Name: Key

Currents & Circuits- Problem Packet

Period:

Date:

1. A 4.0 Ω resistor is connected to a 6.0 V battery. What is the current in the circuit?

$R = \frac{V}{I}$ $I = \frac{V}{R} = \frac{6V}{4\Omega} = 1.5\ A$

2. A 90.0 V battery does 2.7 J of work in transferring some charge during a 2.0 second period.
   a. Calculate the amount of charge transferred.

   $V = \frac{PE}{Q}$ $Q = \frac{PE}{V} = \frac{2.7\ J}{90V} = .03\ C$

   b. Calculate the current flow.

   $I = \frac{Q}{t} = \frac{.03\ C}{2\ sec} = .015A$

   c. Calculate the power.

   $P = I \times V = .015A \times 90V = 1.35\ Watts$

3. An iron is rated at 1680 W and is connected to a 120 V outlet.
   a. Calculate the current that the iron draws.

   $P = I \times V$ $I = \frac{P}{V} = \frac{1680\ Watts}{120\ V} = 14A$

   b. Calculate the energy that is consumed by the iron in one hour.

   Energy $= P \times time = 1680\ Watts \times 3600\ sec = 6{,}048{,}000\ J = 6048\ kJ$

4. A 1.5 V dry cell is connected to a 4500 Ω resistor. Calculate the current in this circuit.

$R = \frac{V}{I}$ $I = \frac{V}{R} = \frac{1.5V}{4500\Omega} = 3.33 \times 10^{-4} A$

5. A 60.0 W light bulb is connected to a 120 V outlet.
   a. Calculate the current flowing through the bulb.

   $P = I \times V$ $I = \frac{P}{V} = \frac{60W}{120V} = .5A$

   b. What is the resistance of the bulb?

$R = \frac{V}{I} = \frac{120V}{.5A} = 240\Omega$

- or -

$P = \frac{V^2}{R}$ $R = \frac{V^2}{P} = \frac{(120V)^2}{60W} = 240\Omega$

6. Eighty percent of the energy used by a sunlamp is converted into heat. When the sunlamp is plugged into a 120 V outlet, it draws 2.0 A. How much thermal energy is released by this lamp in 30 minutes?

30 min = 1800 secs

Energy = P × time   P = I × V

Energy = I × V × time = 2A × 120V × 1800 sec = 432,000 J × .8 = 345,600 J

e/s × J/c × sec   345,600 J × (1 Kwh / 3.6×10⁶ J) = .096 Kwh

7. A transistor radio operates by means of a 9.0 V battery that supplies it with 50 mA (0.0500 A) current.

   a. If the cost of the battery is \$0.90 and it lasts for 300 hours, what is the cost per kWh to operate the radio in this manner?

300 h × 3600 s/h = 1080000 sec

P = I × V = (.05)(9) = .45 w = .00045 Kw × 300 h = .135 Kwh

Energy = I × V × time = (.05A)(9V)(1080000 sec) = 486,000 J (1 Kwh / 3.6×10⁶ J) = .135 Kwh

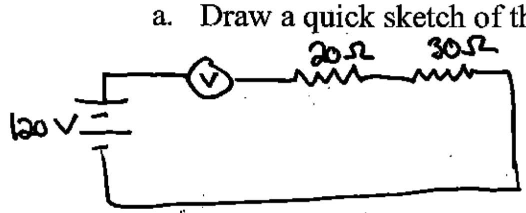
\$.90 / .135 Kwh = \$6.67/Kwh

   b. The same radio, by means of a converter, is plugged into a household circuit by a homeowner who pays \$0.08 per kWh. What does it now cost to operate the radio for 300 h?

P = I × V = .45 watts = .00045 Kw × 300 h = .135 Kwh × \$.08/Kwh = \$.0108

8. A 20.0 Ω resistor and a 30.0 Ω resistor are connected in series and placed across a 120 V potential difference.

   a. Draw a quick sketch of this circuit.



   b. What is the equivalent resistance of the circuit?

$R_T = R_1 + R_2 = 20\Omega + 30\Omega = 50\Omega$

   c. What is the current in the circuit?

$I = \frac{V}{R} = \frac{120V}{50\Omega} = 2.4A$

   d. What is the voltage drop across each resistor?

20Ω: $V = I \times R = (2.4A) \times 20\Omega = 48V$

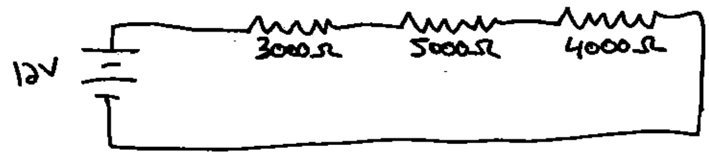
30Ω: $V = I \times R = 2.4A \times 30\Omega = 72V$

   e. What is the voltage drop across the two resistors together?

