

## Battery-Resistor Circuit SIM Homework II

1) (10 pts) Each electric outlet in a home is connected to the power company through a fuse or circuit breaker. When properly installed, current flows from the power company, through the fuse or circuit breaker, through the outlet and the appliances connected to it, and then back to the power company – forming a complete circuit. The fuse or circuit breaker limits the current that the circuit can carry.

*Note:* In a home, the electricity is AC (alternating current) in that the voltage oscillates up and down and the current changes direction with each oscillation. In other electric circuits, like in the flashlight you studied in Physics 1010, the circuit is DC (direct current). The answers to all of the questions in this problem set are identical whether one is using AC or DC electricity since both types heat wires in just the same way. So when you are trying to figure out the answers, just imagine it is a funny home that uses just DC current, which you have already learned about.

a) (5.5 pts) If you plug too many appliances into a socket that has nothing to limit the amount of current that can flow through the plug, then the outlet and home wiring will become dangerously hot.

For this problem, we will use a simulation to help us understand how the wiring is being heated by the current. Start running the Battery-Resistor Circuit Simulation which you can access online

[http://phet.colorado.edu/simulations/sims.php?sim=BatteryResistor\\_Circuit20](http://phet.colorado.edu/simulations/sims.php?sim=BatteryResistor_Circuit20)

i) (1pt) Explain how you need to set the voltage and resistance controls on the simulation so that the resistor simulates the home wiring and has a large current going through it? Be sure to include your reasoning and how it is consistent with what you know about the resistance of wires and about what current is.

ii) (1pt) This applet allows you to “see” what is happening inside the wire under these conditions. Describe what is happening at high current.

iii) (1pt) Why does the wiring become hot?

iv) (0.5pt) If you keep the same battery voltage, but increase the resistance, the resistor:

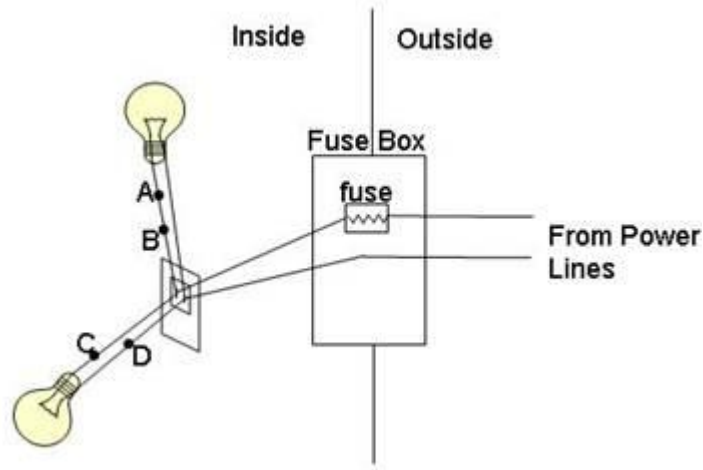
- gets hotter.    gets colder.    stays the same temperature .

(1 pt) Explain this dependence of temperature on resistance in terms of what electrons are doing in the simulation and how that influences the amount of power (energy per second) transferred to the resistor.

(1 pt) Explain this dependence of temperature on resistance in terms of the equations:

$$V=I \times R \text{ and } P=I \times V$$

b) (1 pt) A fuse contains a short, thin wire with an electric resistance much higher than that of the wires used for home wiring. Below is a simplified diagram of the circuitry inside a home with several points marked A through D.



Why will the fuse wire melt before the regular home wiring if too much current is drawn through the circuit?

c) (1 pt) Why will current stop flowing through the appliance when the fuse melts and opens the circuit?

d) (0.5 pts) Consider points A through D.

i) Which of the following wire connections would produce a short circuit allowing electrons to flow through the power lines without flowing through one of the bulbs? Choose all that apply:

- A to B  
  A to C  
  A to D  
  B to C  
  B to D  
  C to D

ii) (1pt) Why is a short circuit very likely to melt the fuse and open the circuit? Be sure to explain the physics principles that support your reasoning.

e) (1 pt) A circuit breaker contains a heater wire and a thermostat. The current flowing through a circuit that is protected by the circuit breaker passes through both the heater wire and the thermostat switch. If the breaker is supposed to prevent too much current from passing through the circuit, should the thermostat switch open or close the circuit when it determines that the heater wire has become very hot? Why?