Name: _____ **Class:** _____

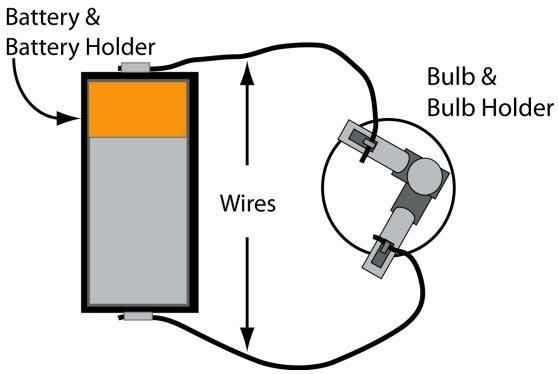
Mandatory Experiment: Electric conduction

In this experiment, you will investigate how different materials affect the brightness of a bulb in a simple electric circuit.

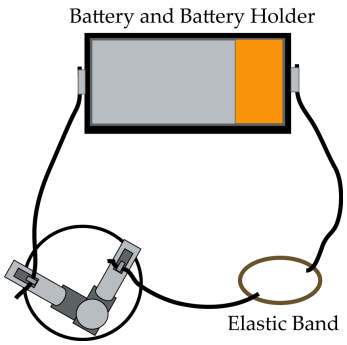
1. Take a battery holder, a battery, a bulb holder, a bulb and two connecting wires and set up the circuit shown at right.

   Does the bulb light?

   _____



2. Suppose you would place the materials you're given, one by one, in the circuit as shown. In the table below, write whether you think the bulb would light or not. **Do not carry out the experiment yet.**



What do you think?	
Material	**Bulb will light (Yes/No)**

3. Insert each of the materials individually into the circuit as shown in the diagram above. Take note of your observations by filling in the table below.

Results		
Material	**Bulb lights**	**Bulb doesn't light**

4. Compare your results in Question 3 with your ideas from Question 2. Which of your ideas were correct, and which were incorrect?

_____

_____

You have seen that different materials have different effects on bulb brightness. This leads us to the two new terms based on our observations. The objects that let the bulb glow are called **conductors**. The objects that make the bulb go out are called **insulators**.

5. Insert some of your own objects into the circuit to test if they are conductors or insulators. Tick the appropriate box in the table below.

Object	**Conductor**	**Insulator**

6. Do the conductors that you have seen so far have anything in common?

_____

_____

In the last few steps we separated a number of materials into groups of conductors and insulators. We now look at some other conductors and compare their effects on bulb brightness.

7. Set up a circuit which allows you to investigate the following hypothesis:

   "Copper wire is a better conductor than nichrome wire."

   Plan your investigation below. Make sure you include a diagram of the set-up you think you will use. (**Hint:** If an insulator makes a light bulb go out and a good conductor makes it light, how could you identify a not-so-good conductor?).

   _____

   _____

   _____

   _____

   _____

   _____

   _____

   _____

   Discuss if you have designed a fair test. If not, what would you need to make the test a fair one?

   _____

   _____

8. Check your plans with your teacher. Do not change your answers to part 7; instead, describe how you carried out your investigation, and the results you got, in the space below. Draw a new diagram of the set-up if you need to.

   _____

   _____

   _____

   _____

   _____

   _____

   _____

9. We can rank materials by how good an insulator they are. This property is called the material's **resistance**. Which has a higher resistance: a piece of copper wire or an elastic band?

