exchange. All of our studies have been carried out in Pyrex glass systems so that there is undoubtedly some borate present in the alkaline solutions. If Dr. Bell's studies were carried out in soft glass then it is possible that the borate acts as a catalyst in the rapid establishment of exchange equilibrium while the soluble substances from soft glass do not act as efficiently.

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RECEIVED MARCH 23, 1935

CONCENTRATION OF TRITIUM (H^3)

Sir:

About a year ago detection of the hydrogen isotope of mass 3 in substantially protium-free deuterium was reported by Lozier, Smith and Bleakney [*Phys. Rev.*, **45**, 655 (1934)]. At that time the tritium concentration was estimated as 5 in 10^6 after the initial volume of ordinary water had been reduced by electrolysis to 1 part in 225,000. Electrolysis has been continued during the past year until the volume has now been reduced to 1 part in 150,000,000. That is, approximately 75 metric tons of ordinary water have been electrolyzed down to 0.5 cc. During this time the tritium concentration as determined by the mass spectrograph has increased to about 1 in 10^4. We are now in a position to obtain the ratio of specific discharge rates of deuterium and tritium, and to estimate the abundance of tritium in nature.

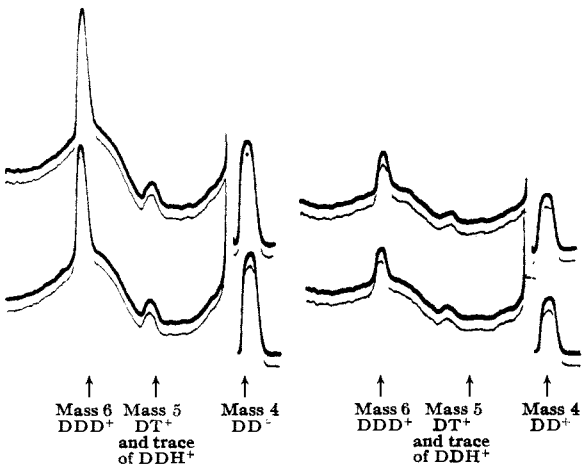

Fig. 1.

The discharge ratio (α_T^D) for deuterium and tritium may be obtained by graphical integration of the total tritium evolved during substantially complete electrolysis of a given sample of protium-free deuterium oxide. The value so obtained is 2.0, in good agreement with the theoretical prediction of Eyring [*Scientific Monthly*, **39**, 415 (1935)]. We have the relation $\alpha_T^H = \alpha_T^D \cdot \alpha_D^H$, and as α_D^H averages about 6 in the Princeton heavy water plant, α_T^H = about 12. In estimating the abundance of tritium in nature it must be borne in mind that during the earlier part of electrolysis, tritium is concentrated chiefly with respect to protium, but during the latter part entirely with respect to deuterium. For the purpose of making a rough computation we assume that α changes from 12 to 2 when the H:D ratio is 1–1. The abundance of tritium in ordinary water is then 7 in 10^{10}.

Figure 1 shows the intensities, recorded automatically, of the ions of masses 6, 5 and 4, the latter on a much reduced scale owing to its great abundance in the mixture. The intensities in the left half of the diagram are at a greater pressure than those on the right. From the pressure influence thus examined over a series of pressures we find that the intensity due to the ion of mass 6 varies as the square of the pressure. It is therefore triatomic and must be DDD^+. The ion of mass 5 varies in intensity nearly directly with the pressure and must therefore be mainly diatomic and hence DT^+. It is from the plot of the intensity–pressure ratio against pressure that, as has been previously described, the atomic content of tritium is deduced. Our results show that by further electrolysis of the deuterium oxide preparations now produced in commercial quantities both in this country and Europe, residues rich in tritium can readily be assembled without significant loss of deuterium since the electrolytic gas so produced can be recombined to yield deuterium oxide from which the tritium has been partially removed.

