

tion that might be urged on the ground of the charter is wholly academic, for the society cheerfully admits, unmindful of the provisions of the charter, any alien who chooses to apply, and, as the recent ballot has proved, allows him to exercise the *de facto* rights and privileges of a corporator. A British-born woman may at least plead that she, at all events, is a "loving subject." The conflict of legal opinion has made it abundantly clear that there is no practical value in the doubt that has been raised as to the ineligibility of women, but there is absolutely no room for difference of opinion as to the ineligibility of the alien to act as a corporator. Why, then, should the British-born woman be excluded and the alien be admitted? If the alien may vote, why may not the British-born woman?

T. E. THORPE.

The Isothermal Layer of the Atmosphere.

THE point raised by Mr. R. F. Hughes in NATURE of January 21 and February 11 is one that appears to deserve consideration by the investigators of the upper air. He contends, I take it, that even if the instrument records perfectly the temperature of the metal strip, it does not necessarily tell us the temperature of the upper air, but the temperature which the strip takes up in order to bring about a balance between the heat received and lost by it; and in calculating this temperature it is unfair to neglect, without investigation, the absorption and emission of radiation by the instrument and the balloon.

If we take the case of the balloon, in a night ascent, we may write for the time variation of the temperature T of the gas in the balloon, assumed to be a sphere of radius r ,

$$\frac{dT}{dt} = -10^{-2}v + \frac{I}{MC} - \frac{4\pi r^2 f \rho v (T - \theta)}{MC} \quad (1)$$

where v is the upward velocity of the balloon in metres per sec., M is the mass and C the mean specific heat of the balloon and its contents, θ the temperature and ρ the density of the outside air, and f a constant.

The first term represents the rate of decrease of temperature owing to expansion of the balloon.

The second term represents the rate of increase of temperature, assumed to take place uniformly through the balloon owing to the excess, I , of energy absorbed over energy radiated. In the lower layers I is almost certainly very small, and probably negative, but it may not be so at great altitudes.

The last term is an empirical formula to represent the rate of decrease of temperature owing to convection of heat from the balloon by the outside air.

If we assume the atmosphere to be transparent and the earth to be a perfect radiator, and write E for the intensity of its radiation per square centimetre, the balloon receives from the earth energy at the rate $2\pi r^2 E$, of which it absorbs, say, one-half, and transmits the remainder. (A very thin rubber membrane has been found to transmit 75 per cent. of low-temperature radiation.) At the same time, the balloon is radiating in all directions at a rate $\frac{1}{2} \cdot 4\pi r^2 B$ approximately, where B is the intensity of radiation of a perfect radiator at the balloon's temperature.

Thus $I = \pi r^2 [E - 2B]$.

If the temperature of the earth is 280°A. ($= 7^\circ \text{C.}$), then E is about 0.55 gm. cal. per min., and is equal to $2B$ when the temperature of the balloon is 235°A. If the temperature of the balloon falls to 200°A. , $B = \frac{1}{2}E$ nearly and $I = \frac{1}{2}\pi r^2 E$.

I know of no measurements of the rate of convection from a rubber balloon, but a considerable number of experiments have been made to determine this rate for metallic thermometers. According to A. de Quervain (*Beiträge zur Physik der Freien Atmosphäre*, vol. i., p. 192), the value of $f\rho v$ for $v = 5$ m.p.s. and $\rho = 1.2 \times 10^{-3}$ is roughly equal to 0.1 gm. cal. per min.

The equation (1) therefore reduces to

$$\frac{dT}{dt} = -10^{-2}v + \frac{\pi r^2}{60MC} [E - 2B - 0.4 \frac{\rho}{\rho_0} (T - \theta)]$$

if $v = 5$ m.p.s. and E, B are measured in gm. cal. per min.

Thus if $\rho = \frac{1}{2}\rho_0$ and $B = \frac{1}{2}E$, T must exceed θ by more than 2°C. if the effect of convection is to exceed that of radiation.

If we take the balloon to be initially of 100 cm. radius, and assume that the heat capacity of the envelope is one-half that of the hydrogen, we have for MC the value

$$1.5 \times 3.41 \times \frac{1}{2} \pi \cdot 10^6 \cdot 8.8 \cdot 10^{-6} = \pi \times 600 \text{ nearly,}$$

the specific heat of hydrogen being 3.41 .

Also r^2 will be 2×10^4 , whence $\frac{\pi r^2}{MC} = 33$, and the first term is

therefore comparable with the last two in the equation (1). If the temperature is diminishing at the rate of 6°C. per kilometre, T will diminish at the same rate if it exceeds θ by about $1^\circ.7 \text{C.}$ Even if convection is only one-third as efficient as Quervain found, the temperature excess is not more than 5°C.

The thermometers are of bright metal, and even if they are directly exposed to the earth radiation they will not absorb at a rate as great as one-tenth of the rate we have assumed for rubber.

The equation for the temperature variation would be

$$\frac{dT}{dt} = \frac{A[E - 2B]}{10MC} - \frac{f\rho v \cdot S}{MC} (T - \theta), \quad (2)$$

where S is the area exposed to the air current, and $2A$ the radiating area, which is certainly less than S for a tube thermometer.

If we take Quervain's figures we get $A = 80 \text{ cm.}^2$, and $\frac{f\rho v S}{MC} = 8 \cdot \frac{\rho}{\rho_0}$ nearly, for a Hergesell instrument, while $\frac{A}{MC} =$

160 , so that for $T = 200^\circ \text{A.}$ we have $\frac{dT}{dt} = 4.4 - 2.7 (T - \theta)$, and

the excess of T over θ would be but slightly greater than 2°C.

We may, then, take it as certain that the temperatures recorded in night ascents can be but slightly affected by radiation so long as the upward velocity is as great as 5 m.p.s. The assumptions made as regards radiation and convection are, of course, only approximate, but I think they err on the side of exaggerating the radiation effect.

In conclusion, I may add that I undertook this calculation believing that it might be possible for radiation materially to affect the temperature, at least of the balloon, because I knew that even at night radiation from external sources was not insignificant. The result is, however, a complete justification of the instrumental records. The isothermal region exists, and it exists for the very reason which, in Mr. Hughes's opinion, renders useless the instrumental records—the necessity for the material air also to preserve a balance between heat received and heat lost by radiation.

E. GOLD.

Vienna, February 15.

The Promotion of Scientific Research.

PUBLIC attention was directed to the subject of scientific research by the proceedings at the annual meeting of the trustees of the Carnegie Trust, and especially by the prominence given to the promotion of original research in the speech of Mr. Balfour, reported in NATURE of March 4. The reports of the proceedings may have engendered in some minds exaggerated notions as to the extent to which philanthropic effort may succeed in solving the problem of providing incentives to original research. It will be as well, therefore, to mention, for the information of those who are unacquainted with the regulations under which monies subject to the trust may be applied in the promotion of original research, that the incomes of the beneficiaries under the trust are very limited, and the conditions which are specified in the scheme of the trustees are very restrictive. Mr. Balfour, though he spoke encouragingly of the methods adopted by the trustees, alluded to the difficulty and delicacy of the task of selecting people for original work, and to the "puzzling questions of administration" with which it is surrounded; and it seems impossible, without the aid of legislation, to devise any scheme for the application of monies to research purposes which will succeed in inspiring confidence in research workers and which will not greatly restrict the research work which it may be designed to encourage. Had inventors of patentable inventions been encumbered by conditions similar to those to which research workers who are the objects of private munificence are subjected, the progress of inven-