of antigen, as it is desirable to wash the amoebae as free as possible from the solid constituents of the culture before extracting.

Test-tube cultures are, of course, more practical than flask cultures for simply maintaining strains of amoebae, since only a few tubes are required. They are also useful for seeding flasks when these are required.

WILLIAM W. FRYE
HENRY E. MELENEY
VANDERBILT UNIVERSITY SCHOOL OF MEDICINE

ON THE REMOVAL OF OXYGEN FROM WATER BY CUT BRANCHES[1]

IT is well known that rooted plants, in water, will remove the dissolved oxygen rapidly, under certain conditions, or not at all, under other conditions. Among the modifying environmental characters are the temperature of the water and the insolation of the shoot. Whether or not rootless shoots, or branches, with leaves, may behave in an analogous way does not appear to be known. The present note indicates that they have the capacity of removing oxygen at least, but whether the rate of such removal can be modified by the factors above mentioned remains to be shown.

In the experiments here summarized the cut ends of leafy branches of a few species of shrubs and trees were kept in distilled water for various lengths of time and the oxygen content of the water was determined at the beginning and at the end of the experimental periods. It was found, in every instance, that the oxygen content of the water was decreased. A similar result was obtained with cut flowers.

As to the effect of the external factors spoken of above, a few experiments appeared to indicate that the temperature of the water had little influence, as opposed to the results with plants having roots. It is possible, however, that the rate of oxygen removal is related to the intensity of the light to which the shoot is exposed. In four experiments, for example, with leafy branches of mulberry the rate of removal was greater during darkness than light.

W. A. CANNON
EDITH A. PURER
STANFORD UNIVERSITY

SPECIAL ARTICLES

MEASUREMENT OF THE VELOCITY OF LIGHT IN A PARTIAL VACUUM[1]

THE plan to measure the velocity of light in a vacuum was proposed in 1929 by the late A. A. Michelson, professor of physics at the University of Chicago and research associate of the Carnegie Institution of Washington. He obtained the funds for the project and lived to see the apparatus installed, but was unable to take part in the measurements, which were carried out by F. G. Pease, of the Mount Wilson Observatory of the Carnegie Institution of Washington, and F. Pearson, of the University of Chicago. The apparatus was installed at Irvine Ranch, near Santa Ana, California; observations were made at intervals during the period from February, 1931, to March, 1933. The method used was that of the rotating mirror, the mirror itself being a cylinder of glass, on the periphery of which 32 equally inclined and optically flat surfaces were ground and figured parallel to the axis. The cylinder was rotated about its axis at a speed such that a beam of light reflected by one surface and traveling a distance of 8 or 10 miles was received and reflected by the next succeeding face of the compound mirror. From the measured speed of rotation of the mirror and the length of path of the beam of light, the velocity of light was readily deduced. The mirror was driven by an airblast regulated by a sensitive, hand-controlled valve; its rotational speed was ascertained stroboscopically by bringing it into coincidence with the vibrations of an electrically driven tuning fork whose frequency was in turn determined stroboscopically by comparison with the period of a gravity pendulum swinging freely under reduced air pressure. The rate of the pendulum was ascertained by flash-box methods in terms of an accurate clock whose rate was determined by comparison with corrected radio time signals from Arlington. For the two optical path lengths of 8 and 10 miles the speeds of the mirror were 730 and 585 rotations per second, respectively. The apparatus was mounted in a tube one mile in length, consisting of 60-foot sections of corrugated steel pipe 36 inches in diameter joined with rubber sleeves, placed on trestles a foot above ground and evacuated to pressures ranging from $\frac{1}{2}$ to 5 mm of mercury. Steel tanks were attached to the ends of the tube; in these the optical parts, consisting of a small diagonal flat, an image-forming concave mirror and two 22-inch optical flats, were installed. Light from an arc lamp, after passing through a collimating lens and slit, was reflected from the upper half of the rotating mirror through an optically plane window in the side of the tube, and after repeated reflections was imaged on one of the large flat mirrors. It was then returned over a path just below the entering path, received on the lower half of the rotating mirror and thence through a small diagonal prism into a micrometer eyepiece. The length of the path followed by the beam of light was ascertained by reference to a base established with extreme care by the U. S. Coast and Geodetic Survey by the side of the pipe line. The ends of the base consisted of two concrete piers with inserted bronze reference plates placed opposite to the 22-inch plane mirrors. Transfer of the positions of these mirrors to the

[1] The study was made with the aid of a grant from the Carnegie Institution of Washington.

[1] Read before the National Academy of Sciences, Cleveland, 1934.