

III. *Chemical Composition of the Earthy insoluble Minerals.*

Silica .....	61·33
Alumina .....	1·72
Protoxide of iron .....	6·06
Protoxide of manganese.....	0·78
Lime .....	3·99
Magnesia.....	22·02
Soda .....	1·38
Potash.....	0·83
Loss.....	1·89
	<hr/> 100·00

III. "On the Preparation of Ethylamine." By J. ALFRED WANKLYN,  
and ERNEST T. CHAPMAN. Communicated by Dr. FRANKLAND.  
Received June 8, 1866.

Having recently had occasion to prepare a considerable quantity of ethylamine, we have made the observation that this base may be obtained with much greater facility than is usually believed.

We digested together equal volumes of iodide of ethyl, strong alcohol, and aqueous ammonia. The digestion was carried on at a very moderate temperature, certainly not exceeding 80°, but the tubes were constantly agitated. In this manner the reaction is completed in about half an hour. The mixed iodides thus obtained were evaporated to expel excess of ammonia, introduced into a retort; enough potash was added to neutralize  $\frac{1}{10}$  of the iodine present, and the mixture was distilled into dilute hydrochloric acid. The receiver was then changed, the same quantity of potash again added, and the products collected as before. Then six times as much potash was added, and the products collected. The remaining two-tenths of the potash were added separately.

Portions of each of these fractions were converted into platinum salts, and the amount of platinum was determined by ignition. Each of the first four fractions corresponding to  $\frac{9}{10}$  of the total bases obtained, gave more platinum than corresponds even to pure ethylamine, and therefore contained ethylamine and ammonia. Only the last fraction, corresponding to  $\frac{1}{10}$  of the entire bases, gave a lower percentage of platinum than corresponds to ethylamine, and therefore contained the di- and tri-bases.

Subjoined are the platinum determinations in this last fraction:—

	I. 0·2133 grm. gave 0·0830 Platinum
	II. 0·3590 „ „ 0·1382 „
or,	I. Platinum per cent. 38·91
	II. „ „ „ 38·59
	Pt Cl <sub>2</sub> N C <sub>2</sub> H <sub>5</sub> II <sub>3</sub> Cl contains 39·37 per cent. of Pt.
	Pt Cl <sub>2</sub> N (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> II <sub>2</sub> Cl contains 35·42 „ „

From which it will be seen that even the last tenth of the bases did not contain much di- and tri-bases.

The former  $\frac{9}{10}$  gave, as aforesaid, rather more platinum than ethylamine salt yields, and therefore contained ammonia.

In order to make out whether there was any di- and tri-base along with the ethylamine in these former fractions, we took No. 3 (corresponding to  $\frac{6}{10}$ ) and made a platinum-fractionation as follows:—

No. 3 gave 40·62 and 40·13 per cent. of platinum. No. 3, after some pure chloride of ammonium had crystallized out (the crystals were analyzed and proved to be quite pure chloride of ammonium), was converted into a platinum-salt, and that platinum-salt fractionated so as to leave the portion richest in the high bases. This salt, which would be rich in the di- and tri-bases if any had been present in No. 3, gave this result:—

·7666 grm. gave ·3090 grm. of platinum = Pt per cent. 40·03.

From which it is manifest that di- and tri-bases were absent.

From the foregoing we concluded that all the higher bases were concentrated in the last fraction, but that ammonia passed over during the whole distillation. The objection might therefore be made that mixtures of ammonia and di- and tri-ethylamines would give the same numbers. In order to deprive this objection of its force we made the following experiments. Iodide of ethyl, alcohol, and ammonia were digested as before, and the mixed iodides so obtained distilled from excess of potash, the vapour thus obtained absorbed by dilute sulphuric acid, care being taken that the acid was not in excess. The fluid so obtained was rendered very slightly acid with the same acid, and then evaporated on the water-bath. The semisolid residue was treated with strong alcohol, and allowed to stand one night. It was then filtered, the filtrate measured, and the amount of sulphuric acid determined in a measured portion. Enough  $\text{KHO}$  was then added to the alcoholic liquid to liberate  $\frac{8}{10}$  of the bases present. The potash was added in solution in water. The liquid was then distilled, the distillate being received in dilute hydrochloric acid. A portion of this liquid was then evaporated to dryness and placed over sulphuric acid. Its percentage of chlorine was then determined:

·3826 of salt gave ·6696 Ag Cl;

∴ 43·29 per cent. Cl. Theory 43·55.

