

while the number of positive charges expelled are 16 and 12 resp.), no other explanation seems possible than that β -particles—6 for the U-series and 5 for the Th-series—are ejected too from the nucleus*.

Indeed, the number of β -ray products in these two series corresponds (complex radiation being taken into account) completely with these numbers.

The same conclusion may be arrived at on quite another line. The periodic number P an element occupies in a strictly periodic series from Li upwards with each triad of group VIII, and all the elements from Ce to Ta concentrated into one place each, can be proved to be equal to $\sqrt{\frac{A-2M}{2c}}$ (M being the number in Mendelejeff's series, A the atomic weight, and c a constant).

Thus, if the total number of electrons per atom is equal (as from the mass and charge of the α -particle may be supposed, $4/5$ of all known atomic weights being of the types $4n$ and $4n+3$) to half the atomic weight, we get

$$N - M = cP^2,$$

and as M is equal too to the number of electrons surrounding the nucleus, cP^2 must be the number of electrons in the nucleus.

Here again we find for U and Pb, as for Th and Bi, the same differences, 6 and 5 resp., as must be expected from the number of β -rays expelled.

TABLE II.

	C.	Mg.	Ar.	Cr.	Zn.	Kr.	Mo.	Cd.	Xe.	Nd.	W.	Pb.	Bi.	Th.	U.
M ...	6	12	18	24	30	36	42	48	54	60	78	86	87	94	96
P	4	10	16	22	26	32	38	42	48	52	54	60	61	68	70
cP^2 ...	0	0	1	2	3	5	6	8	11	12	14	17	17	22	23
$A_{\text{calc.}}$	12	24	38	52	66	82	98	112	130	144	184	206	208	232	238
$A_{\text{exp.}}$	12	24	40	52	65	82	96	112	130	144	184	207	208	232	238

$$A_{\text{calc.}} = 2(M + cP^2); c = 0.00468.$$

The number of nuclear electrons being proportional to the periodic number P , and this number remaining unchanged

* Compare Bohr, Phil. Mag. xxvi. p. 500 (1913).

from Ce to Ta, all these rare earths must contain the same number of nuclear electrons.

Should the α -particle be composed of $4(H^+) + 2$ electrons, then the number of nuclear electrons should be for U 142, that of the positive units 238, and, 380 particles occupying about 2.7×10^{-35} c.cm.*, the positive unit must be of equal size, if not identical with the electron (0.5×10^{-37}), but in a different state.

L. Note on the Electron Atmosphere (?) of Metals.

By CARL R. ENGLUND †.

IN an article published last year ‡ Professor R. W. Wood has advanced a theory of an electron atmosphere to account for some results which he obtained. Some experiments performed by me, at Professor Millikan's suggestion, in the Ryerson Laboratory in the University of Chicago, in the spring of 1911, on sparking potentials at small distances, gave results which appear irreconcilable with such a theory and it is perhaps worth while to mention them here.

A spark-gap was mounted on an interferometer; one of the electrodes was carefully insulated with ebonite, and both electrodes were provided with mirrors so as to form a double-fringe system. This eliminated the possibility of a deformation in the supports which might render the sparking distance between the electrodes at the instant of discharge something less than the distance read upon the double interferometer system. The insulated electrode was connected to a Wilson electroscope, the capacity of the electroscope and electrode being only a few centimetres, and the other electrode was connected to one terminal of a storage-battery giving up to 500 volts. The other battery terminal and electroscope-case were of course earthed (see figure for the connexions). By this means the quantity of electricity discharged during a spark was reduced to the smallest possible amount and a minimum corrosion of the electrodes was obtained.

Measurements of the sparking potentials between silver, nickel, and soft steel electrodes, one plane and the other having a radius of 1 cm., from one half to four sodium wavelengths apart, gave substantial verification of Hobbs's § earlier

* Rutherford, 'Radioactive Substances,' 1913, p. 621.

