DETERMINATION OF ATOMIC WEIGHTS OF THE RARE EARTH ELEMENTS

B. S. HOPKINS, UNIVERSITY OF LLLINOIS

Theoretically the determination of the atomic weight of an element is exceedingly simple. It consists in preparing a pure compound of the element and then transforming it completely into some other compound of the element. The change in weight which is produced by the change in composition gives sufficient data for the calculation of the atomic weight. In practice, however, the determination of the atomic weight of any number of the rare earth group becomes very difficult. This difficulty is apparent when we consider that the rare earth elements are found only in complicated mixtures and that the properties of these elements are so similar that the preparation of a pure compound is attended by well-nigh insurmountable difficulties. The methods used for the determination of the atomic weights of members of this group may be illustrated by the steps necessary for the preparation of pure yttrium material and the calculation of the atomic weight by the use of the ratio Y_2O_3 to $2YCl_3$.

In purifying yttrium material, the mineral, such as gadolinite, was ground finely and extracted with HCl or H_2SO_4. Silica was removed by dehydration. Then the rare earths present in solution were precipitated by hot oxalic acid. The material was then converted to the anhydrous sulfates which were dissolved in water and solid Na_2SO_4 added to precipitate the members of the cerium group. The members of the yttrium group, which are not precipitated by Na_2SO_4, may be separated from each other in two ways (1) by the difference in the solubility of some salts such as the bromates; (2) by slight differences in basicity which permits their gradual separation through the method of fractional precipitation. Utilizing the difference in solubilities the method of fractional crystallization was used by placing a quantity of the mixed bromates in a flask and adding sufficient water to take the whole into solution. Then part of the water was evaporated on the steam bath and the material left to crystallize. Obviously the least soluble crystallized first, leaving the more soluble portions in solution. This liquid was thoroughly drained away from

the crystals into a second flask from which more of the water was evaporated and the process of crystallization repeated. By adding small quantities of water to the first flask and then pouring the soluble portion from each flask into the next in the series, the material was split into fractions of different solubilities. By continuing this method of fractional crystallization for a period of about two years distinct colors were seen in portions of the series, indicating a partial separation of the elements which were present in the original mixture.

Portions of such a series which showed similar properties were set out and the material further fractionated by adding a precipitant in small quantities. After each addition the precipitate was removed, and in this manner several fractions were obtained with varying degrees of basicity. The precipitants used in this work were K_2CrO_4, NH_4OH and $NaNO_2$. The effect of the treatment was followed by observing the changes in the lines of the absorption spectrum and by using trial methods for determining the atomic weights.

The best yttrium material obtained contains only traces of erbium and holmium. The final determination of the atomic weight is being made in the following manner: A quantity of pure yttrium oxide is placed in a double-necked quartz flask and its weight determined. This is then dissolved in pure HCl and the flask is attached to a drying train through which dry air is passed until the solution in the flask crystallizes. Then the temperature of the flask is gradually raised while dry nitrogen and dry HCl are successively passed through the flask until the chloride is thoroughly dehydrated. Finally the anhydrous chloride is fused in an atmosphere of HCl.

The results so far obtained indicate that the atomic weight of yttrium is somewhere between 88.5 and 89.