choosing the concentrations, for if we re-write the reversible reaction

it transpires that we have chosen for the concentration of the resultants, because they are the same, the sum of their individual concentrations, although for the reactants, which also are chemically the same, the individual concentrations have been taken. It is clear that it is the individual concentrations in both cases that have to be taken, and therefore that one-half of the $\text{Cl} \cdot \text{Cl}'$ concentration is involved. Then $k_1 = k_2$. So with any reaction of this type involving two molecules, apart from the question of isotopes altogether, the 4 that always appears in the conventional text-book examples is merely a consequence of a loose and physically unjustifiable mode of representing the concentrations. Writers of future text-books might ponder a little over this. If the same change in the choice of the concentrations is made in the thermodynamical argument, the difference of entropies, $R \log_e 4$, reduces apparently to $R \log_e 1 = 0$.

I have now made some progress in the application of probability considerations to the kinetics of the reaction. The distribution already given (i) has reference merely to the manner in which the two kinds of atoms will arrange themselves among the three kinds of molecules, assuming promiscuous combination between the two kinds, the two kinds being identical. But the particular distribution obtained does, I find, depend upon the kind of recombination assumed. As regards the dissociation of the molecules into atoms prior to their recombination, the matter appears straightforward, at least so far as I have got. Thus whether one supposes that in a certain time a certain fraction of collisions, the same on the average for each kind of molecular collision, is fruitful in dissociating the two molecules into four atoms, or one regards the dissociation as monomolecular, as presumably it would be if light were the dissociating agent, one arrives at the same result, that if x , y , and z denote fractional proportions of Cl_2 , Cl'_2 , and $\text{Cl} \cdot \text{Cl}'$ molecules respectively ($x + y + z = 1$), the relative rate of disappearance of each by dissociation is similarly denoted. By equating this rate of disappearance to the rate of formation for the three kinds of molecules, one gets the equilibrium distribution. The distribution given by (i) is got in this way, whether (1) all the atoms of the two kinds recombine promiscuously or (2) the four atoms formed in a single fruitful collision recombine again only among themselves. If a similar limitation be applied to a monomolecular dissociation, obviously the reaction cannot affect the distribution at all, which remains unchanged whatever the initial distribution. But I also found by inadvertently applying the law of promiscuous recombination separately to each of the nine cases that have to be taken into account on the collision view—since there are three types of molecules which may collide with any one of the three types—instead of to the sums of each of the two kinds of atoms produced, that a very extraordinary equilibrium distribution resulted, given by

$$\text{Cl}_2 : \text{Cl}'_2 : \text{Cl} \cdot \text{Cl}' :: \frac{1}{2}n(1+2n) : \frac{1}{2}(3-2n)(1-n) : \frac{3}{2}n(1-n),$$

which leads to the curious concentration equation

$$[\text{Cl}_2][\text{Cl}'_2] = \frac{1}{2}\{[\text{Cl} \cdot \text{Cl}']^2 + [\text{Cl} \cdot \text{Cl}']\}.$$

This in the case $n=0.5$ happens to reduce to Mr. Chapman's relation (i) (NATURE, June 17, p. 487).

The case, of course, has no physical meaning, but it may serve to show that the equilibrium distribution is sensitive to the particular assumptions made as to

the type of reaction which occurs. I do not imagine I have exhausted the physical possibilities, but, so far as I can see, my distribution relation (i) covers the physically conceivable cases, and therefore the half, not the whole, concentration of the substance undergoing a bimolecular reaction with itself ought to enter into the equilibrium equation.

FREDERICK SODDY.

Science in Medical Education.

THE discussion at the British Medical Association on July 1 on the place of preliminary science in the medical curriculum seemed to indicate practical unanimity on some points, such as the need for a higher minimum standard of general education, the raising of the minimum age for the registration of medical students to seventeen years, and the necessity for the maintenance of a high standard of instruction in physics, chemistry, and biology. There was no indication of the desire on the part of any one of the speakers to reduce the present standard of requirements in any one of these three fundamental sciences, and several suggestions were put forward for extending the courses of each of them into the later years of medical study.

Particularly welcome to many of the science teachers who were present were the remarks of Dr. Brackenbury, who insisted that a high standard of scientific education was just as necessary for the general practitioner as it is in the case of any specialist, and that consequently, in so far as the preliminary science courses are concerned, there should be no division of the courses into a higher and lower standard for different classes of medical students.

On the question of the relegation of the science courses to the school period of the student's education there were some minor points of difference of opinion, and there is need for further consideration of this matter and for the development of a common plan of action. If by raising the age of registration to seventeen years the school period is increased by an average of one year, there will be time for some school instruction in the fundamental sciences after the student has passed a matriculation examination without science, and there can be no doubt that if this time is profitably used, so that the student gains some knowledge of the elementary facts and principles of the sciences, the courses in the first year of study at the universities can be so modified in form as to bring home to the student much more forcibly than the courses do at present the relation of pure to applied science in medicine. The very prevalent idea that a great deal of time is wasted in the first year at the university in learning science that has no application to medicine arises entirely from the fact that the majority of the students come to the university so ignorant of elementary science and so untrained in scientific thought that the time of the university teachers is wasted in teaching the most elementary principles that could and should be taught at school. It seemed, however, to be the general opinion of those who were present at the meeting that the teaching of chemistry, physics, and biology should not cease at the end of the school period, but be extended into the first year of university study in a form which would be more general as regards principles, and more specialised as regards its application to the medical sciences. The suggestion made by Prof. Lorrain Smith and other speakers, that the teaching of science should be extended into the later years of the medical curriculum so that the links that bind the pure sciences to the medical sciences should be continuously presented to the medical student, does

not seem to me really practical unless the time required for a medical qualification is increased.