120 V $V_T = V_1 + V_2 = 48V + 72V = 120V$

9. Three resistors of 3.0 kΩ, 5.0 kΩ, and 4.0 kΩ are connected in series across a 12 V battery.

   a. Draw a quick sketch of this circuit.



   b. What is the equivalent resistance of the circuit?

$$R_T = R_A + R_B + R_C = 3000\Omega + 5000\Omega + 4000\Omega = \boxed{12000\Omega}$$

   c. What is the current through the resistors?

$$I = \frac{V}{R} = \frac{12V}{12000\Omega} = \boxed{.001\ A}$$

   d. What is the voltage drop across each resistor?

$$V_1 = I_1 \times R_1 = .001A \times 3000\Omega = 3V$$

$$V_2 = I_2 \times R_2 = .001A \times 5000\Omega = 5V$$

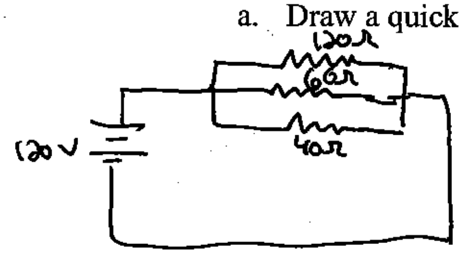
$$V_3 = I_3 \times R_3 = .001A \times 4000 = 4V$$

   e. Find the total voltage drop across the three resistors.

$$\boxed{12V} \qquad V_T = V_1 + V_2 + V_3 = 3V + 5V + 4V = \boxed{12V}$$

10. A 120 Ω resistor, a 60 Ω resistor, and a 40 Ω resistor are connected in parallel and placed across a 12 V battery.

   a. Draw a quick sketch of this circuit.



   b. What is the equivalent resistance of the parallel circuit?

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_T} = \frac{1}{120} + \frac{1}{60} + \frac{1}{40} = \frac{1}{120} + \frac{2}{120} + \frac{3}{120} = \frac{6}{120} = \frac{1}{20}$$

$$\frac{1}{R_T} = \frac{1}{20} \qquad \boxed{R_T = 20\Omega}$$

   c. What is the current through the entire circuit?

$$I = \frac{V}{R} = \frac{12V}{20\Omega} = \boxed{.6A}$$

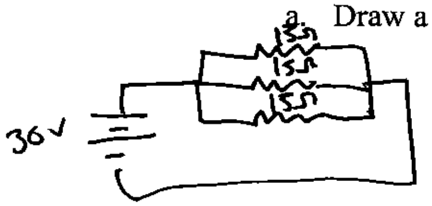
   d. What is the current through each branch of the circuit?

$$I_1 = \frac{V_1}{R_1} = \frac{12V}{120\Omega} = \boxed{.1A} \qquad I_2 = \frac{V_2}{R_2} = \frac{12V}{60\Omega} = \boxed{.2A} \qquad I_3 = \frac{V_3}{R_3} = \frac{12V}{40\Omega} = \boxed{.3A}$$

$$I_T = I_1 + I_2 + I_3 = .1 + .2 + .3 = \boxed{.6A}$$

11. Three 15 Ω resistors are connected in parallel and placed across a 30 V battery.

a. Draw a quick sketch of the circuit.



b. What is the equivalent resistance of the parallel circuit?

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \qquad \frac{1}{R_T} = \frac{1}{15\Omega} + \frac{1}{15\Omega} + \frac{1}{15\Omega} = \frac{3}{15\Omega} \qquad \boxed{R_T = 5\Omega}$$

c. What is the current though the entire circuit?

$$I = \frac{V}{R} = \frac{30V}{5\Omega} = \boxed{6A}$$

d. What is the current through each branch of the circuit?

$$I_1 = \frac{V_1}{R_1} = \frac{30V}{15\Omega} = \boxed{2A}$$ - each one is the same

$$I_T = I_1 + I_2 + I_3 = 2A + 2A + 2A = 6A$$

12. Suppose one of the 15.0 Ω resistors in problem #11 is replaced by a 10.0 Ω resistor.

a. Does the equivalent resistance change? If so, how?

