of the heat is lost by the vaporization of water through the lungs and skin. Indeed, approximately one-third to one-quarter of the water lost from the lungs and skin (more in extremely warm weather), is that vaporized from the skin.

From calorimetric observations it has been found that the maximum amount of heat thus far measured as given off by direct radiation was in the case of a subject who rode nearly 20 hours on a bicycle ergometer, producing the total amount of 7137 calories per 24 hours, of which essentially one-half was lost by the vaporization of water vapor while 3656 calories were lost by direct radiation.

The significance of heat loss to the environment, its relation to environmental temperature, air movement, humidity and protective clothing, is only equalled in importance by a careful study of the heat production. Our observations lead us to the conviction that, save under extreme conditions, heat production and heat loss are two essentially independent processes. Very considerable fluctuations in the heat stored in or lost from the body are possible, resulting in rather profound changes in the temperature of the peripheral tissues without appreciable alteration in heat production.

The details of the temperature measurements are about to be given in a forthcoming number of Asher-Spiro's Ergebnisse der Physiologie.

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THE PASSAGE OF SLOW CANAL RAYS THROUGH HYDROGEN

By A. J. Dempster

Ryerson Laboratory, University of Chicago

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One of the well known properties of canal rays is that of changing their charge while passing through a gas. The charged atoms alter from positive to neutral or back again to positive at almost every collision with a gas molecule. Rückhardt[1] has investigated canal rays of positive hydrogen atoms having a velocity between 1.6×10^8 and 2.3×10^8 centimeters per second (13,000 to 26,000 volts), and found that the radius of the hydrogen molecule deduced from the number of collisions at which charge alterations occur varies from 1.13×10^{-8} cms. for the fastest rays to 2.0×10^{-8} cms. for the slowest.

Using methods that have been developed in the study of the free path of electrons, Aich[2] has found that very slow hydrogen nuclei with a velocity of 7×10^6 cms. per sec. (25 volts), apparently do not penetrate into the hydrogen molecule, but are scattered out of the beam; the radius of the molecule required to account for the scattering or absorption was found to be in fair agreement with the value deduced from the kinetic theory.

Canal rays of an intermediate velocity corresponding to a potential difference of 50 to 2000 volts have been investigated by the author.[3,4] It was observed that the constituents in the rays responsible for light excitation become neutralized as soon as a small amount of hydrogen is introduced. There were also indications that some of the neutral particles again become positive.

In the present experiments rays of positively charged hydrogen atoms or protons that have fallen through 900 volts were used. After being accelerated the rays passed through a slit and were bent into a semicircular path 15.7 cms. in length by a magnetic field and fell on a second slit, as described in previous papers.[5,6] The magnetic field was kept constant, and the accelerating voltage required to bring the rays on to the second slit when no gas was present was compared with the voltage required when hydrogen was present at various pressures. Two effects might be expected. With a pressure of 0.008 mm. of mercury the free path for neutralization of the slowest positive rays observed by Rückhardt would be 2.5 cms. Our rays had a considerably slower velocity of 0.416×10^7 cms. per sec., and his observations indicated a decrease in the free path with a decrease in the velocity. The free path for the change back to positive is 28 centimeters, so that in our experiment the rays may change back and forth from neutral to positive several times in describing the path between the slits. During the time that the atom is neutral, no magnetic deflection would occur, so that when hydrogen is present the rays should require a much stronger magnetic field or much slower initial velocity in order that they should fall on the second slit. An effect of the opposite kind might be expected if the protons should lose velocity in their passage through the gas molecules.

With a constant magnetic field the voltage was observed, in rapid succession, with hydrogen at pressures between 0.008 mm. and 0.00017 mm. of mercury. No alteration at all could be observed in the voltage and magnetic field required to keep the maximum of the rays on the second slit, although a change of 2 volts in the 900 applied could have been detected. We must conclude then that neither of the effects mentioned above has an appreciable effect on the majority of the particles in the beam. The two effects could not exactly compensate over a range of pressures, since the dependance on pressure is different in each case. It is not possible to consider the rays observed with gas present to be the small fraction that have traversed the distance between the slits without undergoing a collision, since with the value of the mean free path given above this fraction is of the order of 10^{-3}, and the intensity of the rays was found to be about the same for the same anode temperature whether gas was present or not.

The conclusion that for the majority of the rays no loss of energy occurs as great as that corresponding to a fall through two volts potential difference indicates that the proton of this speed will pass through a great many molecules and not ionize or excite light, since each of the processes requires more energy than was lost by the protons. The absence of neutralization finds an interpretation on the same basis. The protons pass through the molecules without detaching an electron with which they could combine. There probably exists a critical velocity between 900 and 13,000 volts at which protons acquire this ability to excite or ionize hydrogen, and also a lower critical velocity between 25 and 900 volts, at which the proton loses its ability to pass through the molecules.

Since the presence or absence of an effect of a proton of any velocity on a molecule must depend on the electric forces involved and their variation, rather than on any influence in which the mass of the particle would be important, we should be led to expect analogies in the behavior of protons and electrons of the same velocity. Electrons acquire the velocity of the protons used in these experiments by falling through 0.5 volt, and it is significant that electrons of this speed possess the ability, in the case of several gases, of passing through many molecules without absorption.

Summary.—Protons with a velocity of 4.16×10^7 centimeters per second (900 volts) will pass through many hydrogen molecules without being neutralized. Their velocity is not altered by as much as two volts in passing through the molecules.

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