From these numbers it is obvious that the substance must have been pure ethylamine. It could have contained no ammonia, or at most only minute traces, and therefore the above objection is completely disposed of.

A portion of this pure hydrochlorate of ethylamine was then treated with aqueous ammonia in insufficient quantity to combine with the whole of the hydrochloric acid present. We distilled this liquid into dilute hydrochloric acid, evaporated it to dryness, and determined the amount of chlorine present in the residue. The result was:—

·4528 of salt gave 1·3155 Ag Cl; ∴ 59·94 per cent. Cl.

Chloride of ammonium would give 66·33 „

Chloride of ethylamine. . . . . 43·55 „

From these numbers it appears that ammonia is capable of partially expelling ethylamine from its compounds, and thus we have an explanation of the apparent anomaly of the appearance of ammonia with the ethylamine in the above-described experiments. It appears therefore that pure ethylamine may be readily obtained in the following manner. Equal volumes of iodide of ethyl, strong alcohol and ammonia are to be digested together for about half an hour, at a temperature somewhat below that of boiling water, with continual shaking; the product of this operation boiled to expel excess of ammonia, and then distilled from potash—the distillate being received into dilute sulphuric acid, the ammonia separated by means of alcohol, and the alcoholic solution of the mixed sulphates treated with sufficient potash to liberate about  $\frac{9}{10}$  of the bases present. On distilling this mixture, pure ethylamine, accompanied with alcohol and water, are the sole products found in the distillate.

#### IV. “On the Expansion by Heat of Metals and Alloys.”

By A. MATTHIESSEN, F.R.S. Received June 14, 1866.

(Abstract.)

In a paper “On the Expansion by Heat of Water and Mercury”\*, a method of determining the expansion of bodies is described, by which good results can be obtained with comparatively small quantities of the substances to be experimented with. This method, that of weighing the body in water at different temperatures, has been employed for the present research. The results obtained are given in the following Tables:—

TABLE I.—Formulæ for the Correction of the Cubical Expansion by Heat of the Metals.

Cadmium.....	$V_t = V_0 (1 + 10^{-4} \times 0.8078t + 10^{-6} \times 0.140t^2)^\dagger$ .
Zinc.....	$V_t = V_0 (1 + 10^{-4} \times 0.8222t + 10^{-6} \times 0.0706t^2)$ .
Lead.....	$V_t = V_0 (1 + 10^{-4} \times 0.8177t + 10^{-6} \times 0.0222t^2)$ .
Tin.....	$V_t = V_0 (1 + 10^{-4} \times 0.6100t + 10^{-6} \times 0.0789t^2)$ .
Silver.....	$V_t = V_0 (1 + 10^{-4} \times 0.5426t + 10^{-6} \times 0.0405t^2)$ .
Copper.....	$V_t = V_0 (1 + 10^{-4} \times 0.4463t + 10^{-6} \times 0.0555t^2)$ .
Gold.....	$V_t = V_0 (1 + 10^{-4} \times 0.4075t + 10^{-6} \times 0.0336t^2)$ .
Bismuth.....	$V_t = V_0 (1 + 10^{-4} \times 0.3502t + 10^{-6} \times 0.0446t^2)$ .
Palladium.....	$V_t = V_0 (1 + 10^{-4} \times 0.3032t + 10^{-6} \times 0.0280t^2)$ .
Antimony.....	$V_t = V_0 (1 + 10^{-4} \times 0.2770t + 10^{-6} \times 0.0397t^2)$ .
Platinum.....	$V_t = V_0 (1 + 10^{-4} \times 0.2554t + 10^{-6} \times 0.0104t^2)$ .

\* Phil. Trans. 1866, part I.

† I have employed this method of writing the formulæ to prevent mistakes in the