band are made to traverse the two circles a' and b' both in the same direction and in the same phase, c will trace out the larger circle c'' . If, on the contrary, the motion of the circles c' b' are in opposite directions and so timed that the hands pass through the highest points of the two circles at the same instant, then c will traverse the vertical straight line de . The introduction

FIG 5

of a slight difference of phase will cause the line de to incline to one side or the other. This experiment enables one to illustrate not only the union of two circularly polarized beams to produce plane polarized light, but also to illustrate the rotation of the plane of polarization in quartz, etc.

BOYLE'S LAW, BY MEANS OF A CAPILLARY TUBE.

C. H. PERRINE, INSTRUCTOR IN PHYSICS, WENDELL PHILLIPS
HIGH SCHOOL, CHICAGO.

The apparatus consists of a capillary tube one meter long with a bore of about one millimeter, sealed at one end and fastened to a meter stick with wires at three points. In the tube is about three centimeters of air and sixty centimeters of mercury. The meter stick is clamped to a table stand so as to move around a horizontal axis and to have its broad side facing the operator. The tube may be filled before sealing if care be taken to secure the proper amount of air while closing. This should be done by the teacher. The pupil should be given the tube mounted on the meter stick ready for work. The tube should always be handled with care and never taken from the meter stick on which it is mounted.

In working the experiment first hold the tube vertically with sealed end down and note the volume of the enclosed air. Then slowly invert it to a verticle position with the open end down, noting the change in the volume of the enclosed air. When the reason for the change in volume is clearly understood, i. e., how the change in position affects the pressure on the enclosed air, the pupil is ready to work for data to determine the law. The temperature of the enclosed air should remain constant throughout the experiment. The volume of the air is read directly from the stick. The pressure is obtained by adding to the barometer reading the verticle distance or height of the end of the mercury toward the open end of the tube (a) above the other end (b) of the mercury column ($a c$ or h in Fig. 1). When the closed

end is down $a c$ or h becomes a negative quantity. The general equation then is $P=H+(a-b)$. P , being the total pressure, H the barometer reading, a , the distance of open end of mercury column to the table and b , the distance of closed end of mercury column to table, $a c$ being determined by measuring the distances of a and b from the table.

Begin with the closed end down. The change in volume for the first few times should not be more than one centimeter. Take at least twelve readings in turning from one vertical position to the inverted position.

Plot from the data results as follows:

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"A" with V on Y and P on X .

"B" with V on Y & $1-P$ on X .

It will be noted that the "B" results give a straight line which should pass through zero. If it does not pass through this point and the work has been carefully done, the horizontal distance will indicate the correction that should be given to the readings of the barometer.

DATA.
 $H=76.5$ cm.

V.	h	$\frac{P}{H+h}$	$\frac{1}{P}$	V P.
2.8	62.8	139.3	.0070	408
4.	25.9	102.4	.0099	410
5	6	82.5	.0120	403
5.4	0	76.5	.0130	413
7	-17.5	59.	.0168	413
10	-34.6	41.9	.0238	419
13	-43.9	32.6	.0306	424
15	-48.1	28.4	.0352	440
17	-51.1	25.4	.0399	434
20	-54.8	21.6	.0462	432
22	-56.7	19.8	.0513	436
24	-58.3	18.2	.0559	438
26	-59.9	16.6	.0605	432
28	-62.8	14.7	.0650	423

REPORT OF THE COMMITTEE ON BIOLOGY*

1. The committee recommends that a full year, not earlier than the second year of the high school, be devoted to zoology alone or to botany alone and not a half year to each.

2. As a prerequisite to the course here contemplated it is desirable that the pupil should have a year's training in elementary science in which familiarity with laboratory methods, and some knowledge of elementary physics and chemistry have been acquired.

3. Six periods per week should be a minimum of time

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* Appointed by the Biology Section of the Central Association of Science and Mathematics Teachers to consider the course in Biology in the Secondary Schools.

required. These should be arranged so as to give two double periods for laboratory or field work and two single periods for recitation, lecture, or quiz.

4. A fair apportionment of the pupil's time should be devoted to:

- (a). Laboratory work.
- (b). Field work.
- (c). Text book, recitation work, and supplementary reading.

5. Field work is held to be a necessary and important part of the course and may be arranged under two heads:

(a). The teacher should lead his class bi-weekly into accessible vacant lots and open fields and teach them how to observe and to do field work properly; this of course to be limited to autumn and spring months.

(b). Mimeograph copies of outlines and directions may be given to pupils and much efficient individual work may be done. While this kind of work may not be made a uniform requirement, pupils may be encouraged to do it and due credit given to all who do the work. Written reports of this work are to be rendered to the teacher and such time devoted to them in class as may be necessary to maintain a lively interest.

6. There should be a fair proportion of attention given to morphology, physiology, ecology, and economics. A knowledge of structure is of little value except it be correlated with a knowledge of function and both function and structure are of fundamental importance in relating the organism to its environment. Economics undertakes to correlate the various aspects of animal and plant life with human welfare.

7. The study of zoology or botany should be begun at the most accessible point in preference to the method usually regarded as more logical, viz., that of proceeding from the simplest forms and successively to the more complex. Accessibility is to be determined by the conditions, the previous knowledge and training of the pupils, and the desirability of a minimum use of unfamiliar apparatus and technical manipulation at the outset. Moreover, the plan of the course should be such that subjects which

afford good opportunities for field work may be considered at a time when observations can readily be made in the field and such subjects as are less adapted to field work at a time when outdoor work is not possible.

8. Wherever possible a plot of ground should be available for use in connection with the course. When established and cared for in the proper manner such a plot, even though of small size and in the city may be made to contain an abundant and varied fauna and flora of wild species and thus will afford opportunity for closer observation and study of many forms than is possible in field excursions.

9. The committee also recommends that zoology and botany be accepted as science for college entrance requirements.

10. Lastly, the committee recommends that a similar committee be appointed for the coming year to consider and report at the next meeting on such phases of this subject as may require further consideration. In this connection attention may be called to the desirability of formulating in some detail a plan of work for both zoology and botany which shall indicate the season most suitable for the various phases of the work, the length of time to be apportioned to the various subjects, etc. While such a plan can at best serve only as a general guide and much must be left to the judgment of the teacher, yet the committee believe that it would be of value in many ways.

BACTERIOLOGY IN PUBLIC SCHOOLS.

By WILFRED H. MANWARING, M. D., DEPARTMENT OF PATHOLOGY AND BACTERIOLOGY, UNIVERSITY OF CHICAGO.

The history of early Europe impresses the student of hygiene, not so much with the poetry of certain centuries, as with the ravages of epidemics, the horror of disease and the disregard of sanitary laws that characterized the same periods. Few realize today that in the earlier centuries the average length of human life was less than twenty years, and infectious diseases so common that every third man was marked with smallpox.

Gradually there has been an improvement. Great epidemics