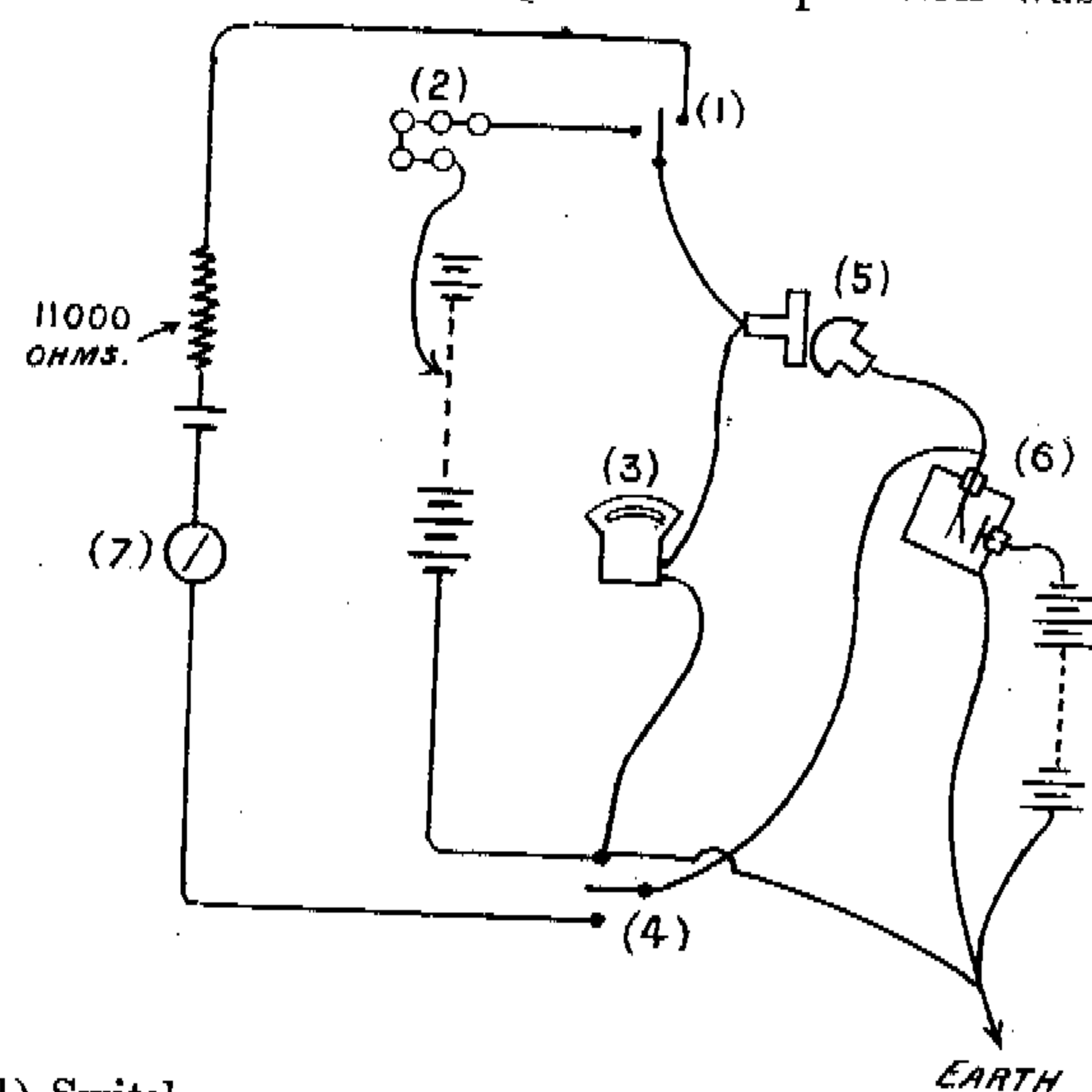
† Communicated by Prof. R. A. Millikan.

‡ R. W. Wood, Phil. Mag. [6] xxiv. p. 316 (1912).

§ Hobbs, Phil. Mag. [6] p. 617 (1905).

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results. The air-film in every case remained an insulator until the voltage reached the sparking potential, when a charge passed over to the electroscop. This operation was usually



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| (1) Switch. | (5) Spark-gap. |
| (2) Lamp res. of 4400 ohms. | (6) Wilson electroscop. |
| (3) Static voltmeter. | (7) Galvanometer. |
| (4) Switch. | |

instantaneous, although occasionally a gradual leak through the insulation seemed to take place. Dust particles or a water-film could in such cases be instantly detected, and hence the electrodes were always carefully cleaned and gently heated before using. If consistent sparking potentials with accompanying insulation between the electrodes down to distances of one-half of a sodium wave-length can thus be obtained, it would seem that the hypothesis of an "Electron Atmosphere" is untenable. At this distance the voltage necessary for discharge was between 80 and 100 volts, and no more delicate test than the electroscop deflexion could well be demanded of an insulator. Wood's "Electron Atmosphere" seemed to extend to a distance of as much as 30 wave-lengths. A recent paper by Brown* seems to indicate that a film of moisture constitutes the "Electron Atmosphere."

Ann Arbor, Mich.
Nov. 8, 1913.

* Brown, Phys. Rev. Oct. 1913.

LI. *The Decline of the Hypothesis of Ionic Dissociation.*
By F. P. WORLEY, D.Sc. (London), Professor of Chemistry,
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DURING the past quarter of a century the doctrine of ionic dissociation, formulated by Arrhenius in 1883-87, has been so persistently advocated that few chemists now regard it as a mere hypothesis; the majority fail to see that no single convincing argument necessitating the hypothesis has ever been brought forward and that its acceptance has been due to the plausibility of the arguments by which, apparently, it may be supported rather than to their cogency: nor is it recognized how far from being secure are not only the minor supports on which it rests but also some, if not all, of those upon which most reliance is placed.

The very simple explanation the hypothesis apparently afforded of so many chemical phenomena left little doubt in the minds of its early advocates that further investigation would dispose of difficulties such as are presented by concentrated solutions and strong electrolytes, for example; but although, of late years, a good deal of fresh evidence has been adduced which has appeared to support the doctrine, difficulties such as those referred to have not been removed†; indeed, it is now tacitly admitted that such phenomena as the colour of salt solutions and the mutual precipitation of salts can no longer be cited in support of the hypothesis. Moreover, much has been done to show that the explanation of the catalytic effect exercised by acids—in the case of changes such as those attending the hydrolysis of cane-sugar and of ethereal salts and the reverse change of etherification—by the hypothesis presents very formidable difficulties and that the effect can be accounted for rationally without its aid‡; especially difficult of explanation is the part played by neutral salts in such phenomena.

One of the strongest arguments put forward by Arrhenius in favour of his hypothesis was the fact that it was possible to correlate the chemical activity of electrolytes with the presumed degree of ionic dissociation as deduced from their molecular electrical conductivities: hence the dissociated ions alone of electrolytes were postulated as concerned in

* Communicated by Dr. H. E. Armstrong, F.R.S.

† Arrhenius, 'Theories of Solutions,' p. 172.

‡ Roy. Soc. Proc. A. lxxxvii. p. 604 (1912). "Studies of the Processes Operative in Solutions. XXIV. The Nature of the Hydrolytic Process." By H. E. Armstrong and F. P. Worley.