# Circuits/Electromagnetics



**WORKSHEET #2**

Name: ______________________

**1.** A hot plate has an internal resistance of 22.0 Ω. It operates on 120 V household AC electricity. (a) How much current did it draw? (b) How much power did it develop? (c) If it operated for 15 minutes, how much heat did it develop? (d) If a kWh costs 4.5 cents, how much did it cost to run the thing?

a. $I = V/R = 120\text{ V}/22.0\ \Omega = 5.454545\text{ A} = \boxed{5.5\text{ A}}$

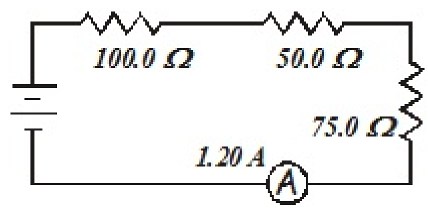
b. $P = V^2/R = (120\text{ V})^2/22.0\ \Omega = 654.54545\text{ W} = \boxed{650\text{ W}}$

c. $E = P \cdot t = 654.54545\text{ W} \cdot 900\text{ s} = 589090.909\text{ J} = \boxed{590\ 000\text{ J or } 590\text{ kJ}}$

d. $\text{cost} = P \cdot t \cdot \text{rate} = 0.65454545\text{ kW} \cdot 0.25\text{ hr} \cdot 4.5\text{ cents/kWh}$

$= 0.7363636\text{ cents} = \boxed{0.74\text{ cents}}$

**2.** Examine this useless circuit. What is: (a) the total resistance, (b) the voltage driving this circuit, (c) the voltage drop for the 75.0 Ω resistor?




a. $R_{total} = R_1 + R_2 + R_3 = 100.0\ \Omega + 50.0\ \Omega + 75.0\ \Omega = \boxed{225.0\ \Omega}$

b. $V = RI = 225.0\ \Omega \cdot 1.20\text{ A} = \boxed{270\text{ V}}$

c. $V = RI = 75.0\ \Omega \cdot 1.20\text{ A} = \boxed{90.0\text{ V}}$

**3.** What happens to the light intensity of a set of identical lamps in series when you add an additional lamp? How come?

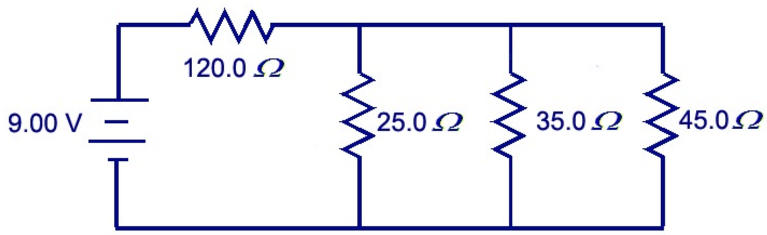
The light intensity of a set of identical lamps in series will drop or decrease when you add an additional lamp in series because the additional lamp is increasing the total resistance. With a constant voltage source, this means the total current will drop. This will drop the power given off by the total circuit as well as the power given off by any given lamp ($P = I^2R$)

**4.** What happens to the light intensity of a set of identical lamps in parallel when you add an additional lamp? How come?

The light intensity of a set of identical lamps in parallel will increase when you add an additional lamp in parallel by the amount of light in the new lamp. The preexisting lamps will neither dim nor brighten as they are still hooked to the same amount of voltage and drawing the same current they did before the additional lamp was added. The new lamp will pull current as well, though, increasing the total load on the power source.

**5.** (a) Draw a circuit which has a 120.0 Ω resistor in series with three resistors that are in parallel with each other; a 25.0 Ω, 35.0 Ω, and 45.0 Ω resistor. The voltage source is a 9.00 V battery. (b) What is the current for this circuit?

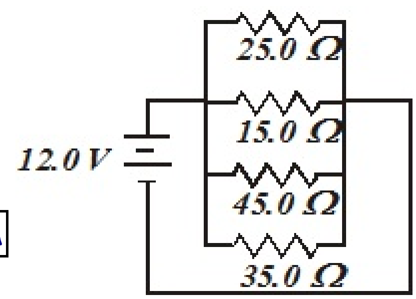
a.




b. $R_{total} = 120.0\ \Omega + ((25.0\ \Omega)^{-1} + (35.0\ \Omega)^{-1} + (45.0\ \Omega)^{-1})^{-1} = 131.013986\ \Omega$

$I = V_{total}/R_{total} = 9.00\ V / 131.013986\ \Omega = 0.068694956\ A = \boxed{0.0687\ A\ \text{ or }\ 68.7\ mA}$

**6.** What is: (a) the current that goes through the 45.0 Ω resistor and (b) what is the total current through the circuit?




a. By KVL, the V across any of these resistors will be 12.0 V.

