WELCOME TO PERIOD 15

Homework Exercise #14 is due today.

Watch video 4, Power Surge, for class discussion one week from today.
What is electrical resistance?
How are voltage, current, and resistance related?
How are voltage, current, and power related?
Remember to put away your phone. No calls or texting during class.
Electrical resistance

• Electrical resistance is the ability of an object to prevent or restrict the flow of current.
• Resistance \( R \) is measured in units of ohms (\( \Omega \)).

Conducting metal pathways have low resistance that allow current to flow.

The filament has high resistance to restrict current flow.

Ceramic insulating ring has very high resistance to prevent current flow.
Measuring the resistance of wires

Do not connect the battery tray to the green board with resistance wires.

1) Set the multimeter to “Ω” to measure resistance.

2) Connect the ends of the multimeter leads to the screws at the ends of the thin 30 cm wire to measure its resistance.

3) To measure resistance across the 15 cm wire, connect the multimeter leads across that wire.
Measuring the voltage across wires

1) Connect the battery tray to the green board with three wires shown in red to make a complete circuit.
2) Set the multimeter to “**V**” to measure DC voltage.
3) Connect the ends of the multimeter leads to the screws at the ends of the **thin** 30 cm wire to measure its resistance.
4) To measure voltage of the 15 cm wire, connect the meter leads across that wire.

Measuring the voltage across the 30 cm wire.
Measuring the current through a bulb.

Measuring the resistance of a bulb. (Disconnect batteries.)

Measuring the voltage across a bulb.
Voltage, current, and resistance

Voltage = Current x Resistance

\[ V = I \times R \]

\( V \) = voltage (in volts)
\( I \) = current (in amps)
\( R \) = resistance (in ohms)

This relationship is Ohm’s Law.
Measuring current and voltage

1) Connect the meters to the thin 30 cm wire as shown.

2) Set the multimeter to $\text{A}$ to measure DC current.

3) Use the “DC voltage adjust knob” on the power source to adjust the voltage to 0 V, 1 V, 2 V, etc.

4) Read the voltage from the volt meter on top of the power source. Use the 0 – 15 volt scale.
Graph of voltage vs. current

- Graph voltage on the vertical axis and current on the horizontal axis.
- Draw a straight, best-fit graph line.
- To find the slope of the graph:
  1) Pick any two points on the line.
  2) Slope = \( \frac{\text{vertical distance between points}}{\text{horizontal distance between points}} \)
- What is the physical meaning of the slope?
  Hint: the graph represents voltage/current
AC/DC electric current

**DC = direct current.** Direct current moves in one direction through a conductor.

Direct current sources include batteries, capacitors, and solar cells.

**AC = alternating current** Alternating current reverses direction 120 times per second or 60 cycles per second.

Alternating current is provided from outlets.
Measuring power, voltage and current

**Power:** Plug the appliance into the outlet on the meter and turn the appliance on. The appliance wattage appears in the display screen.

**Voltage:** Press the **MODE button 4 times** until voltage appears in the display screen.

**Current:** Press the **MODE button once more** and amps appear in the display screen.
Power = current x voltage

- In Activity 6), you found power = current x voltage:
  \[ P = I \cdot V \]

- How can \( P = I \cdot V \) be derived from \( P = \frac{E}{t} \)?

- Hint: In Period 13, we found that electrical potential energy is the product of voltage and charge.
  \[ E_{pot} = Q \cdot V \]
Another hint!

Current = \frac{\text{amount of charge moved}}{\text{time}}

\[ I = \frac{Q}{t} \]

- \( I \) = current (in amperes)
- \( Q \) = charge (in coulombs)
- \( t \) = time elapsed (in seconds)
Deriving power = current x voltage

1) The energy $E$ is electrical potential energy:

$$ P = \frac{E}{t} = \frac{E_{pot}}{t} $$

2) Substitute $Q \times V$ for $E_{pot}$:

$$ P = \frac{E_{pot}}{t} = \frac{Q}{t} \cdot V = \frac{Q}{t} \cdot \frac{V}{t} $$

3) Substitute $Q/t = I$

$$ P = \frac{Q}{t} \cdot V = I \cdot \frac{V}{t} $$
Measuring the resistance of appliances

1) Turn the multimeter dial to the ohm symbol ($\Omega$).
2) Attach both wire leads to the right side of the meter.
3) Connect the meter leads to the prongs of the appliance’s plug.

Caution: do not plug the appliance into an outlet!
Resistance and power

Why does the hair dryer have less resistance when set on “low”? 

\[ P = I \times V: \]

- Does the dryer need more or less power when set on “low”? 
- Does it need more or less current on “low”? 

\[ V = I \times R: \]

- Is a high or low resistance needed for this current?
Edison’s Miracle of Light

1) Explain the difference between AC and DC current.

2) What was Edison’s objection to AC current? Was his objection reasonable?

3) What was a major limitation of Edison’s DC utilities?

4) What device used in conjunction with AC current helps to overcome this limitation?

5) Why could using this device make AC current more efficient to transmit and safer for customers to use?
BEFORE THE NEXT CLASS…

✔ Read textbook chapter 16
✔ Complete Homework Exercise 15
✔ Bring a blank Activity Sheet 16 to class.
✔ Watch video 4, *Power Surge*, for class discussion one week from today.