Chapter 11 Problems

Section 11.1; pg 308

11.1. (I) How much current flows through an air conditioner that uses 220- V electricity and has a resistance of 7.5Ω ?

$$I = \frac{V}{R} = \frac{220 V}{7.5 \Omega} = 29.3 \text{ amps}$$

11.2. (1) Power transmission lines are hung from metal towers on glass insulators. What current flows through one insulator if it has a resistance of $1.0 \times 10^9 \Omega$ and the line has a voltage of $2.0 \times 10^5 \text{ V}$?

$$I = \frac{V}{R} = \frac{2 \times 10^5 volts}{1 \times 10^9 \Omega} = 2 \times 10^{-4} amps$$

11.3 (1) How much current flows through a 2.4-0 headlight in a car with a 12.0- V electrical system?

$$I = \frac{V}{R} = \frac{12 V}{2.4\Omega} = 5 \text{ amps}$$

11.4 (1) The maximum safe ac current through a normal person is 5.0 mA. A repair technician touches the hot wire in an appliance opened for servicing and thereby comes into contact with 120 V. Will he receive a harmful shock (a) if his hands are wet and the resistance of the path through him to ground is 8,000 Ω ? (b) if his skin is dry and he is wearing rubber-soled shoes giving a resistance of 500,000 Ω to ground?

a)
$$I = \frac{V}{R} = \frac{120 \text{ V}}{8000 \Omega} = .015 \text{ amps} = 15 \text{ milliamps **Danger**}$$

 $I = \frac{V}{R} = \frac{120 \text{ V}}{500,000 \Omega} = 2.4 \text{ x } 10^{-4} \text{ amps} = .24 \text{ mA} \text{ -No danger}$
b)

11.5 (II) Calculate the resistance of a vacuum cleaner that uses 14 A of current and operates on 120-V electricity.

I=
$$\frac{V}{R}$$
; therefore R = $\frac{V}{I}$ = $\frac{120 V}{14 amp}$ = 8.57 Ω

Sections 11.2 and 11.3

11.11. (I) Calculate the electric power of a lightning bolt having a current of 20,000 amps and a voltage of 1×10^8 Volts.

P = IV = 20,000
$$\frac{C}{\sec}(1 \ge 10^8 \frac{joules}{C}) = 2 \ge 10^{12} watts$$

11.12. (I) When a truck with a 12-V electrical system starts its engine, a current of 500 A flows through the starter motor. How much power is supplied by the battery to the starter alone?

$$P = IV = 500 \frac{C}{sec} (12 \frac{joules}{C}) = 6000 \text{ watts}$$

11.13. (I) Cords to appliances sometimes warm up because of the thermal energy created by their resistance. How much power is used by the 0.30Ω cord f an appliance through which 12 A flow? (Such a cord is faulty since its resistance should be lower).

P = IV; V= IR; substituting for V we get P =
$$I^2 R$$

P = $(12 \frac{C}{\text{sec}})^2 (.3\Omega) = 43.2$ watts

11.14. (I) (a) Calculate the current through a short-circuit resistance of 0.10Ω that experiences a voltage of 120 V. (b) Calculate the power that is converted to heat by such a short circuit.

a)
$$I = \frac{V}{R} = \frac{120V}{0.10\Omega} = 1200 \text{ amps}$$

b) $P = I^2 R = (1200 \text{ amp})^2 (0.10\Omega) = 144,000 \text{ watts}$

11.15. (I) What is the power rating in watts of an indicator light on a heart monitor if the light is known to have a resistance of 10,000 Ω and operates on 120 V electricity?

P = IV; I =
$$\frac{V}{R}$$
 substituting for I in the first equation yields:
P = $\frac{V^2}{R} = \frac{(120 \text{ V})^2}{10,000\Omega} = 1.44 \text{ watts}$

11.16. (I) The resistances of most substances increase when they are heated. A bulb for a flashlight using 3.0 V has a resistance of 2.0 Ω when cold and 24 Ω when hot. Calculate the current through and the power consumed by the bulb (a) when it is first turned on and is still cold, and (b) when it is hot.

a) $I = \frac{V}{R} = \frac{3 \text{ volts}}{2 \text{ ohms}} = 1.5 \text{ amps}$ Power = I²R = 4.5 watts b) $I = \frac{V}{R} = \frac{3 \text{ volts}}{24 \text{ ohms}} = .125 \text{ amps}$

Power =
$$I^2 R$$
 = .375 watts

Sections 11.4 and 11.5

11.32. (I) (a) Calculate the resistance of a series connection of resistances of 6.0 and 12.0 Ω . (b) Do the same for a parallel connection of the same resistances.

When we add resistors that are in <u>series</u> with each other, we simply take the sum of all the resistors.

$$R_{series} = R_1 + R_2 \dots + R_n$$
$$R_{series} = 6\Omega + 12\Omega = 18\Omega$$

When we add resistors that are in **<u>parallel</u>** with one another, we must use the following rule:

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_n}$$

$$\frac{1}{R} = \frac{1}{6} + \frac{1}{12} = \frac{2}{12} + \frac{1}{12} = \frac{3}{12}$$

since $\frac{1}{R} = \frac{3}{12}$; solving for R, we find that $R = \frac{12}{3}$ ohms= 4 ohms

11.33. (I) (a) What is the resistance of ten 100- W light bulbs connected in parallel? (b) in series? The resistance of a 100-W 120- V light bulb is 144 Ω . (Ignore the temperature dependence of resistance).

a, Remember, when adding resistors that are in parallel, the rule is:

$$\frac{1}{R} = \frac{1}{144} + \frac{1}{144} \dots + \frac{1}{144} = \frac{10}{144}$$
$$\therefore R = \frac{144}{10} = 14.4 \text{ ohms}$$

b. Since there are ten 144 ohm resistors in series it is easier to multiply the resistance by 10, than it is to add 10 of them up.

$$R_{series} = 10(144\Omega) = 1440 \ \Omega$$

11.34. (I) What total resistances can be obtained by connecting a 100Ω and a 20Ω resister together?

- a. If you connect them is series: $R_{series} = 100 \ \Omega + 20 \ \Omega = 120 \ \Omega$
- b. If you connect them in parallel:

$$\frac{1}{R} = \frac{1}{100} + \frac{1}{20} = \frac{1}{100} + \frac{5}{100} = \frac{6}{100}$$
$$\therefore R = \frac{100}{6} = 16.7 \Omega$$

Extra question: In the circuit below, $R_1 = 3$ ohms, $R_2 = 4$ ohms and $R_3 = \frac{9}{7}\Omega$.

The battery voltage is 12 volts.

a. Determine the series equivalent of the parallel resistors.

- b. Determine the total resistance in the circuit.
- c. Determine the current through R₃.
- d. Determine the power required by the circuit.

Bring your completed solutions to class.

