

SOLUTIONS TO “APPLIED CIRCUIT ANALYSIS”

CHAPTER 2

Prob. 2.1

$$R = \frac{\rho l}{A} = \frac{1.72 \times 10^{-8} \times 250}{(\pi/4)(2.2)^2 \times 10^{-6}} = \underline{1.131 \Omega}$$

Prob. 2.2

$$R = \frac{\rho l}{A} \longrightarrow l = \frac{RA}{\rho} = \frac{R \frac{\pi d^2}{4}}{\rho} = \frac{0.5\pi \times 4 \times 10^{-6}}{4 \times 1.72 \times 10^{-8}} = \underline{91.325 \text{ m}}$$

Prob. 2.3

$$R = \frac{\rho l}{A} = \frac{(1.72 \times 10^{-6} \Omega\text{-cm})(4\text{ft})(12\text{in/ft})(2.54\text{cm/in})}{(2\text{in})(2\text{in})2.54\text{cm/in}^2} = \frac{209.7 \times 10^{-6}}{25.81} = \underline{8.13 \mu\Omega}$$

Prob. 2.4

$$R = \frac{P}{I^2} = \frac{1200}{6^2} = \underline{33.33 \Omega}$$

Prob. 2.5

$$R = \frac{\rho l}{A} \longrightarrow l = \frac{RA}{\rho} = \frac{1.2\pi \times \frac{4}{4} \times 10^{-6}}{110 \times 10^{-8}} = \frac{120\pi}{110} = \underline{3.427 \text{ m}}$$

Prob. 2.6

$$l = \frac{RA}{\rho} = \frac{6\pi \times (1.5)^2 \times 10^{-6}}{2.8 \times 10^{-8}} = \frac{600\pi \times 2.25}{2.8} = \underline{1.515 \text{ km}}$$

Prob. 2.7

$$R = \frac{\rho l}{A} \longrightarrow \rho = \frac{RA}{l} = \frac{2.1 \times \frac{\pi}{4} (0.4)^2 \times 10^{-6}}{4 \times 10^{-2}} = \underline{6.6 \times 10^{-6} \Omega\text{m}}$$

Prob. 2.8

$$R = \frac{\rho l}{A} \longrightarrow \rho = \frac{RA}{l} = \frac{410 \times \frac{\pi}{4} (0.5)^2}{50} = 1.61 \, \Omega\text{m}$$

A semiconductor not listed in Table 2.1.

Prob. 2.9

$$R = \frac{\rho l}{A} \longrightarrow R \propto l$$

If we shorten the length of the conductor, its resistance decreases due to the linear relationship between resistance and length.

Prob. 2.10

$$R = \frac{\rho L}{A}, \quad A = \frac{\pi}{4} d, \quad d = 2r$$

same material, $\rho_1 = \rho_2 = \rho$,

$$L_1 = 2L_2, \quad r_2 = 0.5r_1$$

$$R_1 = \frac{\rho L_1}{A_1} = \frac{\rho L_1}{\frac{\pi}{4} 4r_1^2} = 0.2 \longrightarrow r_1 = \sqrt{\frac{\rho L_1}{0.2\pi}}$$

$$R_2 = \frac{\rho L_2}{A_2} = \frac{\rho 2L_1}{\frac{\pi}{4} 4r_2^2} = \frac{2\rho L_1}{\pi \frac{r_1^2}{4}} = \frac{8\rho L_1}{\pi \left(\frac{\rho L_1}{0.2\pi}\right)} = \underline{1.6 \, \Omega}$$

Prob. 2.11

$$\frac{A_{\text{copper}}}{A_{\text{aluminum}}} = \frac{\rho_{\text{copper}} l / R}{\rho_{\text{aluminum}} l / R} = \frac{\rho_{\text{copper}}}{\rho_{\text{aluminum}}} = \frac{1.72 \times 10^{-8}}{2.83 \times 10^{-8}} = \underline{0.61}$$

Prob. 2.12

$$R = \frac{\rho l}{A} = \frac{2.83 \times 10^{-8} \times 20 \times 10^3}{4.7 \times 10^{-4}} = \underline{1.2 \, \Omega}$$

Prob. 2.13

Ohm's law ($V = IR$) states that the voltage (V) is directly proportional to the current (I). The graph in (c) represents Ohm's law.

