

give the length of the simple pendulum having the obtained vibration rate. A good stop-watch is needed; or, by lightly touching and releasing the balance wheel, estimating to fifths of a second, an ordinary watch may be successfully used. My students have obtained results differing from the computed value by about .03 of one per cent.

THE VOLUMETRIC SYNTHESIS OF WATER AS A PRACTICAL QUANTITATIVE LECTURE EXPERIMENT.

BY ERNEST F. BURCHARD,

Instructor of Chemistry, Sioux City (Ia.) High School.

In order to illustrate this phase of the Law of Gas-volumetric proportions to a nicety, and that the experiment may at the same time become a working exercise for the class in the application of the Law of Charles, the essential piece of apparatus is a special eudiometer, *E*, (Fig. 1) at least 50 cm. in length, with a stopcock at the top, and is graduated to 1/10 cc. from the stopcock downwards. Its total capacity should be about 60 cc., and the lower end should be ungraduated and tapered slightly with a swell or ring at the terminus for secure fastening of a rubber tube. The platinum wires pass in at the shoulder, just below the stopcock.

This eudiometer is enclosed by a steam jacket, *J*, a tube of good, clear glass, 45 cm. long, 5 cm. inside diameter, and 3mm. wall. A stout triple-bored rubber stopper fits the bottom, and through it pass the eudiometer and two small tubes, one for the admission of steam, the other to drain off water. To the lower end of *E* is securely fitted at least 75 cm. of fresh, clean (preferably antimony) rubber tubing of 6 mm. inside diameter and 3 mm. wall, to the other end of which is cemented a 6 cm. glass funnel. The whole is supported in an upright position, and

a convenient rest for the funnel is made by sawing a small section out of a small iron ring, in order to slip the funnel easily in and out.

When the apparatus is ready it must be thoroughly dried by a continued blast of hot, dry air, after which the stopcock is closed, the funnel corked, and the whole allowed to cool, after which the eudiometer may be completely filled with mercury that is known to be clean and dry. (It is best to subject the mercury

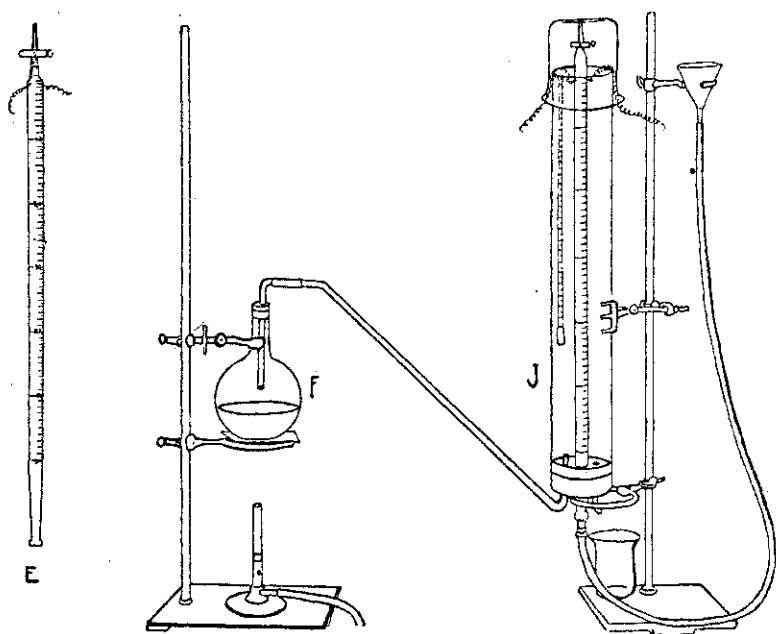


Fig. 1.

to a thorough cleaning, warming and drying in a dessiccator before using it.) The mercury should about half fill the funnel. The electrolytic gas is generated in the usual way, by electrolysis of pure water acidulated with H_2SO_4 , and dried by passing through calcium chloride and concentrated sulphuric acid, from which wash bottle it is passed into the eudiometer after having continued in action for a safe interval. It is essential that the electrolysis apparatus and wash bottles be stoppered absolutely

tight. It may be most convenient to place the gas delivering apparatus on a box in order to bring it near the level of the top of *E*. The gas is admitted to the top of the eudiometer, the tube above the stopcock having been filled to the brim with mercury. While the gas is passing in, the funnel is slowly lowered, until about 10 cc. of the gas is in the eudiometer at atmospheric pressure.

The levels of the mercury in the funnel and within the tube may be most accurately adjusted by a student, who receives his directions from the instructor observing the apparatus through a reading telescope from the rear of the lecture room. A thermometer hangs within the steam jacket, and the original volume, temperature, and barometric pressure, with temperature correction, are recorded. It is best now to cover the top of the jacket with a long, inverted beaker, which fits the outer tube closely, as the heat is thus much more satisfactorily retained. Steam is now passed into the jacket from flask, *F*, and allowed to continue until the interior has become almost clear of condensed drops of water, the hot water running down cleanly, and the temperature maintaining a constant degree for at least seven minutes. This entire heating need not occupy more than twenty minutes. Of course, the water flask should be at boiling point and in readiness before being connected. The levels are once more equalized as before, and the records of volume, pressure and temperature again made, the steam continuing to pass into *J*. At this point, the pressure may be reduced one-half (and it may be necessary to pour out some of the mercury from the funnel when it is so lowered). A spark is passed through the eudiometer from a Ruhmkorff coil or from a Wimshurst machine, and the gases exploded. The levels are now readjusted, and the volume, temperature and pressure recorded. The steam may then be discontinued, and the apparatus allowed to cool until the steam within the eudiometer has condensed, and the effect on its volume observed and noted.

If the electrolytic mixture of hydrogen and oxygen has been pure and dry, and the mercury and interior of the eudiometer have been clean, dry, and all air has been excluded, very accurate results may be expected from the experiment, and the residual

gas, after exploding and cooling, will be inappreciable. Considerable time is, of course, necessary in preparation for this work, and a preliminary trial is advisable, but the actual operation may be successfully carried out in one recitation period, with the exception of allowing the apparatus to cool fully to the temperature of the room, provided everything is in readiness.

The special eudiometer may also be used to demonstrate the Laws of Boyle and Charles, separately or combined.

The following data were obtained in a class-room experiment as outlined above:

I	II	III	IV
Original	Same after	After	
Hydrogen + Oxygen	heating	exploding	After cooling
V = 9.88 cc.	V = 12.5 cc.	V = 8.3 cc.	V = 0.15 cc.
T = 21°.5	T = 98°.7	T = 98°.7	T = 25°.0
P = 727 mm.	P = 727 mm.	P = 727 mm.	P = 727 mm.

In the pupil's report, besides the description of the usual details, drawings, and records, answers may be expected to some such leading questions as these: What volume would 9.88 cc. of a mixture of hydrogen and oxygen at 21°.5, and 727 mm. pressure occupy when heated to 98°.7, the pressure remaining the same? How does this correspond with the observed volume? What percentage of the original volume of gas at 98°.7 remains after the explosion, the temperature and pressure both remaining constant? What is the resulting gas? What becomes of it when cooled? Has any matter been lost or destroyed during the experiment? How do you account for the change? Has the proposition (what was it?) been proved?