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RECEIVED MARCH 22, 1935

DEVELOPMENT OF AN AIR-DRIVEN ULTRACENTRIFUGE

Sir:

Up to last summer, Svedberg alone had produced convectionless centrifuges whose contents could be submitted to optical observation while in motion. In 1931, we undertook at Stanford

the task of developing the air-driven spinning top of Henriot and Huguenard [*Compt. rend.*, **180,** 1389 (1925); *J. Phys. Radium*, **8,** 433 (1927)] as a Svedberg ultracentrifuge, of equal power and possibilities but at an expense so low as to make it fairly generally available. Out of many designs, two may be mentioned here. With the latter we are able to obtain sedimentation velocity measurements similar to that illustrated in the accompanying photograph, which shows all four characteristic features of such measurements.

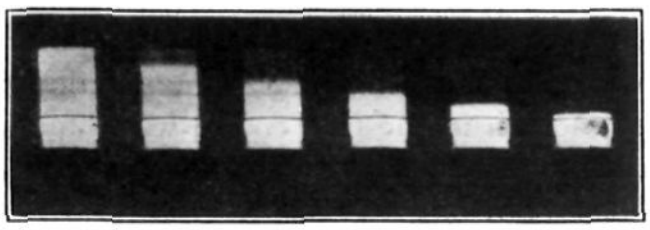

Fig. 1.

An essential part of both designs is that a stationary periscope reaches through a hole in the hollow conical base of the steel rotor and serves to pass light of any desired wave length in the visible or ultraviolet through the cell to a camera. The rotor revolves around the periscope, driven by air supplied at constant pressure and adjusted temperature. The speed of rotation is very accurately measured by beating the note produced by the top either directly or with the assistance of a photoelectric cell against a standard variable oscillator. Speeds are limited solely by the strength of the strongest materials available.

The former cell consists of two disks of crystalline quartz 30 mm. in diameter made water-tight by an expanding rubber seal between them stretched over a baffle plate of hard rubber in which sectorial openings contain the liquid. A fortunate accident enabled us to observe the sedimentation velocity of a boundary in aqueous solution of mercuric chloride: $S = 0.891 \times 10^{-13}$ cm./sec./dyne; theory $= 0.890 \times 10^{-13}$.

The latter cell is of a Svedberg type, about one quarter of the size of his, but with a more homogeneous centrifugal field (14% compared with 20%). It fits into a hole in the steel rotor. The photograph refers to the respiratory protein of the blood of the earthworm at 2020 r. p. s. at 22.5°: $S = 72 \times 10^{-13}$.

In the photograph, the uppermost light portion is oil resting on the solution (5% blood of *lumbricus terrestris* in 1% potassium chloride). There is but one boundary and the solution beneath is homogeneous, indicating only one size of protein particle. The boundary becomes blurred with time through diffusion and the solution below becomes more dilute through radial expansion and increasing velocity. The immobile streaks were due to a smear of cement.

An elegant alternative solution is that of Beams and Pickles recently communicated to *Science*. They have sedimented diluted human blood (not hemoglobin itself).

We envisage four different fields for the air-driven ultracentrifuge. First, that of Svedberg above, applicable to all molecules. Second, immobilized systems in the hollow spinning top perfected by Henriot and Huguenard (see letter recently submitted to *Nature* on the many kinds of measurement so afforded). Third, sedimentation of the Bechhold type in the hollow top. This is presumably the kind of sedimentation we have observed with hemoglobin, methylene blue, etc., during the past few years. Fourth, convectionless sedimentation in a mechanically immobilized liquid of any kind (including for example virus, phage or sucrose).

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RECEIVED MARCH 23, 1935

RADIO-CESIUM ACTIVATED BY NEUTRONS

Sir:

All cases of radioactivity induced by neutron bombardment which have been investigated have been shown to be β-activity. However, it seemed possible that radio-cesium might be an exception to the rule and emit a positron since the emission of an electron would result in the formation of Ba^{134} which apparently does not exist in nature, while the emission of a positron would form a known isotope of xenon, Xe^{134}. The cesium case is also simplified by the fact that it has only one isotope, 133, and that the observed activity, of 100 minute half-life, is hydrogen sensitive, *i. e.*, is due to the capture of a slow neutron. We have therefore determined the sign of the particle and have found that in this case too it is an electron. The measurements were made with a screen-wall Geiger-Müller counter by bending the particles around a lead shield 5 mm. thick with a field of 5000 gauss. The observed effect decayed with a half-life of 80–100 minutes, and we also find the