Prob. 2.14

$$R = \frac{V}{I} = \frac{60}{50 \times 10^{-3}} = \underline{1.2 \text{ k}\Omega}$$

Prob. 2.15

$$I = V/R = (16/5) \text{ mA} = \underline{3.2 \text{ mA}}$$

Prob. 2.16

$$(a) \quad I = \frac{V}{R} = \frac{12}{2 \times 10^3} = \underline{6 \text{ mA}}$$

$$(b) \quad I = \frac{V}{R} = \frac{12}{6.2 \times 10^3} = \underline{1.94 \text{ mA}}$$

Prob. 2.17

$$I = V/R = 240/6 = \underline{40 \text{ A}}$$

Prob. 2.18

$$R = V/I = 12/3 = \underline{4 \Omega}$$

Prob. 2.19

$$V = IR = 30 \times 10^{-6} \times 5.4 \times 10^6 = \underline{162 \text{ V}}$$

Prob. 2.20

$$V = IR = 2 \times 10^{-3} \times 25 = \underline{50 \text{ mV}}$$

Prob. 2.21

$$R = V/I = 12/(28 \text{ mA}) = \underline{428.57 \Omega}$$

Prob. 2.22

$$V = IR = 10 \times 10^{-3} \times 50 = \underline{0.5 \text{ V}}$$

Prob. 2.23

$$\text{For } V = 10, \quad I = 4 \times 10^{-2} \times 10^2 = \underline{4 \text{ A}}$$

$$\text{For } V = 20, \quad I = 4 \times 10^{-2} \times 20^2 = \underline{16 \text{ A}}$$

$$\text{For } V = 50, \quad I = 4 \times 10^{-2} \times 50^2 = \underline{100 \text{ A}}$$

Prob. 2.24

- (a) $I = V/R = 15/10 = \underline{1.5 \text{ A flowing clockwise.}}$
 (b) $I = V/R = 9/10 = \underline{0.9 \text{ A flowing counterclockwise.}}$
 (c) $I = V/R = 30/6 = \underline{5 \text{ A flowing counterclockwise.}}$

Prob. 2.25

- (a) $V = IR = 4 \times 10 = \underline{40 \text{ V, the top terminal of the resistor is positive.}}$
 (b) $V = IR = 20 \text{ mA} \times 10 = \underline{0.2 \text{ V, the bottom terminal of the resistor is positive}}$
 (c) $V = IR = 6 \text{ mA} \times 2 = \underline{12 \text{ mV, the top terminal of the resistor is positive}}$

Prob. 2.26

- (a) $V = 3 + 3 = \underline{6 \text{ V}}$
 (b) $R = V/I = 6/0.7 = \underline{8.6 \Omega}$

Prob. 2.27

- (a) $G = 1/2.5 = \underline{0.4 \text{ S}}$
 (b) $G = \frac{1}{40 \times 10^3} = \underline{25 \mu\text{S}}$
 (c) $G = \frac{1}{12 \times 10^6} = \underline{83.33 \text{ nS}}$

Prob. 2.28

- (a) $R = \frac{1}{10 \times 10^{-3}} = \underline{100 \Omega}$
 (b) $R = 1/0.25 = \underline{4 \Omega}$
 (c) $R = 1/50 = \underline{20 \text{ m}\Omega}$

Prob. 2.29

$$G = \frac{I}{V} = \frac{2.5 \times 10^{-3}}{120} = \underline{20.83 \mu\text{S}}$$

Prob. 2.30

$$R = \frac{\rho l}{\pi d^2} = \frac{4\rho l}{\pi d^2} \longrightarrow d^2 = \frac{4\rho l}{\pi R} = \frac{4\rho l G}{\pi}$$

$$d^2 = \frac{4}{\pi} \times 1.72 \times 10^{-8} \times 4 \times 10^{-2} \times 500 \times 10^{-3} = 4.38 \times 10^{-10}$$

$$d = \underline{2.093 \times 10^{-5} \text{ m}}$$

Prob. 2.31

$$V = IR = \frac{I}{G} = \frac{4 \text{ mA}}{5 \text{ mS}} = \underline{0.8 \text{ V}}$$