The time-table of the later years of medical study is already so overcrowded, there is such urgent demand for more time for pathology, for instruction and practice in the wards, for the study of special medical subjects, and for some course of instruction in psychology, that it is difficult to see how any more lectures on pure science subjects can be squeezed in. It seems to me that the special need of medical education at the present time is a carefully thought out scheme of post-graduate studies, in which the teachers of chemistry, physics, and biology would take part, in all the large medical schools of the country.

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SYDNEY J. HICKSON.

The Mechanics of the Glacial Anticyclone Illustrated by Experiment.

IN various publications issued during the past decade¹ the present writer has treated the peculiar air circulation which obtains above a continental glacier. A number of well-known writers, among them Sir John Murray and Buchan, had early pointed out that essentially anticyclonic conditions obtained over the Antarctic region as a region, but without reference to any connection with the continental glacier; while the late Admiral Peary was the first to note the dominance of centrifugal surface-currents over the Greenland continental glacier,² which important observation was the starting point of the writer's studies.

In all my writings upon the glacial anticyclone I have been at much pains to explain that the domed surface of the ice is essential to the development both of the anticyclone and of the alternating calms and blizzards which record its strophic action. In my "Characteristics of Existing Glaciers" it is stated (p. 149): "It is due to the peculiar shield-like form of this ice-mass that the heavier cooled bottom layer [of air] is able to slide off radially as would a film of oil from a model of similar form. The centrifugal nature of this motion tends to produce a vacuum above the central area of the ice-mass, and the air must be drawn down from the upper layers of the atmosphere in order to supply the void. It is here that is located the 'eye' of the anticyclone." Again (p. 266): "This anticyclonic circulation of the air is not determined in any sense by latitudes, but is the consequence of air refrigeration through contact with the elevated snow-ice dome, thus causing air to slide off in all directions along the steepest gradients."

In my monograph published in the Proceedings of the American Philosophical Society it is stated (p. 188): "It is because the inland-ice masses have a domed surface that they permit the air which is cooled by contact to flow outward centrifugally, and so develop at an ever-accelerating rate a vortex of exceptional strength."

It is, of course, fully realised that a domed surface is not the only one which theoretically might be conceived to produce such an anticyclone, but it is the only one of which we have examples in Nature bringing about such results. Any sort of pyramid would suffice; the essential thing is that the surface

should have its convexity upwards rather than downwards. Either over a concave surface or about a flat one the refrigerating engine cannot operate.

With the view of demonstrating the relation of the air circulation above a continental glacier to the ice-dome, I have prepared some simple devices for experimentation. In the first experiment water was used as the fluid medium to represent air in an apparatus (Fig. 1) which consists of a glass tank 12 in. by 6 in. by 6 in., containing at the bottom a copper vessel of semi-elliptical cross-section to represent a portion of the domed surface of the glacier. This copper vessel may be filled from below and quite independent of the tank itself. When used for the experiment the tank itself is filled with distilled water at room-temperature, rendered slightly alkaline by addition of sodium hydroxide. Phenolphthalein is then sprinkled over the surface of the water in the tank. It soon develops a dark-red cloudiness which remains near the surface. When ice-water is introduced into the copper dome the adjacent layer of water is cooled by contact and slides off to either side, thus drawing down the coloured water from the surface so as to simulate the vortex and the outflow of a glacial anticyclone. If Victoria green is used to

FIG. 1.—A glacial anticyclone simulated in water currents (with use of Victoria green as a colouring dye).

replace phenolphthalein as a dye, its crystals must be supported by a container having a bottom of fine-meshed screen, but in this case ordinary tap-water may be employed, since it is not necessary to render the water alkaline.

A similar experiment may be carried out using air as the circulating medium and smoke as the visible substance which betrays the currents. It is, however, less suited to photographic representation of the circulation, and the device only is therefore represented in Fig. 2. The device consists of a glass jar open at the top, such as is in common use for goldfish; within this jar is a metal dome to represent the domed surface of the glacier. This dome when filled with ice-water at once develops strong anticyclonic circulation of the air in the jar, and the circulation can be made visible if a burning cigarette is supported on a platform near the top of the jar and near its central axis. The jar is covered by a metal plate, the central portion of which is separate and attached to the funnel through which the ice-water is admitted to the dome and on the stem of which is the platform that supports the cigarette. The funnel may almost equally well be dispensed with, and the dome, already filled with ice-water, introduced into the jar with the hand.

¹ "The Ice Masses on and about the Antarctic Continent," *Zeitsch. f. Gletscherk.*, vol. v., 1910, pp. 107-20. "Characteristics of the Inland-ice of the Arctic Regions," *Proc. Am. Philos. Soc.*, vol. xlix., 1910, pp. 96-109. "Characteristics of Existing Glaciers" (Macmillan, 1911), chaps. ix. and xvi. and Afterword. "The Pleistocene Glaciation of North America Viewed in the Light of our Knowledge of Existing Continental Glaciers," *Bull. Am. Geogr. Soc.*, vol. xliii., 1911, pp. 641-59. "Earth Features and their Meaning" (Macmillan, 1912), pp. 283-86. "The Ferrel Doctrine of Polar Calms and its Disproof in Recent Observations," *Proc. Second Pan-American Scientific Congress*, vol. ii., Sec. II., Washington, 1917, pp. 179-89.

² *Geographical Journal*, vol. xi., 1898, pp. 233-34.