$c_2 = k_2 p_2$ for the two sides of the diaphragm. The condition for the establishment of a stationary pressure difference is $c_1 = c_2$. This implies $k_1 p_1 = k_2 p_2$, or

$$\log \frac{p_1}{p_2} = \log \frac{k_2}{k_1}. \qquad (3)$$

Now to a good approximation k depends exponentially on temperature :

$$k = k_0 \exp - Q^*/RT, \qquad (4)$$

where Q^* is related to the heat of solution. For temperatures T_1 and T_2,

$$\log \frac{k_2}{k_1} = \frac{Q^*}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right). \qquad (5)$$

Substitution of (5) in (3) results in (1), the equation given by Denbigh.

The values of Q^* for carbon dioxide and hydrogen may be obtained from the data of van Amerongen[2] on various rubbers. Q^* for carbon dioxide in natural rubber is about $- 2,700$ cal./mole, while Q^* for hydrogen is about $+ 1,000$ cal./mole. It should be noted that the signs are in the right direction, carbon dioxide showing a flow from cold to warm and hydrogen from warm to cold, and that the value for hydrogen is only about a third that for carbon dioxide, in agreement with observation. The value of Q^* for carbon dioxide given by Denbigh, $- 309$ cal./mole, is low, as Denbigh points out, because the temperatures measured were not the true surface temperatures.

If the explanation given is correct, it is clear that every gas the solubility of which in the membrane decreases with increasing temperature will show a thermo-osmotic flow from cold to warm, and conversely for gases the solubilities of which increase with increasing temperature.

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[1] Denbigh, *Nature*, **163**, 60 (1949).
[2] van Amerongen, *J. App. Phys.*, **17**, 972 (1946).

THE temperature coefficient of solubility is undoubtedly *one* of the components of the thermo-osmosis effect. However, Dr. S. Weller is in error when he says "the data can be quantitatively accounted for on this basis alone . . ." To do this it would have to be shown that the observed values of Q^* are *equal* to the known values of the heats of solution. On the other hand, if thermal diffusion is an appreciable second component, this equality would not be obtained. The testing of these possibilities is the object of our experiments and has not yet been achieved on account of difficulties in measuring the surface temperatures.

The treatment put forward by Dr. Weller was known to us at the time of the original communication and depends on the supposition $c_1 = c_2$, that is, that there is no concentration gradient of dissolved gas. It is only when this occurs that the theory based on equilibrium thermodynamics and Henry's law is approximately correct. In the more general treatment it is necessary to allow for the possibility of a finite thermal diffusion within the membrane. This can be done on the basis of Thomson's hypothesis[1] or by the use of Onsager's theorem. This results in an expression of the same *form* as quoted by Dr. Weller and as given in the original communication. The quantity Q^* is the 'heat of transport' across the membrane and reduces to the heat of solution only in the limiting case of no thermal diffusion[2]. Some preliminary results on nitrogen indicate, however, that the latter effect may be appreciable. This gas passes through the rubber membrane from cold to warm. On the other hand, the temperature co-efficient of its solubility is either zero[3], or has a very small positive value[4] which would indicate a flow in the reverse direction to that observed. However, these results are not yet quite certain, as the nitrogen was not of the highest purity.

It may be mentioned that whereas the above is concerned with diffusion normal to an interface, we are now extending observations to the case of thermal diffusion in surface layers on solids in a direction *parallel* to the interface, with possible applications in adsorption, catalysis, sintering, etc.

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[2] Wirtz (*Z. Naturforsch.*, **3a**, 380 (1948)) has reached similar conclusions from a kinetic argument.
[3] Barrer and Skirrow, *J. Polymer Sci.*, **3**, 564 (1948).
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Relativistic Variation of Rest Mass

WE propose to show that the constancy of rest mass during non-uniform movement is by no means a general feature of restricted relativity. It applies only to a special, though very important, type of a model, namely, the point charge model.

It is sufficient for our purpose to write the dynamical laws in the form

$$\frac{\partial T_i{}^k}{\partial x_k} = - F_{ik} \cdot s^k, \qquad (1)$$

with

$$T_i{}^k = \mu_0 c^2 \cdot u_i \cdot u^k; \quad s^k = \rho_0 \cdot w^k,$$

F_{ik} being the electromagnetic field tensor, μ_0 and ρ_0 the rest densities of mass and charge distributions and u^k and w^k the velocity four-vectors of mass and charge convection. Then we obtain from (1) :

$$\mu_0 c^2 \cdot \frac{du_i}{ds} + \frac{\partial \mu_0 c^2 u^k}{\partial x_k} u_i = - \rho_0 F_{ik} w^k, \qquad (2)$$

$$\frac{\partial \mu_0 c^2 u^k}{\partial x_k} = - \rho_0 F_{ik} u^i \cdot w^k. \qquad (3)$$

(3) determines the rest mass balance. In the case of point charges, $u^k = w^k$, (3) becomes a conservation law. In general, however, no conservation of rest mass takes place.

We can immediately apply (2) and (3) to Ampère's experiment (attraction between two parallel currents),