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

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

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

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

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

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

Prob. 2.8

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

<u>A semiconductor not listed in Table 2.1.</u>

Prob. 2.9

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

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

Prob. 2.10

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

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

$L_1 = 2L_1, \qquad r_2 = 0.5r_1$

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

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

Prob. 2.11

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

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). <u>The graph in (c)</u> 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) mA = <u>3.2 mA</u>

Prob. 2.16

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

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

Prob. 2.17

I = V/R = 240/6 = <u>40 A</u>

Prob. 2.18

R = V/I = 12/3 = <u>4 Ω</u>

Prob. 2.19

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

Prob. 2.20

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

Prob. 2.21

R = V/I = 12/(28 mA) = <u>428.57 Ω</u>

Prob. 2.22

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

Prob. 2.23

For V = 10, $I = 4 \text{ x } 10^{-2} \text{ x } 10^{2} = \underline{4\text{ A}}$
For V = 20, $I = 4 \text{ x } 10^{-2} \text{ x } 20^{2} = \underline{16\text{ A}}$
For V = 50, $I = 4 \text{ x } 10^{-2} \text{ x } 50^{2} = \underline{100\text{ A}}$

Prob. 2.24

(a) I = V/R = 15/10 = 1.5 A flowing clockwise.
(b) I = V/R = 9/10 = 0.9 A flowing counterclockwise.
(c) I = V/R = 30/6 = 5 A flowing counterclockwise.

Prob. 2.25

(a) V = IR = 4 x 10 = 40 V, the top terminal of the resistor is positive.
(b) V = IR = 20 mA x 10 = 0.2 V, the bottom terminal of the resistor is positive
(c) V = IR = 6 mA x 2 = 12 mV, the top terminal of the resistor is positive

Prob. 2.26

(a) V = 3 + 3 = 6 V
(b) R = V/I = 6/0.7 = 8.6 Ω

Prob. 2.27

(a) G = 1/2.5 = 0.4 S

(b) $G = \frac{1}{40\times10^3} = \underline{25\ \mu S}$

(c) $G = \frac{1}{12\times10^6} = \underline{83.33\text{ nS}}$

Prob. 2.28

(a) $R = \frac{1}{10\times10^{-3}} = \underline{100\ \Omega}$

(b) R = 1/0.25 = 4 Ω
(c) R = 1/50 = 20 mΩ

Prob. 2.29

$$G = \frac{I}{V} = \frac{2.5\times10^{-3}}{120} = \underline{20.83\ \mu S}$$

Prob. 2.30

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

$$d^2 = \frac{4}{\pi}\times1.72\times10^{-8}\times4\times10^{-2}\times500\times10^{-3} = 4.38\times10^{-10}$$

$$d = \underline{2.093\times10^{-5}\text{ m}}$$

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 ft, then R in Ω/1000ft = 0.001 x 100 = 0.1. In this case, AWG # 1 will be appropriate.

Prob. 2.34

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

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

Prob. 2.35

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

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

Prob. 2.36

1 mile = 5280 ft

R = 4.016 Ω/1000 ft x 1 mile = (4.016/1000)5280 = 21.20

I = V/R = 1.5/21.20 = 70.75 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 MΩ to 1.87 MΩ

(b) $R = 20 \times 10^3 \pm 5\%$, i.e. from 19 kΩ to 21 kΩ

(c) $R = 92 \times 10^8 \pm 20\%$, i.e. from 7.36 GΩ to 11/04 GΩ

Prob. 2.39

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

Prob. 2.40

(a) 240 = 24 x 10^1 >> Red, yellow, brown
(b) 45k = 45 x 10^3 >> Yellow, green, orange
(c) 5.6 M = 56 x 10^5 >> Green, blue, green

Prob. 2.41

(a) $0.62\ \text{M}\Omega \pm 10\%$ gives maximum value of 0.682 MΩ and minimum value of 0.558 MΩ.
(b) $50\ \text{k}\Omega \pm 5\%$ gives maximum value of 52.5 kΩ and minimum value of 47.5 kΩ.