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{15} + \frac{1}{15} + \frac{1}{10} \qquad \frac{2}{30} + \frac{2}{30} + \frac{3}{30} = \frac{7}{30} = \frac{1}{R_T} \qquad \boxed{R_T = 4.28\Omega}$$

b. Does the amount of current through the entire circuit change? If so, in what way? Yes

$$I = \frac{V}{R} = \frac{30V}{4.28\Omega} = \boxed{7A}$$

c. Does the amount of current through the other 15.0 Ω resistors change? If so, in what way?

$$I_1 = \frac{V_1}{R_1} = \frac{30V}{15\Omega} = 2A$$

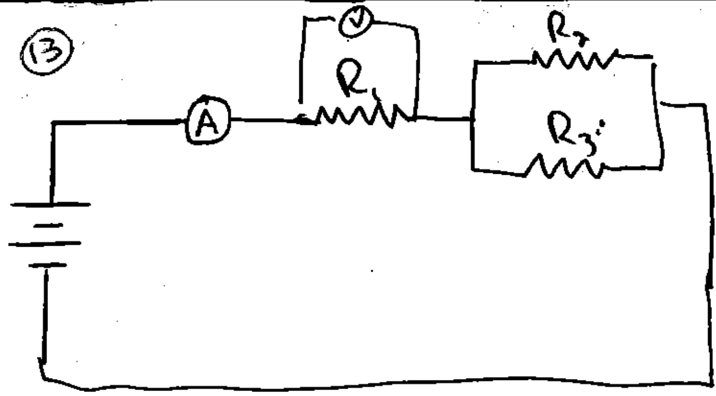
$$I_2 = \frac{V_2}{R_2} = \frac{30V}{15\Omega} = 2A$$

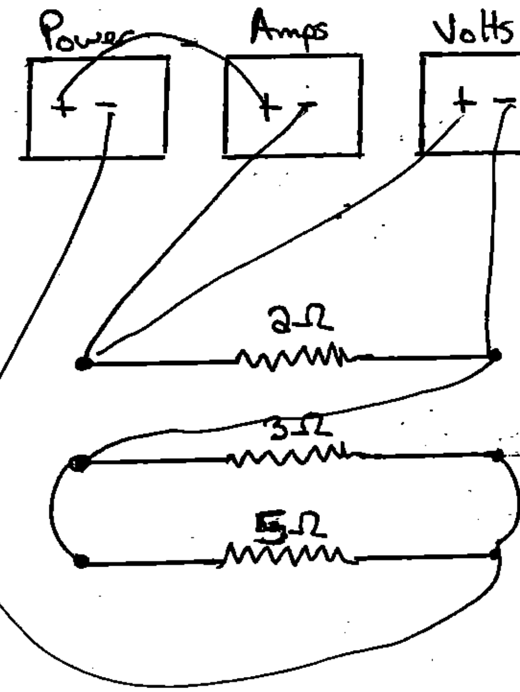
$$I_3 = \frac{V_3}{R_3} = \frac{30V}{10\Omega} = 3A$$

$$I_T = I_1 + I_2 + I_3$$

$$I_T = 2 + 2 + 3 = \boxed{7A}$$

(13)





Resistor R_1 is connected in series with the parallel combination of R_2 and R_3. The ampmeter measures current out of the power supply and a voltmeter is reading the voltage across R_1. Complete the schematic diagram and complete the chart below according to the circuit.

Resistor	Resistance (ohms)	Current (amps)	Voltage (Volts)	Power (Watts)
1	2 Ω	(5) 8A	(6) 16 V	(7) 128 Watts
2	3 Ω	(9) 5A	(8) 15V	(11) 75 Watts
3	5 Ω	(10) 3A	(8) 15V	(12) 45 Watts
Total	(1-2) 3.875Ω	(3) 8A	31 V	(4) 248 Watts

(1) $\frac{1}{R_{2/3}} = \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{3} + \frac{1}{5} = \frac{5}{15} + \frac{3}{15}$

$R_{2/3} = \frac{15}{8} = 1.875\Omega$

(2) $R_T = R_1 + R_{2/3} = 2\Omega + 1.875\Omega = 3.875\Omega$

(3) $I_T = \frac{V_T}{R_T} = \frac{31V}{3.875\Omega} = 8A$

(4) $P_T = I_T \times V_T = 8A \times 31V = 248$ Watts

(5) Series Circ $I_T = I_1 = I_{2/3} = 8A$

(6) $V_1 = I_1 \times R_1 = 2\Omega \times 8A = 16V$

(7) $P_1 = I_1 \times V_1 = 8A \times 16V = 128$ Watts

(8) Series Circuit $V_T = V_1 + V_{2/3}$

$31V = 16V + V_{2/3}$

$V_{2/3} = 15V$

Parallel Circ.

