15-Phys-202

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Quiz 4

Name _____

Useful formulae:

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

$$I = \frac{\mathcal{E}}{R}$$

$$R_{eq} = \sum_{j=1}^{n} R_j \text{ (n resistances in series)}$$

$$\frac{1}{R_{eq}} = \sum_{j=1}^{n} \frac{1}{R_j} \text{ (n resistances in parallel)}$$

1. A certain wire has a resistance R. What is the resistance of a second wire, made of the same material that is half as long and has half the diameter?

   Solution

   In terms of resistivity ρ, which is the same for both wires,

   $$R_1 = \rho \frac{L_1}{A_1} = R$$

   and

   $$R_2 = \rho \frac{L_2}{A_2}$$

   whereof

   $$\frac{R_2}{R} = \frac{L_2 A_1}{L_1 A_2} = \frac{L_2 D_1^2}{L_1 D_2^2} = \frac{L_2}{L_1} \left(\frac{D_1}{D_2} \right)^2 = 2$$

   That is

   $$R_2 = 2R$$

2. Four 18.0 Ω resistors are connected in parallel across a 25.0 V ideal battery. What is the current across the battery?

   Solution

   The equivalent resistance is

   $$R_{eq} = \frac{18.0}{4} = 4.5 \ \Omega$$

   and

   $$I = \frac{\mathcal{E}}{R_{eq}} = \frac{25.0 \text{ V}}{4.5 \ \Omega} = 5.56 \text{ A}$$

3. The current in a single-loop circuit with one resistance R is 5.0 A. When an additional resistance of 2.0 Ω is inserted in series with R, the current drops to 4.0 A. What is R?

   Solution

   For emf $\mathcal{E}$, the current is

$$I_i = \frac{\mathcal{E}}{R} = 5.0$$

   initially, and is

$$I_f = \frac{\mathcal{E}}{R+2} = 4.0$$

   after the additional resistance is inserted. Combining the two equations, we find

$$\frac{R+2}{R} = \frac{5.0}{4.0}$$

   whereof

$$R = 8.0\ \Omega$$