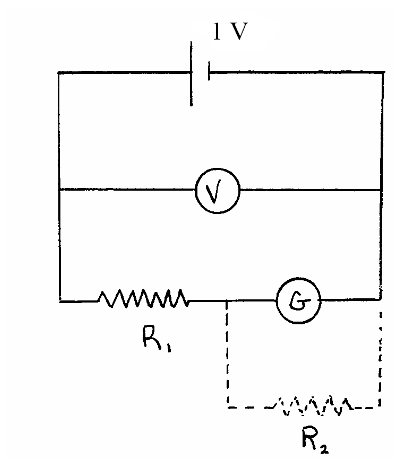
CONSTRUCTION OF A VOLTMETER AND AN AMMETER FROM A GALVANOMETER

Most analog (not digital) electric meters make use of a galvanometer. A galvanometer is a device constructed such that deflection of a needle is proportional to current through the a coil around the base of the needle. The resistance of a galvanometer is usually several ohms. Typically, a current of a fraction of one milliamp will cause full-scale deflection. The various electric meters use resistors in series or in parallel with the galvanometer. In order to choose a resistor for a specific purpose you need to know the resistance of the galvanometer and the current for full-scale deflection.

The circuit of Figure 1 may be used for determining the characteristics of the galvanometer. R_1 is a decade resistance box with a maximum resistance of, say, 10,000 ohms. With R_2 disconnected from the circuit, starting from very large R_1, decrease the value of R_1 until the galvanometer reads full-scale; note the value of R_1. Add R_2, another decade box, to the circuit as shown and vary its value until the galvanometer reads one-half full-scale deflection. Since the value of R_2 is much less than that of R_1, R_2 is very nearly equal to R_g, the resistance of the galvanometer.

Figure 1

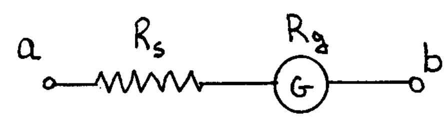


Now back to the circuit without R_2 present; since the galvanometer is fully deflected, Ohm's law permits you to compute the current for full-scale deflection. (Read potential from the voltmeter and the resistance is the sum of R_1 and R_g.) Call this full-scale current I_g.

Construction of a Voltmeter:

A voltmeter consists of a resistor in series with the galvanometer. You will construct a voltmeter to read, say, 3 v full-scale. The problem is to compute the value of R_s needed with the particular galvanometer being used. You know the desired current I_g when the difference of potential between points a and b is 3 v. Ohm's law permits the computation of the total resistance between points a and b. From this it is easy to get R_s.

Figure 2

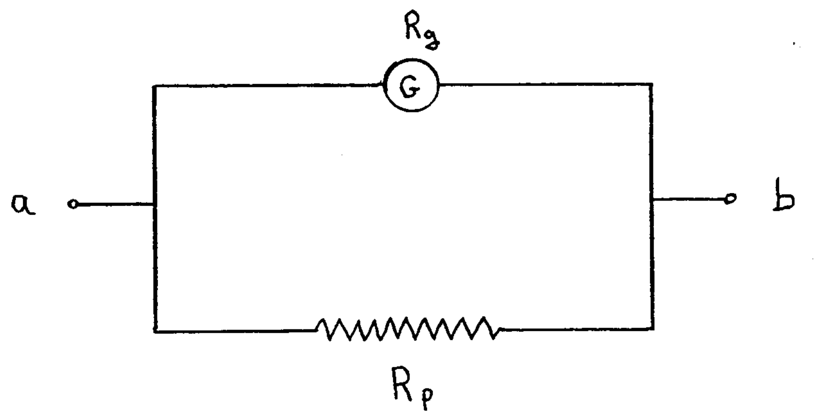


You may check your constructed voltmeter against a commercial voltmeter with a circuit like Figure 1 (without R_2 present). With resistor R_1 changed to the value R_s the two voltmeters should read the same value.

Construction of an Ammeter

An ammeter consists of a resistor in parallel with a galvanometer as shown in Figure 3. You will construct an ammeter to read, say, 3 Amps full-scale; so it is necessary to compute the value of R_p needed for this particular calibration. Since R_g and R_p are in parallel, their potentials must be equal.

Figure 3



The potential Vg for full-scale deflection can be computed from Ohm's law (R_g and I_g are known). Since the desired current through R_p can quickly be determined (3 Amps minus I_g), the value of R_p can now be computed from Ohm's law. This value of R_p is so small that a decade box is NOT suitable. Instead, you will be using copper wire. The wire you will be using has an experimentally observed resistivity of $1.73 \cdot 10^{-6}$ ohm·cm (at a temperature of ~25C). Remember:

$$R = \rho \frac{L}{A}$$

B & S Gauge	Cross-sectional Area(cm^2)
18	0.0081713
20	0.0051912
22	0.0032472
24	0.0020508
26	0.0012819
28	0.0008042

You should make allowances for contact at the posts of the galvanometer to be sure that good electrical contact is made. Check your constructed ammeter against the ammeter in the power supply. Both should read the same value.