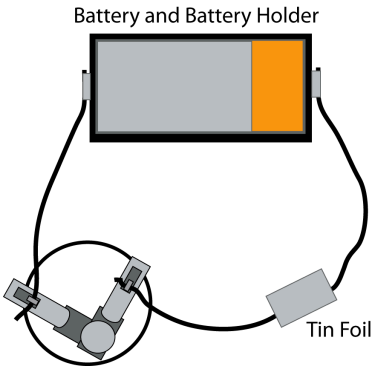
   _____

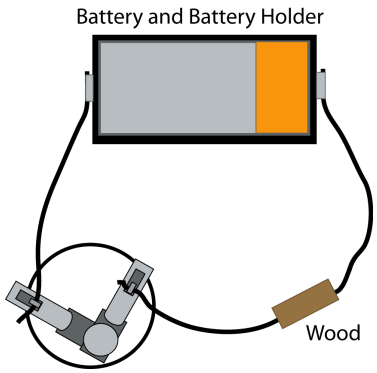
   Which has a higher resistance: a piece of copper wire or a piece of nichrome wire of the same length?

   _____

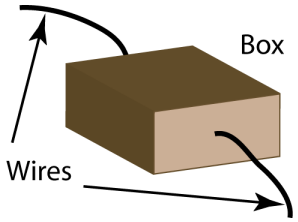
Homework Questions

1. Will the bulb light in the circuits shown below? Explain your answer briefly.





2. The box shown at right contains a material which is connected to the two wires. Describe an experiment which allows you to tell whether the material is a conductor or an insulator. Draw a diagram, and state how you would decide.



_____

_____

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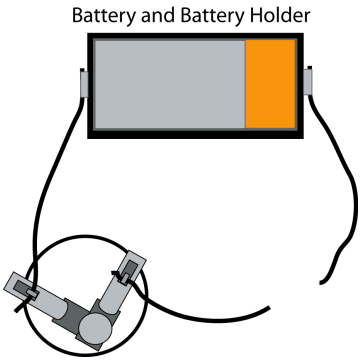
_____

3. In the set-up to the right, the bulb does not light.

   Is there an insulator or conductor between the two wires? Name the insulator or conductor.

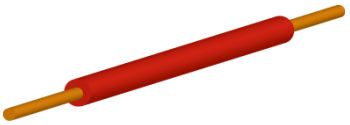


_____

_____

_____

4. In your own words, describe why you think electrical wires are insulated.



_____

_____

_____

_____

Experiment: Ammeters and voltmeters

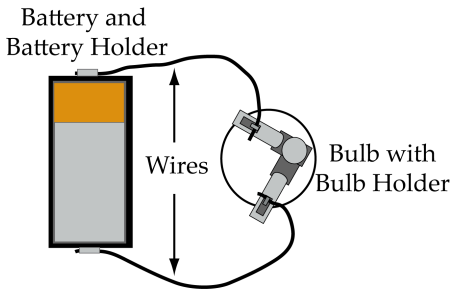
In this experiment, you may assume that:

- **Inside** a battery, the direction of current is from the negative terminal to the positive terminal ("from minus to plus")
- **Outside** a battery, the direction of current is from the positive terminal to the negative terminal ("from plus to minus")
- The brighter a bulb, the greater the current through it.

Section 1: Ammeters

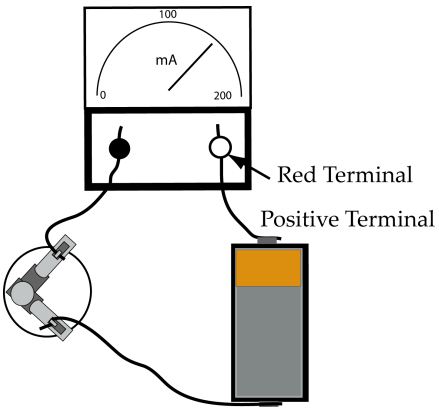
To measure current we use ammeters.

1. Draw a circuit diagram for the circuit shown.



Set up the circuit. Try and remember how bright the bulb is.

2. Now add an ammeter to the circuit as shown.



Does the ammeter change the current in the circuit? Explain how you can tell.

_____

_____

Is the ammeter a good conductor? Explain.

_____

_____

Does the ammeter have a low or a high resistance? Explain.

