ART. XII.—*Radio-active Measurements by a Constant Deflection Method*; by HOWARD L. BRONSON.

THE ordinary method of using an electrometer for comparing ionization currents through gases has been to measure the rates of movement of the needle. The ionization currents are then proportional to these rates, if the following conditions are fulfilled: (1) that the capacity of the system remains constant, (2) that the deflection is proportional to the potential of the quadrants, (3) that the lag of the needle behind the potential is the same for different rates. In some cases these conditions are closely fulfilled, but in others, especially where the needle is moving rapidly, the last condition and probably the first are not. The introduction of additional capacity into the system, while it reduces the rate of motion of the needle, creates the added difficulty of comparing capacities, which not only takes considerable time but is never entirely satisfactory. Another difficulty with this method is that it is practically useless in the case of rapidly changing ionization currents. The desirability, therefore, of a more direct and rapid method of measurement is evident.

If, as usual, one pair of quadrants of the electrometer is connected to earth, and the other pair is not only connected to the testing vessel but also to earth through a very high resistance, it is easily seen that an ionization current in the testing vessel will charge the quadrants until the discharge current through the high resistance is equal to the ionization current. In this case the current will be proportional to the potential of the quadrants, that is, to the deflection of the needle.

Resistances of the order 10^{11} ohms made of pure amyl alcohol and of carbon on glass were tried, and gave results which compared favorably with those obtained by the "rate" method. These results, however, were not satisfactory, because in the case of the liquid resistance there seemed to be a variable polarization, whereas the resistance of the carbon was not perfectly steady. Professor Rutherford then suggested the possibility of using an ionization current in place of the conduction current through a high resistance. For this purpose he furnished a very radio-active bismuth plate from Dr. Sthamer of Hamburg. The activity of this plate was due to a deposit of the so-called radio-tellurium of Marckwald, which has such a long period of decay that it remains practically constant during any short experiment.

The bismuth plate was earthed and covered with a very thin sheet of aluminium to avoid contact potential difference. Another aluminium plate was placed parallel to this and connected to the same quadrants as the testing vessel, and the

whole was protected from air currents. The electrometer had a sensitiveness of about 150 scale divisions per volt, and with the plates 2^{cms} apart, the ionization currents were practically proportional to the deflections throughout the entire length of the scale (500 divisions). When the distance between the plates was increased to 2.8^{cms} the same deflection was produced by an ionization current only one third as large, that is, the sensitiveness of the apparatus was tripled; on the other hand, the current was proportional to the deflection for only about 150

divisions. The currents measured varied from about 10^{-12} to 10^{-10} amperes.

The advantages of this method are obvious; deflections are independent of the capacity, measurements can be made over a large range without readjustment, and observations can be taken in as rapid succession as desired. In some cases observations were taken as often as once in five seconds. Figs. 1 and 2 show the accuracy which can be obtained by single sets of observations.

A and B, fig. 1, are two similar logarithmic decay curves of the excited activity of actinium, and should therefore be parallel. The time 0 was at least 20 minutes after the emanation was removed, so that the initial rise of the excited activity is not shown. The equation of the decay of any radio-active sub-

stance is given by Rutherford (Radio-activity, p. 258) as $\frac{I}{I_0} = e^{-\lambda t}$. From curve A, λ is found to be 0.0193, and from curve B, 0.0195, where the time is measured in minutes. The mean of these two values gives 35.7 minutes as the time required for the excited activity of actinium to decay to half value. This is a rather shorter time than was found by Debierne (Comptes Rendus, No. 138, p. 491), and verified by Miss Brooks (Phil. Mag., Sept., 1904). This smaller value, however, was confirmed by a large number of observations taken

by the "rate" method. The values thus obtained varied considerably, but their mean was about 36 minutes.

Fig. 2 shows three logarithmic decay curves for thorium emanation, which on account of its rapid rate of decay has been found so difficult to measure. By this method the observations for the three curves were taken in about thirty minutes. The value of λ obtained from curve A is 0.0129, from curve B is 0.0127, and from curve C is 0.0128,—a very satisfactory agreement for single sets of observations. A mean value of these λ 's gives about 54 seconds as the time taken for the emanation to decay to half value, which agrees fairly well with the value 51.2 seconds recently obtained by C. Le Rossignol and C. T. Gimingham (Phil. Mag., July, 1904).

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