ficiently high, none of the oil phase goes below the surface. Assuming that the layer on the surface is one particle deep and that the droplets are small enough in diameter to hold their shape, the average diameter of the particles can be measured by the same method as used by Langmuir[1] for measuring the cross-section of oil molecules. By this method, measurements of the same emulsion at two different concentrations are consistent with each other and with measurements made with varying quantities of emulsion.

Measurements are made as follows: An enameled iron tray about eight inches wide, thirty inches long and two inches deep is filled about half full of water. A piece of parafined Al foil is floated on the surface at one end of the tray and attached to a balance exactly as in the Langmuir apparatus. The rest of the water surface is then swept free of monomolecular layers of grease, oil, etc., and a drop or two of the emulsion is caused to spread on this clean surface. Voids are eliminated by pushing the film up against the Al foil by means of a paper sweeper, and the area of the film is determined exactly as in Langmuir's experiments with oil films.

The calculation of particle size requires a knowledge of the total volume of the droplets of the disperse phase *as they exist in the emulsion.* Although, in our experiments to date, this volume is the same as that of the same mass of undispersed material, it would be premature to say that this must always be the case. This volume may be obtained by curdling a known volume of emulsion with a known volume of a solution of a suitable electrolyte, removing any included water from the curd and adding it to the rest of the water-phase. The total volume of the water-phase is then measured and the volume of the disperse phase is found by difference. This gives at once the concentration C of the emulsion. Then the average diameter of the droplets of the disperse phase in the emulsion is

$$d = \frac{CV}{A}$$

where V is the volume of the emulsion which was spread on the water and A is the area which is covered.

This method was developed at the Research Laboratory of the General Electric Company. It is a pleasure to express my thanks for their permission to publish it.

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[1] Proc. Nat. Acad. Sci. *3*, 251, 1917.

A SURFACE TENSIOMETER AND AN OSMOMETER FOR CLASS WORK

APROPOS of articles in recent numbers of SCIENCE (June 11 and July 2) on the ring method of measuring surface tension and, in the latter article, on the application to this purpose of a chainomatic balance, it may be of interest to add a note descriptive of a piece of apparatus, based on the principles of the above, which we devised over a year ago and which was successfully used by our class in general physiology during the past session. Our problem was to contrive something so cheap and simple that a class of well over a hundred students doing individual work might each be supplied with an outfit. The diagram will explain the general features. The balance lever is a thin strip of bamboo of which more than a sufficient number for the whole series was obtained from a small Japanese mat. Strips of aluminum clipped on to each end and to the center of the bar were punched to a standard pattern. A piece of platinum wire bent to form a circular loop of known circumference is suspended from one arm and from the other a white metal chain of suitable length and known weight per linear unit, terminated by a piece of thread as illustrated. The wooden support is graduated behind the chain and, for the rest, a few pins serve to suspend and confine the balance arm. The dish containing the liquid to be tested is most simply held in the hand but may be supported at the proper level for greater accuracy.

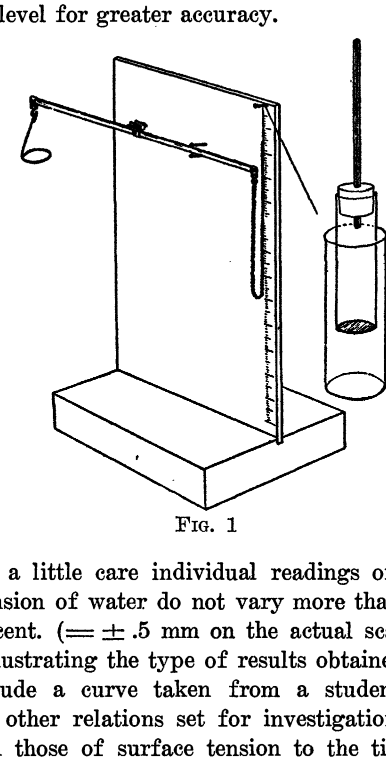

FIG. 1

With a little care individual readings of the surface tension of water do not vary more than $\pm .3$ to $.4$ per cent. ($= \pm .5$ mm on the actual scale).