Prob. 2.32

(a) For the #10 AWG,

$$R = 600 \text{ ft} \left(\frac{0.9989 \Omega}{1000 \text{ ft}} \right) = \underline{0.5993 \Omega}$$

(b) For the #16 AWG,

$$R = 600 \text{ ft} \left(\frac{4.01 \Omega}{1000 \text{ ft}} \right) = \underline{2.41 \Omega}$$

Prob. 2.33

A length must be specified. If we assume $l = 10 \text{ ft}$, then $R \text{ in } \Omega/1000\text{ft} = 0.001 \times 100 = 0.1$. In this case, AWG # 1 will be appropriate.

Prob. 2.34

$$(a) \quad A_{cm} = 420 = d_{mil}^2 \quad \rightarrow \quad d = 20.493 \text{ mil} = \underline{0.02049 \text{ in}}$$

$$(b) \quad A_{cm} = 980 = d_{mil}^2 \quad \rightarrow \quad d = 31.3 \text{ mil} = \underline{0.0318 \text{ in}}$$

Prob. 2.35

$$(a) \quad A_{cm} = d_{mil}^2 = (0.012 \times 1000)^2 = \underline{144 \text{ CM}}$$

$$(b) \quad A_{cm} = \frac{\pi}{4} (0.2 \times 1000)(0.5 \times 1000) = \underline{78,540 \text{ CM}}$$

Prob. 2.36

$$1 \text{ mile} = 5280 \text{ ft}$$

$$R = 4.016 \Omega/1000 \text{ ft} \times 1 \text{ mile} = (4.016/1000)5280 = 21.20$$

$$I = V/R = 1.5/21.20 = \underline{70.75 \text{ mA}}$$

Prob. 2.37

(a) Blue = 6, red = 2, violet = 7, silver = 10%

$$R = 62 \times 10^7 \pm 10\% = \underline{0.62 \text{ M}\Omega \pm 10\%}$$

(b) Green = 5, black = 0, orange = 3, gold = 5%

$$R = 50 \times 10^3 \pm 5\% = \underline{50 \text{ k}\Omega \pm 5\%}$$

Prob.2.38

- (a) $R = 17 \times 10^5 \pm 10\%$, i.e. from 1.53 M Ω to 1.87 M Ω
 (b) $R = 20 \times 10^3 \pm 5\%$, i.e. from 19 k Ω to 21 k Ω
 (c) $R = 92 \times 10^8 \pm 20\%$, i.e. from 7.36 G Ω to 11/04 G Ω

Prob. 2.39

- (a) $52 = 52 \times 10^0 \gg$ Green, red, black
 (b) $320 = 32 \times 10^1 \gg$ Orange, red, brown
 (c) $6.8k = 68 \times 10^2 \gg$ Blue, gray, red
 (d) $3.2 M = 32 \times 10^5 \gg$ Orange, red, green

Prob. 2.40

- (a) $240 = 24 \times 10^1 \gg$ Red, yellow, brown
 (b) $45k = 45 \times 10^3 \gg$ Yellow, green, orange
 (c) $5.6 M = 56 \times 10^5 \gg$ Green, blue, green

Prob. 2.41

- (a) $0.62 M\Omega \pm 10\%$ gives maximum value of 0.682 M Ω and minimum value of 0.558 M Ω .
 (b) $50 k\Omega \pm 5\%$ gives maximum value of 52.5 k Ω and minimum value of 47.5 k Ω .