_____

3. Suppose you switch the ammeter and the bulb. Do you think the ammeter reading would change? Explain.

_____

_____

Check your prediction. Does the bulb use up current?

_____

4. Replace the bulb with a resistor. Write down the ammeter reading.

_____

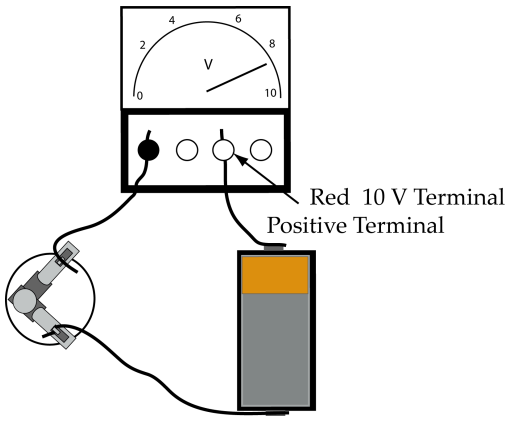
Is the current through a battery constant, or can it change? How can you tell?

_____

_____

Section 2: Voltmeters

1. Set up the circuit at right.



Is the voltmeter connected in series or in parallel?

_____

Does the bulb light?

_____

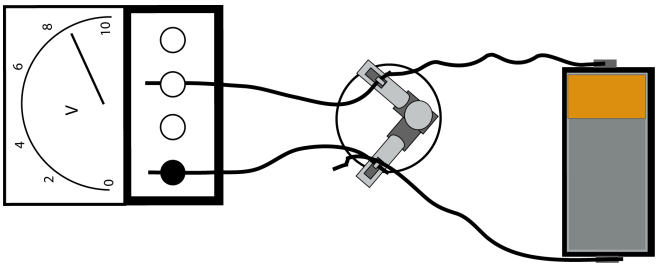
Does the voltmeter change the current in the circuit? Explain how you can tell.

_____

Does the voltmeter have a high or a low resistance? Explain.

_____

2. Draw a circuit diagram for the circuit below. How is the voltmeter connected now?



Set up the circuit. Does the bulb light?

Write down the voltmeter reading.

Does the voltmeter now have a noticeable effect on the current through the bulb? Explain.

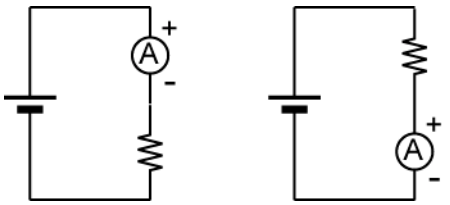
In which set-up does the voltmeter appear to be more useful?

3. Replace the bulb with a resistor. Write down the voltmeter reading.

Does the voltage across a battery seem to be constant, or can it change?

Homework Question

1. Draw two experimental set-ups that correspond to the two circuit diagrams below. The two resistors are the same.



A student says that the ammeter readings are different, because in one of the circuits the resistor will have used up some of the current before it gets to the ammeter. Do you agree? Explain your answer.

_____

_____

Mandatory Experiment: Ohm's Law

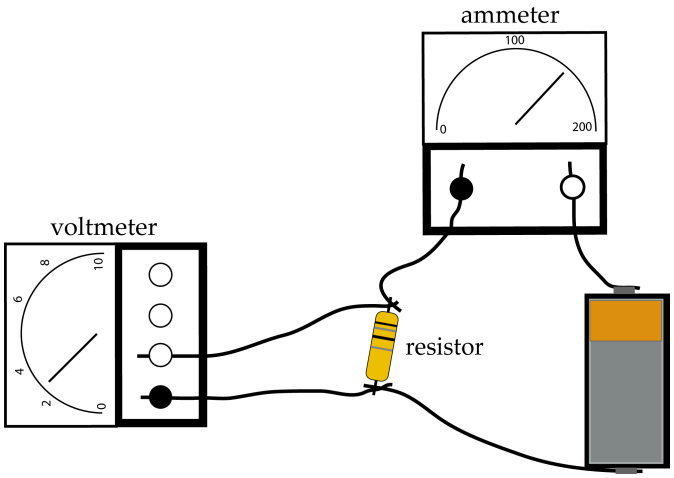
1. Set up the circuit shown. Measure the current and the voltage, and write your measurements in the first row of table 1.

