[4] Williamson (*Physic. Rev.*, **21**, 110, 1923), using a tartaric acid solution composed of 64 parts of water to 1 of saturated solution in an absorption cell 3.2 cm. in length, found no transmission below 2450 Å. Using a 3 mm. layer of 1.7% solution we found with a quartz spectrograph no transmission below 2340 Å. Moreover, through even a 0.17% solution, we obtained no unsensitized ozone formation.

[5] Kailan, *Monatshefte Chem.*, **34**, 1209 (1913).

[6] Lewis and Randall, *Thermodynamics*, McGraw-Hill Book Co., **1922**, p. 476.

[7] Eucken, *Ann. Chem.*, **440**, 111 (1924).

[8] Wulf, *J. Amer. Chem. Soc.*, **47**, 1944 (1925).

DIFFUSION OF ELECTRONS

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In order to calculate the efficiency of resonance it is necessary to know the average number of impacts Z that an electron makes in traversing a layer of gas when there is no field. The calculation of the quantity Z is given in this paper.

Method I.—Consider an element of area df in the xy plane located at the origin of a set of polar coördinates r, θ, ϕ. At a distance r from the origin there is a volume-element dV. In polar coördinates the element $dV = r^2 \sin\theta d\theta d\phi dr$. θ is the angle between the radius vector r and the z-axis. ϕ is the angle between the x, z plane and the plane containing r and z. If ρ is the number of electrons in unit-volume and N is the number of electrons that pass through a square centimeter per second, *more in the positive than in the negative direction*, then the number of such electrons that pass through the element of area df per second is [1,2]

$$Ndf = \int \frac{\rho v}{\lambda} e^{-\frac{s}{\lambda}} dV d\omega \qquad (1)$$

where v is the constant velocity of the electrons, λ is their mean free path and $d\omega$ is the solid angle subtended by df at dV. The integration is taken with respect to the total volume V. If no electric field acts then s is the radius vector r; otherwise it is the length of the parabolic path of the electrons between df and dV.

The solid angle $d\omega$ is the fraction of the surface $4\pi r^2$ which the element df subtends at dV.

$$d\omega = \frac{df \cos\theta}{4\pi r^2}.$$

Then the resultant number of electrons that pass through unit-area in one second is

$$N = \frac{v}{4\pi\lambda} \int_0^{2\pi} \int_0^\pi \int_0^\infty \rho e^{-\frac{r}{\lambda}} \cos\theta \sin\theta \, dr d\theta d\phi.$$

If ρ depends on z only (i.e., the case of diffusion in the z direction), we have to a first approximation

$$\rho = \rho_0 \left(1 + \frac{1}{\rho_0}\frac{\partial\rho}{\partial z} r \cos\theta\right).$$

Substituting above and integrating we obtain

$$N = -\frac{v\lambda}{3}\frac{\partial\rho}{\partial z}. \tag{2}$$

This is the equation for diffusion and the diffusion-coefficient is $D = \frac{1}{3}v\lambda$. In the present problem N is a constant and equation (2) can be integrated. We obtain

$$\rho = \frac{3N}{v\lambda}(a-z)$$

where $\rho = 0$ when $z = a$ (i.e., at the plate where the electrons are removed).

The average number of impacts that an electron makes in traversing the distance a is then

$$Z = \int_0^a \frac{v\rho}{N\lambda} dz = \frac{3}{2}\frac{a^2}{\lambda^2}.$$

This number is seen to be independent of the velocity of the electrons. Hertz[2] has derived a similar relation when the electrons are accelerated in the distance a by a small field from an initial velocity zero. His final relation for the average number of impacts in this case is $\frac{3}{4}\frac{a^2}{\lambda^2}$ instead of $\frac{3}{2}\frac{a^2}{\lambda^2}$.

Method II.—The diffusion of electrons can also be considered a "Brownian-movement" problem. The distance a tranversed by an electron is then[3]

$$a^2 = 2D\bar{t}$$

where $\bar{t}$ is the average time it takes an electron to diffuse the distance a and D is the diffusion coefficient. The average number of impacts that an electron makes in the distance a will be the average time $\bar{t}$ divided by the time τ between impacts, $\left(\tau = \frac{\lambda}{v}\right)$. That is

$$Z = \frac{\bar{t}\cdot v}{\lambda} = \frac{a^2 v}{2D\lambda}.$$

Substituting for D its value $\frac{1}{3} v\lambda$ from equation (2) we find again

$$Z = \frac{3}{2} \frac{a^2}{\lambda^2}.$$

Summary.—The average number of collisions which an electron makes when diffusing through a gas, a distance a, when no field is acting on the electron, is calculated to be $\frac{3}{2} \frac{a^2}{\lambda^2}$. λ is the mean free path of the electron. The number of impacts is seen to be independent of the velocity of the electron.

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[1] Riecke, *Ann. d. Phys.*, **66**, 353 (1898).

[2] Hertz, *Z. f. Phys.*, **32**, 298 (1925).

[3] Einstein, *Ann. d. Phys.*, **17**, 559 (1905).

CORRELATION BETWEEN SHAPE AND BEHAVIOR OF A CHROMOSOME

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Yellow females of a race of Drosophila melanogaster, in which the two X-chromosomes are attached to each other, occasionally produce daughters that are heterozygous for yellow and for the sex-linked characters of their fathers. In this event, the daughter has received from the mother one of her two X-chromosomes detached from its mate.

In the spring of 1922, a wild type female of this kind, whose father was scute broad apricot, was mated to a forked bar male and produced, besides yellow and scute broad apricot sons, a number of forked bar sons. The forked bar males were tested in order to discover whether the mother had been an XXY female, and they proved to be sterile; they were non-disjunctional XO males. F_1 females were mated to X-ple males and gave two unexpected results; a recurrence of a number of patroclinous males and a very low number of flies of cross-over classes; among those which occurred was an unusually large proportion of double cross-overs.

Counts were then made to ascertain the percentage of crossing-over and among the flies that were examined there was a high percentage of gynandromorphs of one type. The mothers of the gynandromorphs were heterozygous for the yellow-bearing chromosome. The gynandromorphs were