate to nitrite, potassium inflaming. Magnesium slowly dissolves, liberating a little hydrogen, reducing the nitrate, and becoming partly converted into Beetz's black suboxide of magnesium. Methyl iodide is decomposed; butyric ether and chloroform are sparingly soluble without decomposition. Ether is insoluble, but by its contact causes the liquid to break up into its two constituents.

It is a good electrolyte, ammonia and hydrogen appearing at the negative electrode, and nitrogen and ammonia nitrate at the positive electrode. Its decomposition may be thus represented:—



Positive electrodes of silver, lead, copper, zinc, and magnesium are dissolved by the liquid as (ammoniated) nitrates. A positive electrode of mercury is converted into a compound almost insoluble in the liquid. When the electrode is acted upon, the generation of nitrogen does not take place.

January 16, 1873.

T. ARCHER HIRST, Ph.D., Vice-President, in the Chair.

Pursuant to notice given at the last Meeting, Mr. Spottiswoode proposed and Admiral Richards seconded the Right Hon. Hugh Culling Eardley Childers, Chancellor of the Duchy of Lancaster, for election and immediate ballot.

The ballot having been taken, Mr. Childers was declared duly elected.

The following communications were read :—

- I. “A new Formula for a Microscope Object-glass.” By F. H. WENHAM. Communicated by W. B. CARPENTER, M.D., F.R.S. Received October 31, 1872.

A pencil of rays exceeding an angle of 40° from a luminous point cannot be secured with less than three superposed lenses of increasing focus and diameter, by the use of which combination rays beyond this angle are transmitted, with successive refractions in their course, towards the posterior conjugate focus : until quite recently, each of these separate lenses has been partly achromatized by its own concave lens of flint glass, the surfaces in contact with the crown glass being of the same radius, united with Canada balsam ; the front lens has been made a triple, the middle a double, and the back again a triple achromatic. This combination therefore consists of eight lenses, and the rays in their passage are subject to errors arising from sixteen surfaces of glass.

In the new form there are but ten surfaces, and only *one* concave lens of dense *flint* is employed for correcting *four* convex lenses of *crown* glass : as this might at first sight be considered inconsistent with theory, a brief retrospect of the early improvements of the microscope object-glass will help to define the conditions. The knowledge of its construction has been entirely in the hands of working opticians ; and the information published on the subject being scanty, this has probably prevented the scientific analyst from giving that aid which might have been expected.

Previous to the year 1829 a few microscopic object-glasses were made, composed of three superposed achromatic lenses ; but this combination