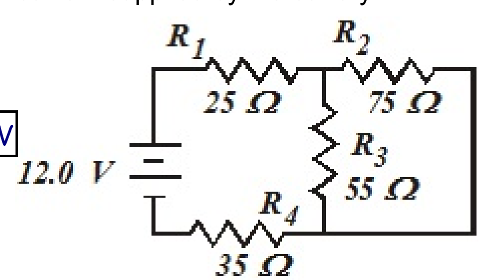
$I = V/R = 12.0\ V/45.0\ \Omega = 0.26666667\ A = \boxed{0.267\ A\ \text{ or }\ 267\ mA}$

b. $R_{total} = ((25.0\ \Omega)^{-1} + (15.0\ \Omega)^{-1} + (45.0\ \Omega)^{-1} + (35.0\ \Omega)^{-1})^{-1}$

$= 6.35080645\ \Omega$

$I_{total} = V_{total} / R_{total} = 12.0\ V/ 6.35080645\ \Omega = 1.889524\ A = \boxed{1.89\ A}$

**7.** What is (a) the voltage drop across the 75 Ω resistor, (b) the total current supplied by the battery?




$R_{total} = 25\ \Omega + ((75\ \Omega)^{-1} + (55\ \Omega)^{-1})^{-1} + 35\ \Omega = 91.73077\ \Omega$

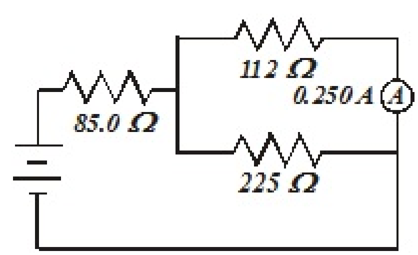
a. $V_2 = (R_{23}/R_{total}) \cdot V_{total}$

$= 12.0\ V \cdot 31.73077\ \Omega / 91.73077\ \Omega = 4.15094\ V = \boxed{4.2\ V}$

b. $I_{total} = V_{total} / R_{total} = 12.0\ V/ 91.73077\ \Omega$

$= 0.13082\ A = \boxed{0.13\ A\ \text{ or }\ 130\ mA}$

**8.** What is (a) the total resistance of the circuit, (b) the total current in the circuit, (c) the power developed in the circuit?




a. $R_{tot} = 85.0\ \Omega + ((112\ \Omega)^{-1} + (225\ \Omega)^{-1})^{-1} = 159.77745\ \Omega = \boxed{160.\ \Omega}$

b. $V_{112\Omega} = V_{225\Omega}$

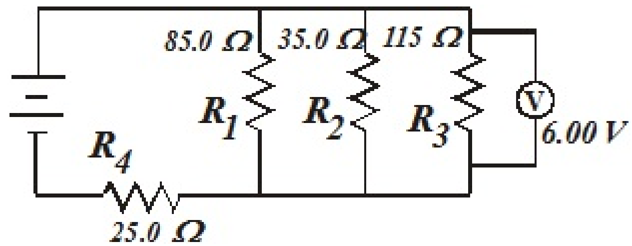
$112\ \Omega \cdot 0.250\ A = 225\ \Omega \cdot I_{225\Omega}$

$I_{225\Omega} = 0.1244444\ A$

By KCL, $I_{tot} = 0.250\ A + 0.1244444A = 0.374444\ A = \boxed{0.374\ A}$

c. $P = I^2R = (0.374444\ A)^2 \cdot 159.77745\ \Omega = 22.402179\ W = \boxed{22.4\ W}$

**9.** What is (a) the total resistance of the circuit, (b) the total current in the circuit, (c) the power developed by $R_3$, the 115 Ω resistor, and (d) the electrical potential provided by the battery?




a. $R_{tot} = ((85.0\ \Omega)^{-1} + (35.0\ \Omega)^{-1} + (115\ \Omega)^{-1})^{-1} + 25.0\ \Omega$
$= 45.394933\ \Omega = \boxed{45.4\ \Omega}$

b. By KCL, $I_{tot} = I_1 + I_2 + I_3 = V_1/R_1 + V_2/R_2 + V_3/R_3$
$= 6.00\ V/85.0\ \Omega + 6.00\ V/35.0\ \Omega + 6.00\ V/115\ \Omega$
$= 0.0705882\ A + 0.1714286\ A + 0.0521739\ A$
$= 0.2941907\ A = \boxed{0.294\ A\ \text{or}\ 294\ mA}$

c. $P_3 = V_3^2/R_3 = (6.00\ V)^2 / 115\ \Omega = 0.31304\ W = \boxed{0.313\ W\ \text{or}\ 313\ mW}$

d. $V_4 = R_4 I_4 = 25.0\ \Omega \cdot 0.2941907\ A = 7.35477\ V$
By KVL, $V_{bat} = V_1 + V_4 = 6.00\ V + 7.35477\ V = 13.35477\ V = \boxed{13.35\ V}$