Prob. 2.42

- (a) 10 Ω , 10% tolerance \gg Brown, black, black, silver
 (b) 7.4 k $\Omega = 74 \times 10^2$, 5% tolerance \gg Violet, yellow, red, gold
 (c) 12 M $\Omega = 12 \times 10^6$, 20% tolerance \gg Brown, red, blue

Prob. 2.43

0.25 V

Prob. 2.44

250 V

Prob. 2.45

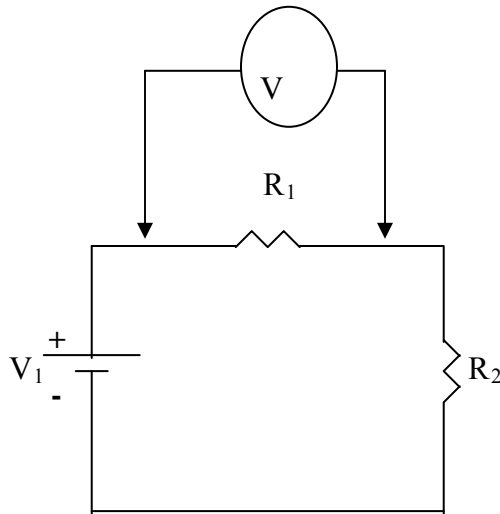
You connect the light bulb terminals to the ohmmeter. If the ohmmeter reads infinity, it means there is an open circuit and the bulb is burnt.

Prob. 2.46

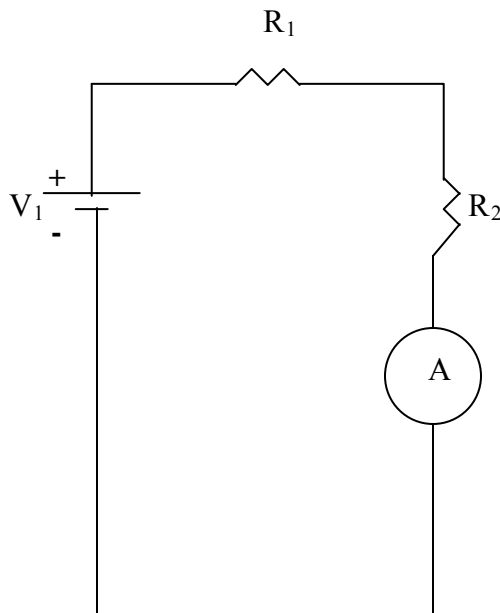
The voltmeter should be connected in parallel with the lamp, while the ammeter should be connected in series.

Prob. 2.47

The voltmeter is connected across R_1 as shown below.

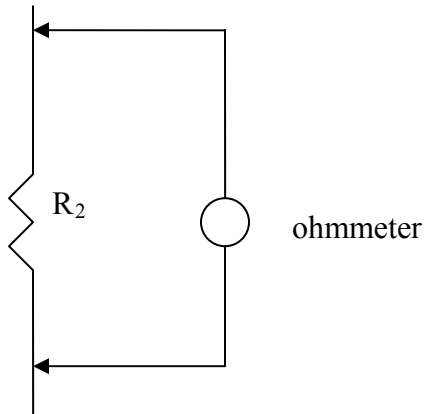
**Prob. 2.48**

The ammeter is connected in series with R_2 , as shown below.



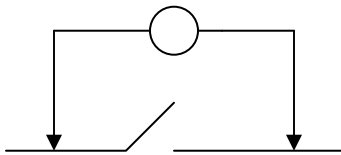
Prob. 2.49

The ohmmeter is connected as shown below.



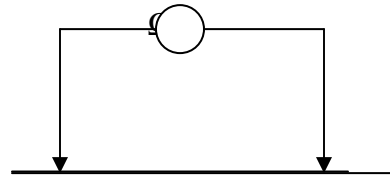
Prob. 2.50

As shown below (see (a)), off state gives infinite resistance, while on state (see (b)) gives zero resistance



(a)

Off state gives infinite resistance



(b)

On state gives zero resistance

Prob. 2.51

Electric shock is caused by an electrical current passing through a body.

Prob. 2.52

- Check that the circuit is actually dead before you begin working on it.
- Unplug any appliance or lamp before repairing it.
- Refrain from wearing loose clothing and jewelry. Loose clothes can get caught in an operating appliance.
- Use only one hand at a time near the equipment to preclude a path through the heart.
- Always wear long-legged and long-sleeved clothes and shoes and keep them dry.
- Do not stand on a metal or wet floor. (Electricity and water do not mix.).
- Do not work by yourself.