where the square bracket has the usual significance of concentration.

Now in Deacon's process, which is represented by the chemical equation

$$4HCl + O_2 = 2H_2O + 2Cl_2,$$

we should have

$$\frac{[Cl_2]}{[Cl_2']} = \frac{[HCl]^2}{[HCl']^2} \quad . \quad . \quad . \quad . \quad . \quad (ii)$$

Taking $\frac{[HCl]}{[HCl']}$ as 3, $\frac{[Cl_2]}{[Cl_2']}$ is 9, provided that the temperature and concentration of the oxygen are selected so that the concentration of the chlorine is small at equilibrium.

But the ratio of the atoms of the two varieties of chlorine is given by

$$\frac{[Cl_2] + \frac{1}{2}[ClCl']}{[Cl_2'] + \frac{1}{2}[ClCl']},$$

and this, by equations (i.) and (ii.), is equal to $\frac{10 \cdot 5}{2 \cdot 5}$, which differs appreciably from 3.

Deacon's process is selected merely for the purpose of illustration.

If the isotopic varieties of chlorine are inseparable by the method above indicated, it is clear that

$$\frac{[Cl_2] + \frac{1}{2}[ClCl']}{[Cl_2'] + \frac{1}{2}[ClCl']} = \frac{[HCl]}{[HCl']} = \frac{[Cl_2]^{\frac{1}{2}}}{[Cl_2']^{\frac{1}{2}}}, \quad . \quad . \quad (iii.)$$

whence

$$2[Cl_2]^{\frac{1}{2}}[Cl_2']^{\frac{1}{2}} = [ClCl'] \quad . \quad . \quad . \quad . \quad (iv.)$$

Now consider two solids composed entirely of Cl_2 and Cl_2' molecules respectively. The vapour pressures of the two solids will be very nearly (if not exactly) the same—say p—at the same temperature t.

Evaporate a gram-molecule of both the solids. Reduce the pressure of the Cl_2 isotope to p_1, and that of the Cl_2' isotope to p_2, and then introduce both unsaturated vapours into a van't Hoff's equilibrium box. The total work done in these operation is

$$Rt \log_e \frac{p^2}{p_1 p_2}.$$

Now remove 2 gram-molecules of the ClCl' variety (which from equation (iv.) will obviously be at the pressure $2\sqrt{p_1 p_2}$) from the equilibrium box. Increase the pressure to p, and finally condense at this pressure to the solid form. The work done during this series of operations will be

$$Rt \log_e \frac{4p_1 p_2}{p^2}.$$

Therefore the total work performed in effecting the change represented by the equation

$$Cl_2 \text{ (solid)} + Cl_2' \text{ (solid)} = 2ClCl \text{ (solid)}$$

is $Rt \log 4 = A$.

But it is difficult to understand how the free energy A could differ appreciably from zero if the molecular heats of the three varieties of chlorine are nearly the same—as they are generally supposed to be—and if the entropy of the reactants Cl_2 and Cl_2' is equal to that of the resultant 2ClCl' at the absolute zero temperature, as Nernst postulates in his heat theorem.

An attempt is being made in the Jesus College Laboratory to separate the isotopes of chlorine by a method similar to that given above. A negative result would be difficult to reconcile with Nernst's theorem that $\frac{dA}{dt} = 0$ at the absolute zero.

D. L. CHAPMAN.

Jesus College, Oxford.

A Note on Telephotography.

HAVING examined a number of formulæ for the circle of illumination in telephotography, and found them all to be inapplicable in certain cases, I propose the following, which seem reasonable and are applicable in all cases. These formulæ are particularly vital in the line along which telephotography is at present developing.

Let C_F = Full circle of illumination.
C_E = Circle of equal ,,
C_M = Mean circle of ,,
M = Magnification.
f_1 = Focus of positive lens.
f_2 = ,, negative ,,
b = Diameter of positive lens.
c = ,, negative ,,

Then

$$C_F = \frac{M^2(f_1 c + f_2 b) - M f_2 b}{M(f_1 - f_2) + f_2} \quad . \quad . \quad . \quad (1)$$

$$C_E = \frac{M^2(f_1 c - f_2 b) + M f_2 b}{M(f_1 - f_2) + f_2} \quad . \quad . \quad . \quad (2)$$

$$C_M = \frac{M^2 f_1 c}{M(f_1 - f_2) + f_2} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The last formula (3) is not only the simplest, but it is also the accurate value for the circle when the aperture (b) of the positive lens is small. It is the mean between the full (1) circle and the evenly illuminated (2) circle. The first (1) is the most usually used. It gives the diagonal of the largest plate that can be employed. The second (2) gives the circle that is equally illuminated. If it is possible to make the aperture (b) of the positive lens equal to the diameter (c) of the negative lens, this formula becomes the simplest.

$$C_E = Mc.$$

I have received an opinion on the above from a distinguished authority upon geometric optics. He is of the opinion that it is necessary to add that certain assumptions have been made in deciding these formulæ. These assumptions are (α) that the lenses are thin, (β) that the aberrations may be neglected, and (γ) that the focal lengths of both lenses, f_1 and f_2, are definite quantities.

(α) Photographic positive lenses are usually not thin. Negative telephoto lenses, except some high-power lenses, are always thin. With a thick lens the "equivalent planes" for the two sides (the "object space" and the "image space") are different. As all measurements in the above formulæ are made from the back of the positive lens and the front of the negative lens, no confusion can arise between the equivalent planes.

(β) The aberrations of a photographic lens are negligible.

(γ) The positions of the equivalent planes of the negative lens move over a small space with a change of magnification. This quantity is negligible in deciding the circle of illumination, which does not need to be known exactly.

The position of the equivalent plane of the whole varies greatly with a change of distance of object. This can be completely corrected by substituting the "back conjugate focus" of the positive lens for the distance, in place of the "principal" focus (f_1) in the above formulæ. In telephotography the object is usually "at infinity," and this correction is not necessary.

In a short note it is not possible to do more than indicate the conditions in which these formulæ may be used. Consult Lan-Davis on "Telephotography" and Beck and Andrews's "A Simple Treatise on Photographic Lenses" (Appendix) for "equivalent planes."

A. B.