Letters to the Editor.

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The Equivalent Heights of the Atmospheric Ionised Regions in England and America.

IT was recorded in NATURE of Sept. 3, 1927, that, in experiments carried out for the Radio Research Board of the Department of Scientific and Industrial Research, evidence had been obtained of the existence of at least two ionised regions in the upper atmosphere. This evidence was derived, in the first instance, from observations made at night using wireless waves of medium length as the atmospheric exploring agency, but, more recently, the use of short waves has made it possible to carry out similar experiments during the daylight hours. The results of these experiments confirm the earlier conclusion as to the existence of the two ionised regions while the use of short waves, as was anticipated, markedly lengthens the period during the twenty-four hours when the lower region is penetrable and the upper region accessible. Using a wave-length of just under 100 metres, it is found that even about mid-day the lower region is penetrable on some days. On other days it is found that, due to the inhomogeneity of the lower region, waves of this length are 'reflected' by it one moment and a short time later get through. This is illustrated by a typical series of observations made at King's College, London, on Jan. 13, 1929, using 99.8 metre waves emitted by the National Physical Laboratory transmitter at Teddington, for which the following equivalent heights (km.) of 'reflection' were recorded at 10-minute intervals between 1000 and 1400 G.M.T.: 229, 229, 236, 244, 217, 229, 229, 230, 204, 196, 229, 100, 99, 93, 98, 99, 96, 98, 232, 99 (and 220), 99, 229, 229, 99.

It will be seen that these heights fall into two definite series, of mean values 226 km. and 98 km.

Now measurements of the equivalent height of the ionised layer have also been made in America, and it is of interest to compare the English and American results under similar conditions. For example, Breit, Tuve, and Dahl (*Proc. Inst. Rad. Eng.*, vol. 16, 9, p. 1236; 1928), employing their elegant group-retardation method, have recorded that, at Washington, using 75 metre waves, they obtained evidence of multiple reflections in that effective heights in the ratio 1 : 2 : 4 had been measured. The actual heights recorded were 105 km., 225 km., and 450 km.

Now we may identify the value of 105 km. in America as corresponding to the 98 km. (lower region) in England. But in considering whether the remaining rays are multiply reflected rays from this region or not, we may note that, in terms of such an explanation, the triply reflected ray is missing and that the photographs show that the doubly reflected ray is often of greater intensity than the singly reflected ray. Both of these difficulties disappear if we adopt the double-layer hypothesis for the American results as well as for the English observations. According to this explanation, singly reflected rays were obtained at Washington from regions at heights of 105 km. and 225 km., and a doubly reflected ray was also obtained from the upper region. A close correspondence with the English mean values of 98 km. and 226 km. is thus obtained.

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Solutions and Heat Engines.

IT is not usual for an author to complain of a review of his book; but I confess that the theory of osmotic pressure put forward (in place of an account of my own reasoning) by the reviewer, in NATURE of Feb. 16, of my book "Gases and Liquids," almost took my breath away. As the reviewer's reply, in NATURE of Mar. 9, to Prof. Armstrong's criticisms of this theory seems to me totally inadequate, perhaps I may be allowed space for some remarks.

The reviewer says that in a solution "the effect of the bombardment [by solute molecules] is to tend to expand the volume of the solution, and that therefore if water can flow in through a membrane it will do so." This theory implies that a net positive expansion pressure acting from within on the walls of the containing vessel is produced owing to the presence of the solute, and at the same time a net negative pressure causing water to pass in. Any less coherent theory I am unable to conceive. In a solution, no appreciable pressure towards either the outside or inside of the solution exists until the semi-permeable partition is brought into contact on the outside with pure solvent or a solution not isotonic with the solution in the osmometer. There is no pressure because, though the solute molecules exercise pressure, the pressure of the solvent is correspondingly diminished, just as, with gas at constant volume and pressure, there is no change of pressure when we substitute an equal volume of another gas at the same pressure for part of the original gas. The 'osmotic' pressure which develops in an osmometer is quite evidently due to the fact that the more concentrated molecules of the pure solvent diffuse through the semi-permeable membrane faster, until the full osmotic pressure is developed, than the diluted solvent molecules in the solution. It is thus to the solvent, and not to the solute molecules, that the pressure is due, as Prof. Armstrong has pointed out.

In my book I have developed this theory quantitatively, and shown, as I think, that it gives the actual experimental figures for depression of freezing-point, elevation of boiling-point, and osmotic pressure, though not what van't Hoff wrongly thought were the figures. While I am sorry that the review has given no account of the reasoning in the book, I must not complain; but I think I am justified in joining my protest to that of Prof. Armstrong against what seems to us and many others the incoherent theory put forward by the reviewer.

I have tried in my book to be fair to the memories of van't Hoff and Carnot, both of whom were men of outstanding genius. But where they were in error they were just in error, like other mortals.

J. S. HALDANE.

DR. HALDANE considers my statement of van't Hoff's theory (it is not mine) as incoherent. I cannot do better than quote, as an alternative statement, from the account of osmotic pressure in the book under review (p. 109): "Let us imagine pure hydrogen and pure nitrogen at ordinary atmospheric pressure and contained in two equal gas-tight chambers separated from one another by a rigid septum permeable to the hydrogen but completely impermeable to the nitrogen. The hydrogen contained in chamber 1 will immediately begin to diffuse into the nitrogen in chamber 2, and will continue to do so until the pressure of the hydrogen is the same in the two chambers. . . . If the pressure in the first chamber is kept constant, by reducing its volume or letting in hydrogen as required, the pressure in the second chamber will be two atmospheres."