

Is Scientific Inquiry a Criminal Occupation?

I ASK the question because, under the provisions of the Safeguarding of Industries Act, 1921, which came into operation on October 1, scientific workers and the public may be fined one-third of the value on all scientific appliances and on all chemicals—other than sulphate of quinine—imported into this country. Why this quinine salt alone of all chemicals should be free I do not understand, unless it be because it is largely used as a contraceptive and the philanthropic framers of the Act are alive to the fact, which of all others is the most important for us to recognise, that our country has double the population it can carry. Obviously, they are bent on discouraging and hindering scientific inquiry in every possible way; the Act can have no other effect; only a small proportion of the articles it covers are, or ever will be, made in this country. No more iniquitous measure was ever passed into law.

I have given notice that at the next meeting of the council of the Chemical Society I will move that action be taken forthwith to secure the repeal of the Act. If it be not annulled, scientific workers generally must agree to boycott all apparatus and materials of English manufacture. For once we must wake up and show that we can both help ourselves and protect the interests of our country.

Sir William Pope, in a recent speech dealing with American conditions, pointed out that chemists at least were so organised in the U.S.A. that they could make their voice heard with effect in the legislature. Here the legislature, bureaucracy in general, does not care a rap for science. A request made by Sir William Pope several months ago to the Board of Trade, on behalf of the Federal Council, that the Council might be heard on the proposed Bill was never more than formally acknowledged.

If we believe in our craft and its national value we must be militant in its protection.

I shall be glad to receive names and addresses (written legibly on postcards, please) of those who are willing to join in a memorial to the Prime Minister. If we desire to gain a position for science in this country, it is our duty to show, for once, that we can do something—that we are not mere talkers.

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Radiation and Chemical Action.

As regards Prof. Lindemann's criticism of the radiation hypothesis of chemical reactions, namely, that exposure of an aqueous solution of sucrose plus acid to sunlight brings about no sensible increase in speed, two possible ways of meeting the criticism present themselves. The first is to assert that the absorbing power of the water—that is, its screening effect on the molecules of the reactant solutes—is so great that the effective radiation of sunlight is reduced to negligible dimensions in a thin layer. This suggestion was made by the present writer at the Faraday Society's discussion on September 28 last. In the light of Mr. Taylor's experiments, this suggestion is seen to be untenable. The alternative way of dealing with the criticism is based on the relatively small absorption capacity of the reactant solutes as suggested by Mr. McKeown and the present writer (Journ. Amer. Chem. Soc., p. 1304, June, 1921). In the paper referred to it is shown that a clear distinction must be drawn between photochemical and thermal conditions, the former involving an absorption coefficient term.

Briefly, the treatment of the photochemical process is as follows:—

Consider a layer of sugar solution, cross-section 1 cm.² and of thickness dx , at a temperature T_1 . The number of molecules of sugar present is given by pdx/kT_1 , where p is the osmotic pressure in absolute units. If the layer be acted on by black-body radiation of temperature T_2 , the total energy of frequency ν absorbed per second is $2\alpha E_\nu \cdot dv \cdot dx$, where α is the absorption coefficient of the sugar. The chemically effective energy absorbed is a fraction γ of the above, namely,

$$\frac{4\pi\alpha\gamma h\nu^3}{c^2} \cdot e^{-h\nu/kT_2} \cdot dv \cdot dx.$$

This energy divided by $h\nu$ gives the number of sugar molecules decomposed photochemically per second, and therefore the fractional number decomposed in the layer per second is

$$\frac{4\pi\alpha\gamma\nu^2 kT_1}{c^2 p} \cdot e^{-h\nu/kT_2} \cdot dv.$$

For the action of sunlight this must be multiplied by $\theta^2/4 = 5.42 \times 10^{-6}$, where θ is the apparent angular semi-diameter of the sun. Putting $\nu = 2.86 \times 10^{11}$, $T_1 = 293^\circ$ abs., $T_2 = 6000^\circ$ abs., and $p = 22.4/3.42$ atmospheres (Taylor's experimental conditions), and giving to dv the probable value 3×10^{13} , we get the fraction decomposed per second by the photochemical action to be $1.06 \times 10^{-4} \alpha \cdot \gamma$. The value of the thermal unimolecular velocity constant is approximately 4.3×10^{-6} . Whilst actual data on the amount of absorption by the dissolved reactants are lacking, it is evident that the photochemical decomposition may readily be of the same order as the thermal effect, or even of a smaller order. It certainly does not exceed it by any such impossible magnitude as 10^{13} , and it is not surprising, therefore, that, with the very small time of exposure (about 1 second) given by Mr. Taylor to the droplets of the sugar solution, no appreciable change in the reaction velocity should have been observed.

A very rough estimate of the order of magnitude of $\alpha \cdot \gamma$ may be obtained as follows:—In the first place, let us set $\gamma = 1$, its maximum value (in the case of anthracene γ has been estimated by Weigert as 0.04). As regards α , Coblentz has measured the percentage transmission of solid sugar in the infra-red region. In the neighbourhood of 1μ the value of α , obtained from Coblentz's data, is 46. In the case of 10 per cent. sugar solution the absorption coefficient, in so far as it depends on the sugar, would be reduced to about one-tenth of this value, corresponding to the tenfold dispersion of the sugar molecules. Hence, in so far as these data are applicable, one would infer that the maximum value of $\alpha \cdot \gamma$ does not exceed 5, thus making the photochemical fractional decomposition at most of the order 5×10^{-4} , which is 100 times the thermal for the acid strength employed by Mr. Taylor. As the thermal change in 1 second is quite inappreciable, it is possible for the photochemical change to be inappreciable also. (I omit, for the sake of brevity, consideration of the fact that the inversion of sugar is not a simple process, but involves at least three consecutive processes, so that the precise value of the effective wave-length has not as yet been ascertained.)

Finally, it may be pointed out that no determination of the amount of radiation absorbed by the sugar in the solution has as yet been carried out by Mr. Taylor. If this were small, no chemical change in excess of the thermal change would be anticipated.

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