As illustrating the type of results obtained in class we include a curve taken from a student's notes. Among other relations set for investigation we may mention those of surface tension to the time factor

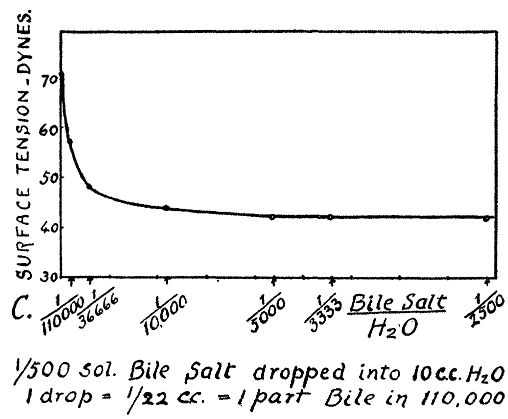

Fig. 2

(after adding bile, protein, etc.) and to toxicity in the case of the alcohol series. The experiments absorb little time, possess an intrinsic fascination and should speedily bring an apprehension of fundamental principles.

Another useful and educationally valuable piece of apparatus largely used by the same class of students is the osmometer, illustrated in the adjoining diagram. The students construct it individually according to Tamman's method (see Philip's "Physical Chemistry"), the copper ferrocyanide membrane being deposited in a film of hardened gelatin on the end of a piece of glass tubing, into which a capillary tube is fitted by means of a rubber stopper. Ease of construction combined with adequate working speed renders this type of osmometer very suitable for class work.

In its use a first approximation to the osmotic concentration of a solution may be made by comparing the unknown with a known concentration of sugar in regard to relative rates of endomosis from water (see Brown, *Ann. Bot 36*: 436) which helps toward obtaining, finally, a concentration which will balance the unknown. With care, the freezing point method may be rivalled in accuracy.

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A SIMPLE SYNTHETIC MEDIUM FOR THE CULTIVATION OF BACTERIA

In the course of studies carried out under the direction of Professor C.-E. A. Winslow in this laboratory it has seemed important to devise a highly simplified synthetic medium in which the test organism used (a strain of Bact. coli) would grow and in which the effects upon its growth of the various electrolytes could be studied without interference from impurities in the medium. After considerable study the following medium has been devised:

Ammonium tartrate, recrystallized	5 grams
Lactose (Mulford)	5 grams
Ammonium phosphate $(NH_4)_2HPO_4$	.01–.02 grams
Distilled water	1,000 cc

The reaction of the medium after sterilization is between pH 5.0 and pH 5.2. The lactose and tartrate produce no visible ash on oven treatment, but in spite of the absence of electrolytes often considered necessary the strain of Bact. coli studied has persisted with apparently undiminished vigor in this medium for twenty-three generations. No attempt has been made to study other organisms, but it has seemed worth while to describe the medium in case it may be of use to other students of similar problems.

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SPECIAL ARTICLES

THE MOTION OF A SPINNING TOP BEFORE IT REACHES THE GROUND

A good deal of interest has been taken in the motion of spinning tops of various shapes and spinning under various conditions, and a study of the problems involved has in recent years proved to be of considerable practical importance. In spite of all that has been done I have found in the literature which I have examined nothing about the motion of an ordinary top while the string is still unwinding and the top in the air. I recall as a youngster knowing that if a top is to land on its toe and spin as it should it can not always be thrown right side up. But on the other hand it often is possible to throw a top right side up, and have it stay right side up and spin merrily.

It is evident that after a top has got up a good spin any continued pull of the string is likely to introduce a torque that will cause precession and so change the direction in which the toe of the top points. But just what the conditions are under which the top should be held in a given position, just how the spin is caused to be mainly about the axis of the top, and just how the torque acts are matters that are not immediately clear. With certain simplifying assumptions it may be that a mathematical analysis of the problem would not be difficult, but the following simple treatment seems sufficient to explain the more obvious facts.

First, as to the position in which the top is actually held. If the string is sufficiently long, the top may be thrown with the toe pointing straight down, but as the string is made shorter it becomes necessary, if the top is thrown horizontally and without initial angular velocity, to tip the axis farther and farther. With a string of only moderate length I have no diffi-