A Direct Determination of "h."[1]

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THE experiments herewith reported were undertaken for the sake of subjecting to rigorous experimental test the three assertions contained in Einstein's photo-electric equation[3]

$$\tfrac{1}{2}mv^2 = PDe = h\nu - P.$$

These assertions are

[1] Abstract of a paper presented at the Washington meeting of the Physical Society, April 24, 1914.

[2] Ber. d. D. Phys. Ges., 16, 107, January 30, 1914.

[3] A. Einstein, Ann. d. Phys. (4), 20, 199, 1905.

1. That there is a linear relation between the frequency of the impressed light and the maximum energy of emission of the electrons ejected by it.

2. That the slope of the line representing the linear relation between PD and ν is h/e, *i. e.*, that this slope times e is Planck's "h."

3. That the intercept of the PD line on the ν axis gives the frequency ν_0 at which the metal in question first begins to be photo-electrically active.

The second and third of these assertions have not heretofore been made the subject of accurate test nor can they be so made without simultaneous measurement *in vacuo* of both contact potentials and photo-potentials in the case of metals which are sensitive throughout a long range of frequencies. The spectral lines used in the test must further be strictly monochromatic and of frequency determinable with a high degree of precision.

The first of the assertions of Einstein's equation has previously been tested with widely varying results by Ladenburg,[1] Kunz,[2] Hughes,[3] Richardson and Compton,[4] and Cornelius.[5] The most satisfactory of these measurements are probably those of Richardson and Compton, though Pohl and Pringsheim[6] do not regard even these as sufficient to distinguish between $PD \propto \nu$ and $PD \propto \nu^2$, much less to test between any closer relations such as $PD \propto \nu$ and $PD \propto \nu^{\frac{3}{4}}$, the latter being the relation implied by Lindemann's theory. Very recent measurements made in the Ryerson Laboratory by Kadesch[8] between $\lambda = 3{,}900$ and $\lambda = 2{,}300$ seem however to speak positively in favor of a proportionality between PD and ν. The present measurements made on sodium from $\nu = 6{,}800$ to $\lambda = 2{,}300$ fully confirm Kadesch's linear relationship and further, they fix the value of the slope, *i. e.*, of h/e at 4.123×10^{-15} volt/frequency with an error of not more than $\frac{1}{2}$ per cent.

Inserting the author's value of e, viz., 4.774×10^{-10} which is thought to be correct to within .2 per cent., there results from this value of h/e

$$h = 6.561 \times 10^{-27}.$$

This value of "h" combined with the author's value of e gives with the aid of Planck's equation the following value for the constant of total radiation

$$\sigma = 5.688 \times 10^{-5},$$

which is very close to the value obtained by Coblentz[9] from a study of all the data at present available.

When this value of σ is combined with the author's value of e and substitution made in Planck's equation, the Planck-Wien constant of spectral radiation

[1] E. Ladenburg, Verh. d. D. Phys. Ges., 9, 504, 1907.

[2] J. Kunz, PHYS. REV., 29, 212, 1909; also 33, 208, 1911.

[3] A. L. L. Hughes, Phil. Trans., 212, 205, 1912.

[4] O. Richardson and R. T. Compton, Phil. Mag., 24, 575, 1912.

[5] D. W. Cornelius, PHYS. REV., 1, 16, 1913.

[6] R. Pohl u. P. Pringsheim, Verh. d. D. Phys. Ges., 15, p. 637, 1913.

[7] F. A. Linderman, Verh d. D. Phys. Ges., 13, 1107, 1911.

[8] W. H. Kadesch, PHYS. REV., May, 1914.

is found to be

$$c_2 = 1.434$$

which is within one part in 700 of the latest Reichsanstalt value of this constant.

The value of ν_0 obtained for sodium, the metal upon which all of these experiments have been made, is $.439 \times 10^{15}$, which corresponds to $\lambda = 6,800$.

Planck's constant "h" is thus found to stand out in connection with photoelectric measurements, perhaps more sharply, more exactly, and more certainly than in connection with any other type of measurements thus far made.