Solutions

Each answer shows the steps, then the **result**.

2.1

- $R = V/I$

$$R = \frac{12}{0.25} = \mathbf{48}\ \Omega$$

2.2

- $R = \rho L/A$

$$R = \frac{(1.7 \times 10^{-8})(5.0)}{1.5 \times 10^{-6}} = \mathbf{0.057}\ \Omega$$

2.3

- radius = 0.40 mm = 4.0×10^{-4} m, and $A = \pi r^2$

$$A = \pi(4.0 \times 10^{-4})^2 = \mathbf{5.0 \times 10^{-7}}\ \mathbf{m^2}$$

2.4

- the resistivity is $\rho = RA/L$: the property of the material that, with the length and the cross-sectional area, fixes the resistance of a sample

2.5

- twice the diameter gives four times the area, since $A = \pi d^2/4$
- $R = \rho L/A$, so the resistance is **one quarter** of the first wire's

2.6

- the resistance of the thermistor **decreases** as it is warmed
- the resistance of the LDR **decreases** as the light gets brighter

3.1 D

- the same mass of the same material means the same volume, so twice the length gives half the area
- $R = \rho L/A$ then rises by $2 \times 2 = 4$

3.2 B

- $R = V/I$, so the factor is $\dfrac{2}{1.6} = 1.25$
- the resistance rises because the filament is hotter

3.3

(a) $R = \rho L/A$, and ρ and A are the same for every length

- so R is proportional to L: a straight line whose intercept is zero, because a wire of zero length has no resistance

(b) radius $= 0.18$ mm $= 1.8 \times 10^{-4}$ m

$$A = \pi(1.8 \times 10^{-4})^2 = \mathbf{1.0 \times 10^{-7}\ m^2}$$

(c) the gradient is ρ/A

- $\rho =$ gradient $\times A = 4.8 \times 1.02 \times 10^{-7}$
- $\rho = \mathbf{4.9 \times 10^{-7}}\ \Omega\,\mathrm{m}$

(d) the gradient uses every reading, so a single wrong reading matters less, and any constant error in measuring the length shows up as an intercept instead of changing the gradient

3.4

(a) the largest resistance uses the longest edge and the smallest faces: $L = 0.050$ m and $A = 0.010 \times 0.020 = 2.0 \times 10^{-4}$ m^2

$$R = \frac{(3.5 \times 10^{-5})(0.050)}{2.0 \times 10^{-4}} = \mathbf{8.8 \times 10^{-3}}\ \Omega$$

(b) the smallest uses $L = 0.010$ m and $A = 0.020 \times 0.050 = 1.0 \times 10^{-3}$ m^2

$$R = \frac{(3.5 \times 10^{-5})(0.010)}{1.0 \times 10^{-3}} = \mathbf{3.5 \times 10^{-4}}\ \Omega$$

(c) the ratio is **25**: the length is 5 times larger and the area is 5 times smaller, and $R = \rho L/A$

3.5

(a) almost no current in the reverse direction

- in the forward direction almost no current until about 0.6 V, then a steep rise
- so the resistance is very large in reverse and below the switch-on p.d., and small once the diode conducts

(b) $R = V/I$

$$R = \frac{12}{2.0} = \mathbf{6.0}\ \Omega$$

(c) $R = \dfrac{3.0}{0.80} = \mathbf{3.75}\ \Omega$

- at the lower p.d. the current is smaller, so the filament is cooler and its resistance is lower