   Some of the circuit elements get all the current. Name them.

   _____

   _____

   Most, but not all of the current goes through the resistor. Explain why this is so.



_____

2. Add a second battery in series with the first as shown. Write down the new voltmeter and ammeter readings in table 1.

   When a second battery is added in series, what happens to the voltage across the resistor?

   _____

   _____

   _____

   When a second battery is added in series, what happens to the current through the resistor?

   _____

   _____

   _____

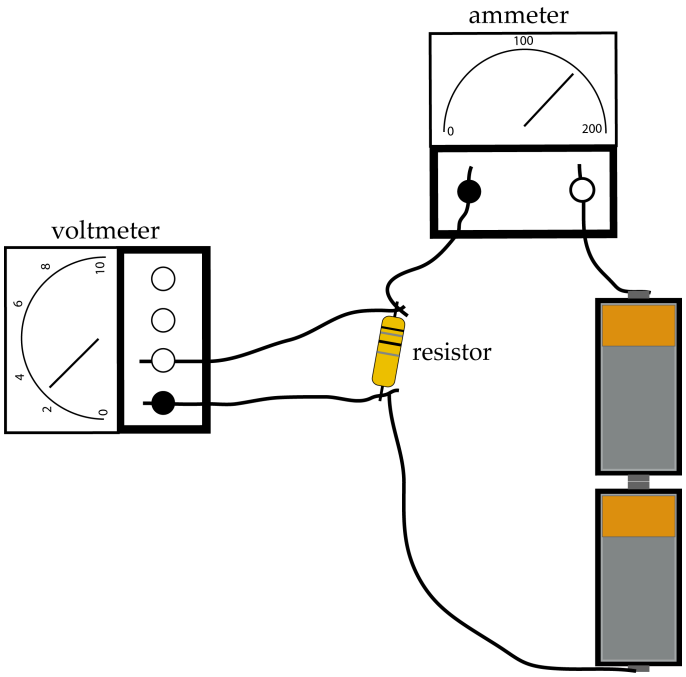


Table 1: Voltage and current for a resistor.

