the arrows and *the rate of flow*, that is, *the current*, will increase until the "electrical friction" in the external resistance, CFZ, plus that in the internal resistance, BD, just counterbalances the electromotive force of the cell when the current will become constant. This condition of steady flow is reached when the rate of consumption of energy in heating the wire is just equal to the rate at which energy is supplied by the chemical action in the cell. The current rises to its full value in a very small fraction of a second. When the voltmeter, V, is connected by means of two short wires to Z and C it reads the *difference of potential* between them. This difference in potential corresponds to the difference in water pressure between A and E in Fig. 1 (35 lbs. per sq. in.). Suppose that the reading of the voltmeter is found to be 0.8 volt. This 0.8 volt is then the fall in potential in the external resistance, CFZ, just as the 35 lbs. per sq. in. is the fall in pressure in the long pipe EFA. The fall in potential in the cell itself may be found by subtracting the fall in the external resistance, 0.8 volt, from the total rise, 1.08 volts (the electromotive force) just as the fall in the pipe BD may be found by subtracting the fall in the longer pipe, 35 lbs. per sq. in., from the total rise produced by the pumps, 40 lbs. per sq. in. The fall of potential in the cell is therefore 0.28 volt. The electromotive force may be found by reading the voltmeter when the wire CFZ is not connected to the cell. Since practically no current is flowing no pressure is being expended in overcoming resistance and the voltmeter reads the total rise in pressure due to the chemical action.

Since the difference of potential between the ends of the external resistance, as well as the difference of potential between the two surfaces of the liquid adjacent to the plates Z and C are known, it is only necessary to find the current through the circuit in order to calculate the external and internal resistances from Ohm's law. An ammeter connected somewhere in the external resistance CFZ will give this current.

A RAPID METHOD OF GAS STANDARDIZATION.

BY E. M. CUNNINGHAM,
High School, San Jose, Cal.

Every teacher of chemistry and physics has found that the mathematical work connected with the standardization of gases is both laborious and time-consuming. This is especially true of drill work in connection with the study and the applications following the study of Boyle's and Charles' laws. In my classes in chemistry, I have, in the past, either trusted to a comparison of

students' answers or else have used valuable time in the solution of these problems with a possibility of error in the process.

Again the students, after having mastered the underlying principles of these laws, have in turn consumed their time on the operations, which consist, as teachers know, of subtractions and multiplications and divisions of difficult numbers. This process has at times overshadowed, in the minds of the pupils, the real problem involved; for example, the determining of the weight of a liter of oxygen or finding the equivalent of sodium or magnesium.

Aiming to avoid these difficulties, I have devised with considerable labor the accompanying chart and am offering it to my brother science teachers in the hope that it will be found as useful to them as it is to me.

Suppose 140cc. of gas is obtained under a pressure of 764mm. and a temperature of 20° C. and it is necessary to standardize. On the chart trace downward to the intersection of the given temperature and pressure; thence diagonally following a broken line to the standardized volume for every 100cc. of gas taken. Multiply this volume by 1.40 (there being 140cc. of gas) and the result gives the required standardized volume of gas. If a reasonable amount of care be taken the answer is correct to the first decimal place.

The scope of the chart is sufficient to include the usual problems. The corrections for vapor density and the difference of levels may be made and the final pressure will fall within the chart's range in most cases. This chart may have other uses. I am presenting it for the purpose of gas standardization only.