Electrical Resistance

Read from **Lesson 3** of the **Current Electricity** chapter at **The Physics Classroom**:

http://www.physicsclassroom.com/Class/circuits/u9l3a.html
http://www.physicsclassroom.com/Class/circuits/u9l3b.html
http://www.physicsclassroom.com/Class/circuits/u9l3c.html

MOP Connection: Electric Circuits: sublevels 4 and 5

Physics Idea: As charge flows through an electric circuit, it encounters resistance. **Resistance** is a measure of the amount of hindrance to the flow of charge.

1. The cause of resistance to the flow of charge within an electrical wire is _____.
   a. mobile charge carriers collide with atoms of the resistor
   b. mobile charge carriers have mass (possess inertia) which resists their motion
   c. the electric field that causes charge flow diminishes with distance
   d. charge is consumed or used up as it flows through the wire

2. Resistance is quantifiable - that is, it can be measured and calculated. The standard metric unit used to express the amount of electrical resistance is the ____.
   a. Joule b. Watt c. Volt d. Amp e. Ohm

3. For the following pairs of wire descriptions, choose the wire that has the greatest resistance.

   Resistance to charge flow will be greatest in … . (Circle the best answer.)

   a. … a wire which is thin … a wire which is thick
   b. … a wire which is long … a wire which is short
   c. … a wire which is made of copper … a wire which is made of plastic
   d. … a wire which is made of copper … a wire which is made of silver

4. The rate at which charge flows through a circuit is ___________ to the resistance.
   a. inversely related b. directly related c. not related

5. For the following pairs of circuit descriptions, choose the circuit that has the greatest current.

   Given that all other factors are equal, the current will be greatest in a circuit that has … .

   a. … a high resistance … a low resistance
   b. … wires that are long … wires that are short
   c. … wires that are wide … wires that are thin
   d. … 12-gauge wires (1/12th inch diameter) … 14-gauge wires (1/14th inch diameter)
   e. … copper wiring … silver wiring

6. Resistance is not the only variable that affects the current in an electric circuit. The current is also affected by the electric potential difference (**ΔV**) impressed across its ends. The electric potential difference is simply the battery *voltage*. As the battery voltage is increased (by swapping in higher voltage batteries), the current is _____________________ (increased, decreased).

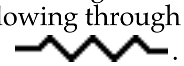
The relationship between electric potential difference (**ΔV**), resistance (**R**) and current **(I)** is given be the equation.

$$\mathbf{I = \frac{\Delta V}{R}}$$

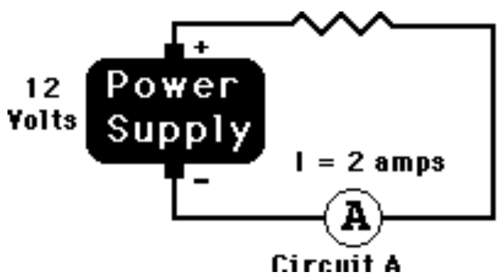
This equation, sometimes referred to as the Ohm's law equation, is often written as **ΔV = I•R**. Like all equations in physics, it can be used as a recipe for problem-solving and an equation to guide one's thinking about how an alteration in one variable affects another variable.

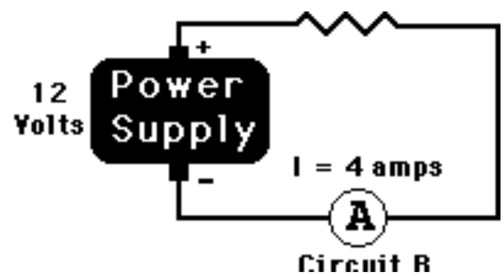
7. A circuit is set up such that it has a current of 8.0 amps. What would be the new current if ….
   a. … the resistance (**R**) is increased by a factor of 2? ______________
   b. … the resistance (**R**) is increased by a factor of 4? ______________
   c. … the resistance (**R**) is decreased by a factor of 3? ______________
   d. … the battery voltage (**ΔV**) is increased by a factor of 3? ______________
   e. … the battery voltage (**ΔV**) is decreased by a factor of 2? ______________
   f. … the resistance (**R**) is increased by a factor of 2 and the battery voltage (**ΔV**) is decreased by a factor of 2? ______________
   g. … the resistance (**R**) is decreased by a factor of 4 and the battery voltage (**ΔV**) is increased by a factor of 3? ______________

8. Express your understanding of the use of the **I = ΔV / R** equation by filling in the following blanks.
   a. An electrical device with a resistance of 2.0 Ω has an electric potential difference of 6.0 V impressed across it; the current in the device is _____ amperes.
   b. An electrical device with a resistance of 3.0 Ω has an electric potential difference of ______ V impressed across it; the current in the device is 4.0 amperes.
   c. An electrical device with a resistance of _____ Ω has an electric potential difference of 120 V impressed across it; the current in the device is 6.0 amperes.

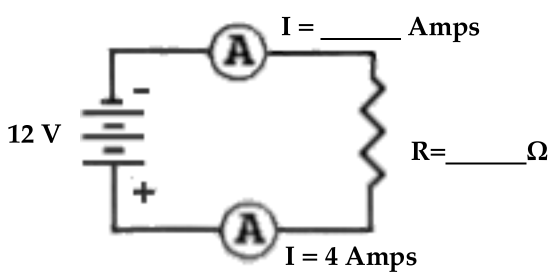
9. Resistors are electrical devices designed to have a specific resistance. They are inserted in circuits to modify the actual current flowing through the circuit. When diagramming a circuit, a resistor is represented by the symbol .

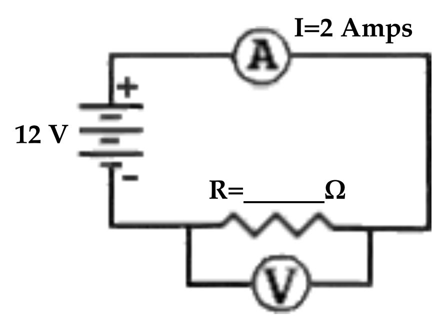
   Which of the resistors in the two circuits (A or B) has the greatest resistance? Calculate the value.





10. Use arrows to show the direction of conventional current flow through the following circuits and use the **I = ΔV / R** equation to fill in the blanks.

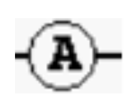




The three new circuit symbols introduced in the above diagrams are


Power Supply


Voltmeter (for measuring **ΔV**)


Ammeter (for measuring **I**)