Number of batteries	Voltage (V)	Current (mA)	Current (A)
1			
2			
3			

3. Predict what would happen to the voltage and the current through the resistor when you add a third battery.

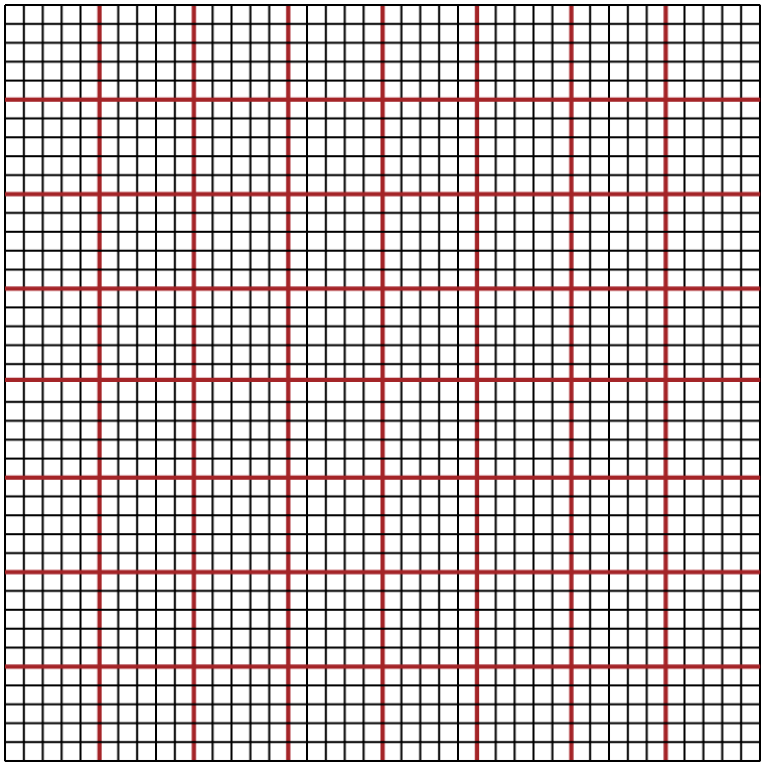
_____

_____

Check your predictions, and write your results in table 1.

_____

4. If you have not done so already, convert your mA readings to A. Plot a graph that shows how the current through the resistor changes when the voltage across the resistor is changed. Plot voltage on the vertical axis, and current (in A) on the horizontal axis.



Do your data points appear to lie on a straight line?

_____

Does the line appear to go through, or nearly go through, the origin?

_____

What do these answers suggest about how voltage and current are related?

_____

5. Find the value of the slope. What units do you use?

   _____

   If you want to increase the current through the resistor by 1 A, by how much would you need to change the voltage? Explain.

   _____

   _____

6. The ratio of voltage and current is called the **resistance** of the resistor. Do you think the resistance of a resistor is constant? Explain how you can tell from the graph.

   _____

   _____

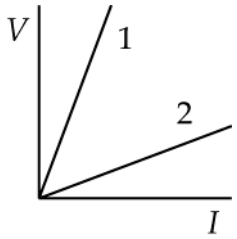
   _____

The relationship between voltage and current that you have found in this experiment is called **Ohm's Law**.

Homework Questions

1. A student carries out an experiment like yours for two different resistors, 1 and 2. She plots her results in a single graph.

   Which resistor has the greatest resistance, 1 or 2? Explain.

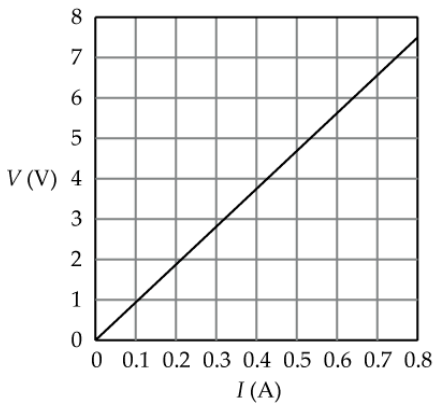


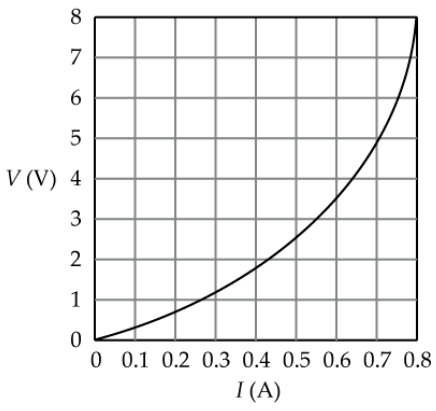
   _____

   _____

   _____

2. The graph on the left below shows how the current through a resistor changes when the voltage across it is changed. The graph at right below shows the same for a light bulb.





Use the graphs to calculate the resistance of the resistor when the current through it is 300 mA, and when it is 600 mA. Do the same for the bulb. Write your results in the table below.

	I (A)	*V* (V)	*R* (W)
resistor			
resistor			
bulb			
bulb			

In your own words, explain how you can tell, just by looking at the shape of the graph, how the resistance of an object changes when you increase the current through that object.

_____

_____

_____

Does Ohm's Law apply to a light bulb? Explain how you can tell.

_____

_____