

XI. "On the Production of Coloured Spectra by Light." By  
Captain ABNEY, R.E., F.R.S. Received June 9, 1879.

(Preliminary Note.)

Last year I incidentally mentioned in a note to the Royal Society ("Proceedings," vol. xxviii, p. 291), that the production of natural colours by the agency of light, examples of which were shown by Becquerel, was probably caused by the oxidation of silver compounds employed. I have ventured to return to the subject, in order to show that the colours are so produced and are not due to interference.

I have sent, for the Society's inspection, pictures of the solar spectrum on silver plates, and also on compounds of silver held *in situ* by collodion. It will be observed that the spectrum has imprinted itself in approximately its natural colours; that on the silver plates it is more brilliant than on the collodion film, but that in the latter the colours are seen by transmitted as well as by reflected light.

I reserve for the present the exact details of the production of these pictures, but may say that they are produced by oxidation of silver compounds when placed in the spectrum; an exposure of two minutes being amply sufficient with a wide slit to impress the colours. The colouring matter seems to be due to a mixture of two different sizes of molecules of the same chemical composition, one of which absorbs at the blue end and the other at the red end of the spectrum, and the sizes of these molecules are unalterable whilst exposed to the same wave-lengths as those by which they were produced. I believe it possible and probable that the colours may be preserved unchanged when exposed to ordinary daylight.

XII. "Relations between the Atomic Weights and certain Physical Properties (Melting and Boiling Points and Heats of Formation) of Elements and Compounds." By THOMAS CARNELLEY, D.Sc., Assistant Lecturer on Chemistry in Owens College, Manchester. Communicated by Professor H. E. ROSCOE, F.R.S. Received June 10, 1879.

(Abstract.)

The object of the present paper is to trace the influence of the atomic weights on the melting and boiling points and heats of formation of elements, and especially of their compounds. It is shown that, as regards the elements, the melting points are a periodic function

of their atomic weights, whilst, for compounds, the following conclusions are drawn:—

I. That the melting and boiling points and heats of formation of the normal halogen compounds of the elements are a periodic function of the atomic weights of the constituent elements.

II. That the influence of the halogen on these same physical properties increases with the number of its atoms in the compound.

III. That in any normal halogen compound the influence of either of the elements on the melting or boiling point increases with its own atomic weight, and decreases with the atomic weight of the other element.

IV. The melting or boiling point or heat of formation of a bromide is always nearer to that of the corresponding chloride than to that of the corresponding iodide; and that the melting or boiling points of the halogen compounds of the middle member of three consecutive elements of the same group are always nearer to those of the first member (*i.e.*, the one with least atomic weight) than to those of the last member.

The former of these phenomena probably depends on the fact that the atomic weight of Br is nearer to that of Cl than to that of I, *i.e.*, less than the mean of the two: and the latter on the fact that the atomic weight of the middle member of three consecutive elements of the same group is always less than the mean of those of the other two elements.

V. That the melting and boiling points of the halogen compounds of the elements belonging to the first and second groups of Mendelejeff's classification are widely separated from those of the other groups, being in fact considerably higher. Different relations too often appear to exist between the melting points of the *even* members of these two groups to those which exist between groups (3—7) inclusive; while the compounds of the elements, which are often placed in the *odd* divisions of the first and second groups are generally altogether irregular. In the case of the odd members of the first group this may be explained by the fact that it is very uncertain whether Cu, Ag, and Au really belong to the same group as Na or not, as pointed out by Mendelejeff in his memoir on the "Periodic Law," in which he places these elements not in the first group along with Na, but in the eighth with Fe, Pd, Pt, &c.

As far as existing data allow us to judge, the compounds of the elements with monatomic organic radicals also obey the same laws as those of the halogen compounds.

A process for calculating unknown melting and boiling points (in the case of halogen compounds) by a method of limits is next described, which gives very good results when applied to known melting and boiling points, the average error for *all* known boiling points being

$\pm 4^{\circ}5$  C., or 0.8 per cent., and for *all* known melting points  $\pm 15$ , or 3 per cent. The calculated values for a large number of unknown melting and boiling points are given.

It is also shown that a knowledge of the melting or boiling points of the halogen compounds of an element may serve for the determination of the atomic weight when the application of the methods of specific heat and vapour density are inadmissible, or the results obtained by these contradictory.

An application of this is made in the case of beryllium, concerning the atomic weight of which there has recently been some dispute. From his determination of the specific heat of the metal, Emmerson Reynolds concludes that it is a dyad with atomic weight 9.2, whereas Nilson and Petterssen, from their determination of the specific heat, assign to it the atomic weight 13.8, in which case it would be trivalent. Now, according to calculation, the melting points of the chloride, bromide, and iodide of beryllium ought to be  $(820-870)^{\circ}$ \*  $(802-820)^{\circ}$  and  $(766-777)^{\circ}$  respectively. The boiling points, also, ought to *diminish* from the chloride to the iodide, if beryllium is a dyad with atomic weight 9.2. If it be a triad with atomic weight 13.8 these melting points ought to be about  $500^{\circ}$  lower, and the melting and boiling points ought to *increase* from the chloride to the iodide. With the object of settling this point the melting points of the chloride and bromide have been carefully determined, and it was found that the chloride melts at  $858-890^{\circ}$ , thus agreeing with the limits  $(820-870)^{\circ}$  calculated for  $\text{BeCl}_2$  ( $\text{Be}=9.2$ ). The bromide also fuses between  $858$  and  $890^{\circ}$ , and at almost exactly the same temperature as the chloride, but if anything slightly higher, the calculated number for  $\text{BeBr}_2$  being  $802-820^{\circ}$ . The rather high number found for the bromide is probably due to the substance being so readily volatile below its melting point that the heat absorbed during conversion into vapour cools the remainder of the solid, and thus prevents it melting so soon as it otherwise would do. These results confirm the view that beryllium is a dyad, with atomic weight 9.2; for though the melting point of the bromide is *apparently* slightly higher than that of the chloride, for the reason already given, yet  $\text{BeBr}_2$  is far more volatile than  $\text{BeCl}_2$ .

XIII. "Separate Enumerations of Primes of the Form  $4n+1$  and of the Form  $4n+3$ ." By J. W. L. GLAISHER, M.A., F.R.S., Fellow of Trinity College, Cambridge. Received June 11, 1879.

The present note contains the results of separate enumerations of primes of the forms  $4n+1$  and  $4n+3$  for seven groups each of 100,000

\* Reckoned from absolute zero  $-273$ .