Prob. 2.42

(a) 10Ω, 10% tolerance >> Brown, black, black, silver
(b) 7.4 kΩ = 74 x 10^2 , 5% tolerance >> Violet, yellow, red, gold
(c) 12 MΩ = 12 x 10^6 , 20% tolerance >> Brown, red, blue

Prob. 2.43

0.25 V

Prob. 2.44

250 V

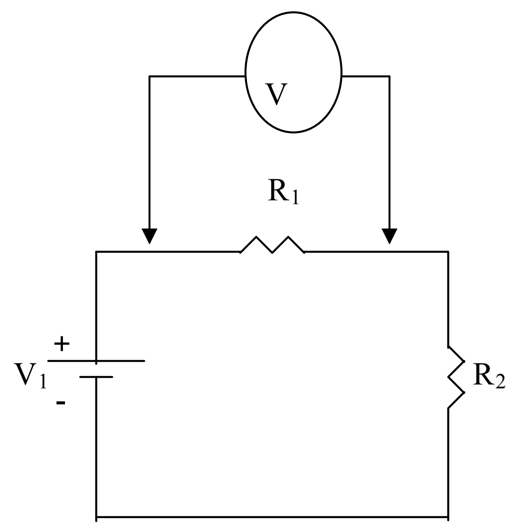
Prob. 2.45

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.

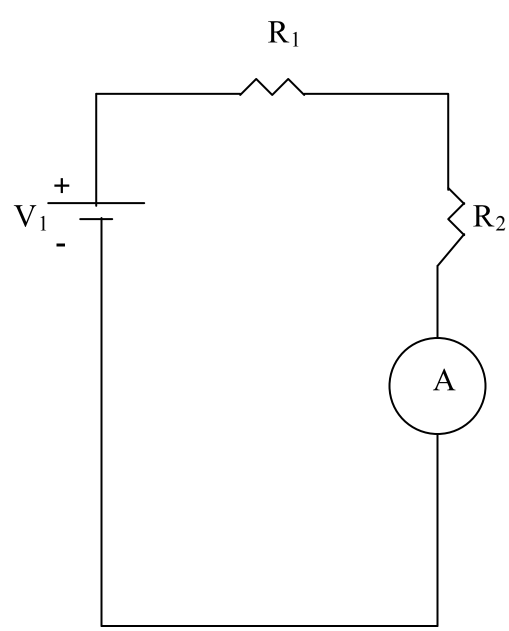
Prob. 2.47

The voltmeter is connected across R_1 as shown below.



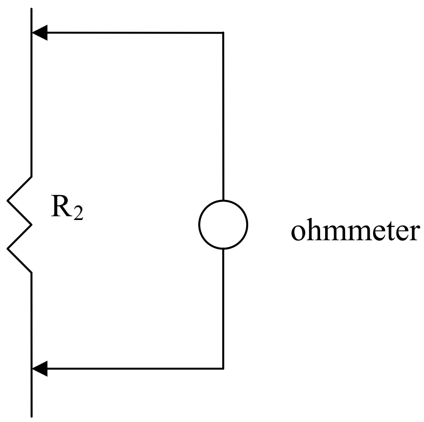
Prob. 2.48

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



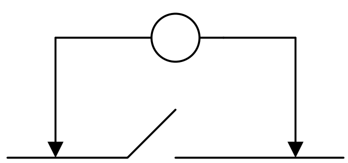
Prob. 2.49

The ohmmeter is connected as shown below.

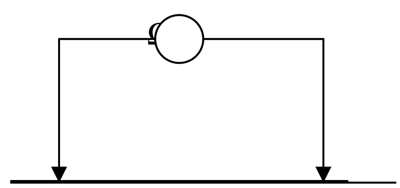


Prob. 2.50

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.