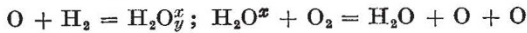


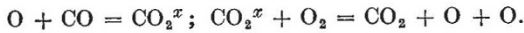
carbon monoxide. The expression has been partly derived from data obtained at Leningrad and partly from those published by Hinshelwood and Thompson in 1929. The activation energy for $H_2 + O_2$ was found to be 22,000 cal., which does not differ much from the corresponding value (25,000) given by Hinshelwood and Grant.

Hinshelwood and Grant further state that, contrary to theoretical considerations, which lead to the relationship $p_1 = B_c \cdot E/RT$, the value of the lower limit does not actually depend on temperature. I again refer to our paper, where the value of the lower limit was shown to vary with temperature according to the expression $ae^{-14,000/RT}$. It may be added that, within the limits of experimental error, 14,000 is half of 25,000. The problem of the relationship between the values of the upper and the lower limit will be discussed in another paper which will appear in the next issue of the *Phys. Z. Sovjetunion*. So far as the oxidation of hydrogen and of carbon monoxide is concerned, the theoretical equation $p_1 p_2 = \text{constant}$ will be shown to hold good.

In our paper of 1930, already cited, I have advanced the following scheme for the development of chains :



In 1929³ a similar scheme was proposed for $CO + O_2$:



In a paper dated 1932, Hinshelwood, Thompson and Hadman⁴ give a somewhat modified scheme of the development of chains :



Attention is invited to the fact that, since, in the last scheme, the development of chains is brought into relation with ternary collisions, it would require quadruple collisions for the rupture of the chains in the gas phase to account for the existence of the upper pressure limit of ignition. In view of the above, it seems that my scheme is to be preferred.

N. N. SEMENOFF.

Leningrad.

¹ Hinshelwood and Grant, *Proc. Roy. Soc., A*, **141**, 29; 1933.
² Kopp, Kowalsky, Sagulin, Semenov, *Z. phys. Chem.*, **6 B**, 307; 1930.
³ Semenov, *Chem. Rev.*, **6**, 347; 1929.
⁴ Hinshelwood, Thompson, Hadman, *Proc. Roy. Soc., A*, **133**, 297; 1932.

I THINK it most useful that different lines of attack should be compared and contrasted, and am very pleased to associate myself with the publication of the above note. My indebtedness to the general ideas of Semenov has been acknowledged *passim*, though in the present instance I must remark that the upper limit of the hydrogen-oxygen reaction was discussed by Hinshelwood and Thompson in 1929¹, where the theory of some kind of gas phase deactivation was put forward and the fact that chain breaking must depend upon a higher power of concentration than chain starting was implicitly taken into account. The paper of Grant and Hinshelwood contained a quantitative re-investigation of the matter, yielding what seemed definite proof of the ternary collision hypothesis. With regard to the third point in the above letter, it should be remarked that Grant and Hinshelwood explained the influence of temperature on the lower limit, at least to their own satisfaction.

C. N. HINSHELWOOD.

¹ *Proc. Roy. Soc., A*, **122**, 610; 1929.

Internal Temperature of Stars

It may be of interest to notice that the investigation of the process of thermal transformation of light elements in stars¹ enables us to check the upper limit for the temperature of internal regions. In fact, so far as lithium is present, for example, on the star surface, it is natural to accept that it is in equilibrium with the lithium content in the internal regions of the star near the stellar nucleus, where the production of different elements takes place. On its way from the stellar nucleus through the hot regions of the star, lithium atoms will be partly destroyed by thermal collisions with hydrogen atoms ($Li^7 + H^1 \rightarrow 2He^4$) and will not reach the surface at all if the temperature of the internal regions is too high.

For the rate of the reaction in question we have :

$$\omega \sim \int \pi \left(\frac{h}{mv}\right)^2 \cdot e^{-2\pi Ze^2/hv} \cdot v \cdot N \cdot 4\pi v^2 \left(\frac{m}{2\pi kT}\right)^{3/2} \cdot e^{-mv^2/2kT} dv \quad (1)$$

where Z is the atomic number of the element, v and N the velocity and density of protons, and T the absolute temperature.

Calculating the integral we obtain :

$$\omega \sim N h^{3/2} \frac{(4\pi Ze^2)^{3/2}}{m^{3/2} (kT)^{3/2}} e^{-3/2 (m/kT)^{1/2} (2\pi Ze^2/h)^{1/2}} \quad (1')$$

On the other hand, in the time $1/\omega$ a lithium atom will travel through the distance

$$l \sim \sqrt{D/\omega} \quad (2)$$

where the diffusion coefficient D is given by the expression :

$$D \sim (kT)^{1/2} / N^1 \sigma M^{1/2} m^{1/2} \quad (2')$$

Here N^1 is the total number of atoms in a cubic centimetre, σ the cross-section of collision, and M the atomic weight of the atoms in question.

Using (1') and (2'), we obtain from (2) :

$$l \sim \frac{m^{3/2} (kT)^{7/2}}{\sqrt{N N^1 \sigma^{1/2} h^{3/2} M^{1/4} (4\pi Ze^2)^{1/2}}} e^{3/4 (m/kT)^{1/2} (2\pi Ze^2/h)^{1/2}} \quad (3)$$

Accepting $N \sim N^1 \sim 10^{24}$ and $\sigma \sim 10^{-18}$ cm.², we obtain for lithium ($Z = 3$) the following numbers :

T (C°)	10^6	5×10^6	10^7	5×10^7	10^8
l (cm.)	10^{13}	10^8	10^4	10	1

From this table the conclusion is reached that either lithium is present on the star surface only occasionally or that no regions with temperatures of more than several millions of degrees can exist in the interior of a star.

G. GAMOW.
L. LANDAU.

Ksoochia Basa,
Khibini.
Aug. 10.

¹ Atkinson and Houtermans, *Z. Phys.*, **54**, 656; 1929.

Liberation of Electrons from Surfaces by Ions and Atoms

OLIPHANT and Moon¹ recently proposed a theory of electron emission at ion collisions, and succeeded in interpreting the data of Oliphant². They differentiate two kinds of liberation of electrons : an emission of electrons due only to the kinetic energy of the imparting ions, and an emission which results essentially from the neutralisation of the ions at the surface. On the basis of this theory one would expect to find an