The Faraday cylinder was joined to one pair of quadrants of an electrometer, while the electrode was given any desired potential by means of potentiometer scheme. The positive potential corresponding to any wave-length was determined, either by giving the electrode a potential just sufficient to prevent the escape of electrons, or by varying the potential applied and then plotting curves with this, and the corresponding photo-electric current, as coördinates. In the former method fresh surfaces were frequently cut, especially when the balancing potential was approached. In the latter, for each potential applied the current given by surfaces of different age was determined, a fresh one being cut for each exposure. The current for zero age was then found by extrapolation. This precaution was found to be unnecessary, however, since the slope of the age-current curves fell to zero at the balancing potential.

The range of wave-lengths employed was that from 2155 to 3970 A.U. Longer waves could not be used, with the quartz arrangement, because of the small dispersion. The positive potential was found to vary directly as the frequency of the light. This relation is expressed by the equation,

$$V = kn - V_0.$$

The value of k found for sodium was 3.87, that for potassium 3.83. The true value is somewhat higher, every source of error tending to reduce the value given by experiment.

THE THEORY OF PHOTO-ELECTRIC AND PHOTO-CHEMICAL ACTION.[1]

BY O. W. RICHARDSON.

IN this paper it is shown that the following equations are valid for all substances at all temperatures:

$$\int_{\nu_0}^{\infty} \frac{F(\nu\nu_0)h\nu^3}{e^{\frac{h\nu}{RT}}-1}\left\{\varphi(\nu) - \frac{h\nu e^{\frac{h\nu}{RT}}}{e^{\frac{h\nu}{RT}}-1} - RT^2\frac{\partial \log F(\nu\nu_0)}{\partial T}\right\}d\nu = 0, \qquad (10)$$

$$\int_{\nu_0}^{\infty} \frac{F(\nu\nu_0)h\nu^3 d\nu}{e^{\frac{h\nu}{RT}}-1} = A_1 T^{\frac{1}{2}} e^{\int^T \frac{\omega}{RT^2}dT} = \Phi(T)e^{-\frac{h\nu_0}{RT}}, \qquad (16)$$

$$\int_{\nu_0}^{\infty} \frac{h\nu^3}{e^{\frac{h\nu}{RT}}-1}\left\{\frac{F(\nu\nu_0)}{RT}\left(\frac{\partial w}{\partial \nu_0}\right)_T + \frac{\partial F(\nu\nu_0)}{\partial \nu_0}\right\}d\nu = 0, \qquad (17)$$

$$\int_{\nu_0}^{\infty} \frac{\nu^3 T_\nu F(\nu\nu_0)}{e^{\frac{h\nu}{RT}}-1}h d\nu = 2RT\Phi(T)e^{-\frac{h\nu_0}{RT}}, \qquad (27)$$

where the notation is the same as in Phil. Mag., Vol. 24, p. 570 (1912), except that T is written for temperature instead of θ, $F(\nu\nu_0)$ is written for $\epsilon F(\nu)$, $\varphi(\nu)$ is the energy abstracted from the radiation by an atom which is liberated under the excitation of radiation of frequency ν and $\Phi(T)$ may be regarded as defined by the right-hand one of the two equations (16). ν_0 is the value of ν at which $F(\nu\nu_0)$ becomes zero.

[1] Abstract of a paper presented at the Chicago meeting of the Physical Society, November 29, 1913.

It is also shown that the following values of the functions involved are consistent with all of the equations (10), (16), (17) and (27), viz.:

$$\left.\begin{aligned} \varphi(\nu) &= h\nu, \text{ universally,} \\ F(\nu\nu_0) &= \frac{A_1 h}{R^2}\left(1 - e^{-\frac{h\nu}{RT}}\right)\frac{\nu - \nu_0}{\nu^3}, \quad \nu_0 < \nu < \infty, \\ T_\nu &= h(\nu - \nu_0), \\ h\nu_0 &= \omega - \tfrac{3}{2}RT, \\ \Phi(T) &= A_1 T^2. \end{aligned}\right\} \quad (43)$$

PALMER PHYSICAL LABORATORY, PRINCETON, N. J.

DETERMINATION OF e/m FROM MEASUREMENTS OF THERMIONIC CURRENTS.[1]

BY SAUL DUSHMAN.

IN a paper on "The Effect of Space Charge and Residual Gases on the Thermionic Current in High Vacuum,"[2] Dr. I. Langmuir has developed the following formula for the thermionic current from a heated filament to a coaxial cylindrical anode.

$$i = \frac{2\sqrt{2}}{9}\sqrt{\frac{e}{m}}\frac{V^{\frac{3}{2}}}{r} = \frac{k \cdot V^{\frac{3}{2}}}{r}. \quad (1)$$

The formula has been tested experimentally by measuring the thermionic currents from a heated tungsten filament 10 mils diameter to a molybdenum anode, 7.62 cm. long and 2.54 cm. diameter. All end corrections were avoided by making use of two auxiliary anodes over the ends of the filaments, on the guard-ring principle.

The glass tube containing these electrodes was thoroughly exhausted by means of a molecular pump, the tube being heated to 360° C. and liquid air interposed between it and the pump. The anodes were freed from gases by bombardment with electrons of high velocity. This was secured by applying a very high potential of four or five thousand volts to the heated filament (cathode) and molybdenum cylinders (anode).

After the electrodes had been treated in this manner it was found that the space charge formula given above held very accurately over the range of voltages tested: 35 to 130. In each case the filament was heated to a temperature so high that in accordance with the Richardson equation very much higher currents could be obtained (provided a sufficiently high voltage was used).

Substituting for e/m in the above equation, the most probable value, 1.76×10^7, the constant k becomes 14.6×10^{-3}, where i is expressed in milliamperes per cm. length, V in volts, and r in cms. The values of i actually obtained for different values of V agreed with those calculated by means of this value for k, to within one per cent. These results were obtained under conditions in which

[1] Abstract of a paper presented at the Chicago meeting of the Physical Society, November 29, 1913.

[2] PHYS. REV., December, 1913.