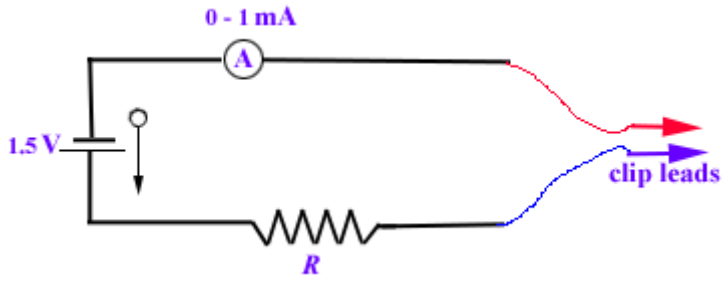
415.

Problem 33.40 (RHK)

A simple ohmmeter is made by connecting a 1.50-V *flashlight battery in series with a resistor R and a* 1.00-mA *ammeter, as shown in the figure. R is adjusted so that when the circuit elements are shorted together the meter deflects its full-scale value of* 1.00 mA. *We have to calculate the values of the resistances across the terminal which would give a deflection of* (a) 10%, (b) 50%, *and* (c) 90% *of full scale*. (d) *If the ammeter has a resistance of* 18.5 Ω *and the internal resistance of the battery is negligible, we have to calculate the value of R.*



Solution:

In the figure circuit diagram of an ohmmeter has been drawn. When the clip leads are shorted together, it is given that the 1.0-mA ammeter shows full scale deflection. That is a 1.0 mA current is flowing through

the circuit. Assuming that the ammeter and the battery have negligible resistances, the value of the resistance *R* will have to be

$$R = \frac{1.5\ \text{V}}{1.0\times10^{-3}\ \text{A}} = 1500\ \Omega.$$

(b)

If the ammeter shows 10% deflection of the full scale, the current in the circuit will be 0.1 mA. Therefore, the external resistance, R_x, across the leads will be as given by the relation

$$R_x + 1500\ \Omega = \frac{1.5\ \text{V}}{0.1\times10^{-3}\ \text{A}} = 15000\ \Omega,$$

or

$$R_x = 13{,}500\ \Omega = 13.5\ \text{k}\Omega.$$

(c)

If the ammeter shows a 50% deflection of the full scale, the current in the circuit will be 0.5 mA. The resistance, R_x, will be given by the relation

$$R_x + 1500\ \Omega = \frac{1.5\ \text{V}}{0.5\times10^{-3}\ \text{A}} = 3000\ \Omega,$$

or

$$R_x = 1500\ \Omega = 1.5\ \text{k}\Omega.$$

(d)

If the ammeter shows a 90% deflection of the full scale, the current in the circuit will be 0.9 mA. The resistance, R_x, will be given by the relation

$$R_x + 1500\ \Omega = \frac{1.5\ \text{V}}{0.9 \times 10^{-3}\ \text{A}} = 1666\ \Omega,$$

or

$$R_x = 166.6\ \Omega.$$

(e)

If the ammeter has a resistance of $18.5\ \Omega$ and the internal resistance of the battery is negligible, the required value of R will be given by the equation

$$R + 18.5\ \Omega = \frac{1.5\ \text{V}}{1.0 \times 10^{-3}\ \text{A}} = 1500\ \Omega,$$

or

$$R = 1481.5\ \Omega.$$