they have N_2 molecules present in the first vibration state, their 19.0 volt value will be too low by the amount of this excitation (0.29 volts). It is quite true that the Boltzmann distribution gives only a negligible number of such excited molecules, at the effective temperatures used, but attention should be called to the fact that the vibrational levels of the normal state of symmetrical molecules are strictly metastable, and the number of molecules in such states may therefore be far in excess of that given by the Boltzmann factor. Unpublished work by C. A. Pulskamp, of this laboratory, shows that this is indeed true for the normal level of O_2 . Hence the Turner and Samson value of D for N_2 may well be 8.5 volts or even higher. On the other hand, direct experimental values of the ionization potential of N_2 run as high as 16.9 volts, leading to D as high as 9.24 volts. I think that all we may conclude is that the heat of dissociation of N_2 is in the heighborhood of 9 volts.

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The Temperature of the Planets

Recent measurements with a thermocouple by Coblentz, Lampland, Pettit, Nicholson and others of the temperatures of the planets have yielded temperatures below 200° Kelvin for Jupiter, Saturn, Uranus, Neptune and the night side of Mars. The dayside of Mars was found to be around 300° Kelvin. These results have been regarded by some writers to mean that Mars has an enormous diurnal temperature fluctuation and that the outer planets are very cold. Such inferences are perhaps doubtful because the atmosphere of a planet may be cold and the surface of the planet warm. For example, in the case of the earth a detailed calculation led to the following statement (Maris, Terr. Mag. and Atmos. Elec. 33, 233 (1929)): "An observer on Mars measuring the temperature of the Earth with a telescope and sensitive thermocouple would find radiation from the night equator representing a temperature of a little over 205° Kelvin, the temperature at the base of the stratosphere, plus a small amount of radiation from the warmer strata below; from the night poles he would receive radiation representing a temperature of 230° Kelvin, the temperature of the stratosphere in this region." The calculation indicated that the day side of the earth would radiate energy characteristic of temperatures as high as 350° Kelvin if the air were dry, as over a desert, and of somewhat lower temperatures if the air were humid.

Therefore it would seem that the atmosphere of a planet should be considered in estimating planetary temperatures from thermocouple observations. Explanations of the low densities of the outer planets will depend to some extent upon what temperatures are assigned to the planets. E. O. HULBURT

Naval Research Laboratory, September 17, 1929.

Chemical Heats of Activatian

Two methods of attack on the quantum mechanical problem of chemical heats of activation have been suggested. (Langer. Phys. Rev. 34, 92 (1929); London, Zeits. f. Electrochem. 35, 552 (1929). In this note I should like to advance a third, which should prove powerful, as it has already led to a qualitative success from a semi-classical point of view. The method is a direct application of the Franck-Condon considerations (Franck, Trans. Faraday Soc. 21, 536 (1926); Condon, Phys. Rev. 28, 1182 (1926); Proc. Nat. Acad. 13, 462 (1927); Phys. Rev. 32, 858 (1928)) to the case of a radiationless transition, in much the same manner as was used by Franck and

Sponer (Göttinger Nach. 241, 1928). To investigate the HI thermal decomposition, potential energy curves of I_2 , H_2 , and HI were plotted, using Morse's (Morse, Phys. Rev. 34, 57 (1929)) function. In the "zero" approximation the shape of one HI curve may be considered as not being deformed by the proximity of a second HI molecule. A one-dimensional collision was then pictured by drawing a second curve at an appropriate distance from the first. The allegiance of H_q in the first molecule, H_aI_a , could then change from I_a to H_b and the allegiance of I_b in the second molecule, H_bI_b , could simultaneously change from H_b to I_a by a radiationless transfer if no change in position were necessary to bring about the fulfillment of the energy equation,

$$x + y + Q = a + b$$

HI + HI = H₂ + I₂ + Q

where the letters represent the vibrational energies of the respective molecules written below them and where Q is the heat of reaction. The postulate was laid down that translational energy does not enter into the reaction mechanism (as is quite often assumed) and was justified by the work of Beutler and Josephy (Naturwissenschaften 15, 540 (1927); Zeits. f. Physik 53, 747 (1929)); Webb and Wang (Phys. Rev. 33, 329 (1929)); and Kallman and London (Naturwissenschaften 17, 226 (1929); Zeits. f. Phys. Chem. 28, 207 (1929)). The heat of activation is then,

$$A = x + y + F$$

where F is the (repulsive) energy necessary to

bring the molecules together to the position at which that particular collision was considered to occur. Over one hundred cases were calculated graphically and it was found that the smallest value of

$$A' \equiv x + y$$

came out to be 50 k. cal. The difference between this value and the experimentally observed heat of activation (44 k. cal.) is of the correct order of magnitude for the attractive forces existing between the molecules. (The heat of sublimation is about 5.5 k. cal.)

The possibility of the strict application of the quantum mechanics to this working method is being further investigated. The detailed description of the above results has been submitted for publication to the Journal of the American Chemical Society.

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