$V_{2/3} = V_2 = V_3 = 15V$

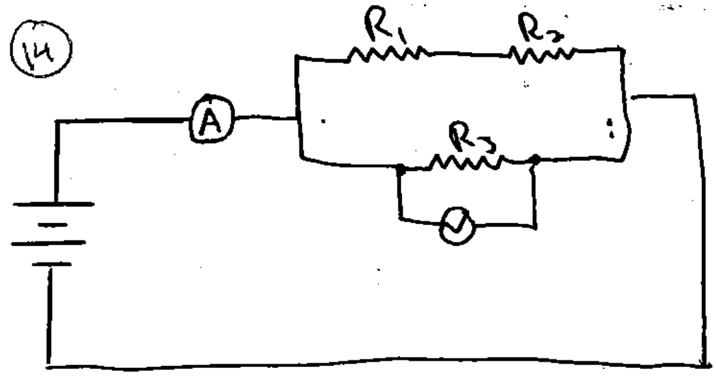
(9) $I_2 = \frac{V_2}{R_2} = \frac{15V}{3\Omega} = 5A$

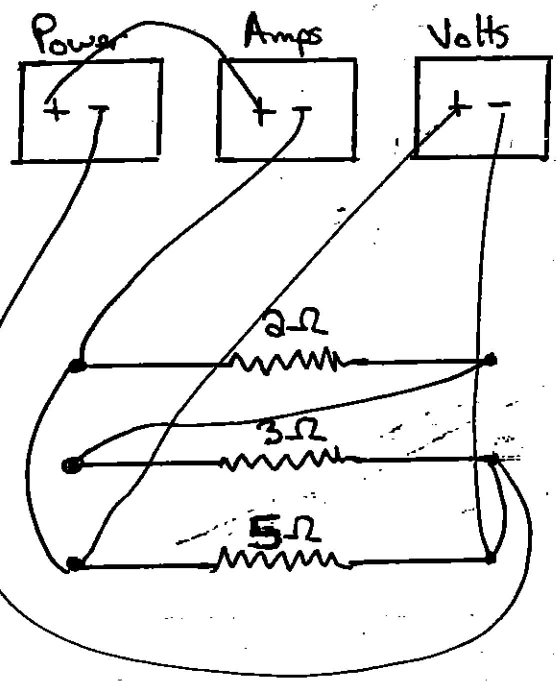
(10) $I_3 = \frac{V_3}{R_3} = \frac{15V}{5\Omega} = 3A$

(11) $P_2 = I_2 \times V_2 = 5A \times 15V = 75W$

(12) $P_3 = I_3 \times V_3 = 3A \times 15V = 43W$

(14)





Resistor R_1 is connected in series with R_2 and the combination is parallel with R_3. The ampmeter measures current out of the power supply and a voltmeter is reading the voltage across R_3. Complete the schematic diagram and complete the chart below according to the circuit.

Resistor	Resistance (ohms)	Current (amps)	Voltage (Volts)	Power (Watts)
1	2 Ω	(7) 6.2 A	(8) 12.4 V	(10) 76.88 Watts
2	3 Ω	(7) 6.2 A	(9) 18.6 V	(11) 115.32 Watt
3	5 Ω	(5) 6.2 A	(4) 31 V	(6) 192.2 Watts
Total	(1) 2.5 Ω	(2) 12.4 A	31 V	(3) 384.4 Watts

(1) $R_{1/2} = R_1 + R_2 = 2\Omega + 3\Omega = 5\Omega$

$\frac{1}{R_T} = \frac{1}{R_{1/2}} + \frac{1}{R_3} = \frac{1}{5\Omega} + \frac{1}{5\Omega} = \frac{2}{5}$

$R_T = \frac{5}{2} = 2.5\Omega$

(2) $I_T = \frac{V_T}{R_T} = \frac{31V}{2.5\Omega} = 12.4A$

(3) $P_T = I_T \times V_T = 12.4A \times 31V = 384.4$ Watts

(4) Parallel Circ. $V_T = V_{1/2} = V_3 = 31V$

(5) $I_3 = \frac{V_3}{R_3} = \frac{31V}{5\Omega} = 6.2A$

(6) $P_3 = I_3 \times V_3 = 6.2A \times 31V = 192.2$ Watts

(7) Parallel Circ. $I_T = I_{1/2} + I_3$

$12.4 = I_{1/2} + 6.2 \quad I_{1/2} = 6.2A$

Series Circ $I_{1/2} = I_1 = I_2 = 6.2A$

(8) $V_1 = I_1 \times R_1 = 2\Omega \times 6.2A = 12.4V$

(9) $V_2 = I_2 \times R_2 = 3\Omega \times 6.2A = 18.6V$

(10) $P_1 = I_1 \times V_1 = 6.2A \times 12.4V = 76.88$ Watts

(11) $P_2 = I_2 \times V_2 = 6.2A \times 18.6V = 115.32$ Watts