15 Electrical Circuits

Name_____

Lab A: AMMETERS AND VOLTMETERS

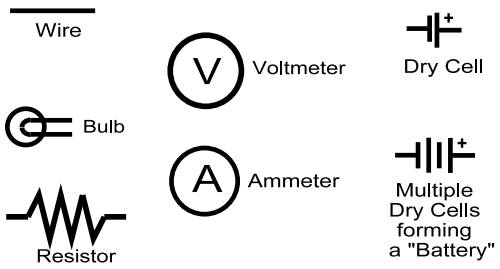
AP Physics B

You have completed ***electrostatics***, the study of electrical charges at rest. Mankind's earliest knowledge of electrostatics dates back many centuries. We are now entering the study of electrical charges that are in motion - ***electrodynamics***. Electric circuits, with currents to run lamps and motors, did not develop until batteries were invented around the year 1800. The growth of the use of electricity was then so rapid that it produced not just a part of physics but a new electrical civilization in less than a century.

An electric energy source and an electric energy user can be connected in a way that furnishes evidence that electrical energy is being used. That hookup is called an **electrical circuit**. Every electrical circuit must have at least one energy source and one energy user. It must also have a way to connect the energy source and the energy user. The connectors, the energy source, and the energy user are the **circuit elements**.

In this lab, you will be hooking up various simple circuits and measuring quantities known as **voltage** and **current**. One can compare the flow of electrons through a circuit to the flow of water through a stream. Current in an electrical circuit is much like current in a stream - it is a measurement of flow. Electrons flow in circuits, of course, not water. As for voltage, synonyms for voltage include "potential difference" and "electromotive force". Voltage is literally the potential energy difference per unit charge in a circuit. In the analogy to a stream, voltage would be like a waterfall that provides the impetus for the current.

In constructing electrical circuits, one follows (or creates) diagrams to signify the various elements and how they are connected. At right are some common symbols used for circuit elements.



Please note that in physics parlance, a "battery" is a connection of several wet or dry cells, not a single dry cell as is used colloquially. Your car "battery" is a true battery because it consists of several connected wet cells.

An **ammeter** is a device that measures how much current is moving through a circuit. Current is measured in **amperes**. That is why the current measurer is called an ammeter. A **voltmeter** is a device that measures how much voltage is generated or used by a circuit element. Voltage is measured in **volts**. Ammeters and voltmeters are designed to be hooked into a circuit in very specific ways. Improper connection of these meters to a circuit can destroy them. Be very careful when hooking meters into circuits!

Ammeter Procedure

When you measure the current in a circuit, you connect the ammeter directly into the circuit, with one wire connecting the positive (+) terminal of the ammeter to the part of the circuit leading to the positive (+) terminal of the dry cell. The second wire connects the negative (-) terminal of the ammeter to the part of the circuit leading to the negative (-) terminal of the dry cell.

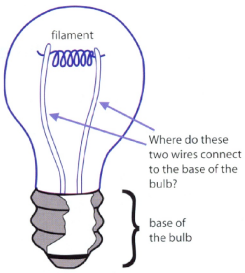
Another rule is that you should **never** hook an ammeter into a circuit that does not have some sort of resistor (such as a light bulb) in it. Otherwise, you will be setting up a short circuit and may overload the ammeter.

Voltmeter Procedure

When you measure a dry cell's voltage, one wire is connected from the positive (+) terminal of the dry cell to the positive (+) terminal of the voltmeter. The second wire connects the negative (-) terminals of the dry cell and the voltmeter. The voltmeter is then hooked **across** the dry cell. Whenever a voltmeter is used to measure (in volts) the voltage of any electrical circuit element, the voltmeter is **always** hooked **across** that element, such that the side of the element corresponding to the positive side of the circuit is attached to the positive terminal of the meter, and the negative side of the element is attached to the negative terminal of the meter.

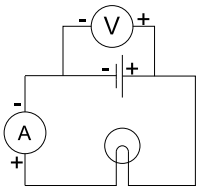
Unlike ammeters, voltmeters can be hooked into circuits that have no resistors in them. If there are resistors, however, voltmeters should be hooked **across** the circuit, not directly into it.

Before you begin the main experiment, let's try lighting a bulb using only one wire and one battery. Unscrew a light bulb from its socket and figure out how to connect the parts.
Sketch in the space below how you make the connections.

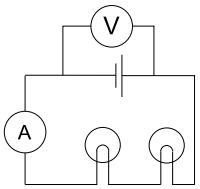


Then deduce how the light bulb is wired, and complete the wires in the diagram at right to show how they must connect to the base of the bulb.

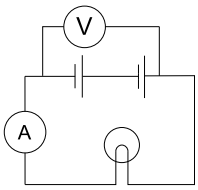
Now hook up the four circuits shown below. (Each lab partner should independently build one of the circuits.) Record the current and voltage for each circuit in the table as well as the relative brightness of the bulbs.



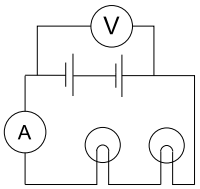
Circuit #1



Circuit #2



Circuit #3



Circuit #4

Circuit	Current (amperes)	Voltage (volts)	Bulb Brightness (qualitative)
1			
2			
3			
4			

1. Which circuit(s) had the brightest bulb(s)? ANSWER ALL QUESTIONS IN COMPLETE SENTENCES

2. What simple explanation (in terms of energy sources and energy users) can you give for your answer to question 1?

3. Which circuit(s) had the dimmest bulb(s)?

4. What simple explanation (in terms of energy sources and energy users) can you give for your answer to question 3?

5. In the scientific method, one should only change one variable to observe how it affects another variable. (You cannot change two variables simultaneously to see how only one of them affects a third variable.) Which pairs of circuits should you compare to see if the number of bulbs affects the voltage readings? What effect, if any, do you see?

6. Which pairs of circuits should you compare to see if the number of bulbs affects the current readings? What effect, if any, do you see?

7. Which pairs of circuits should you compare to see how voltage affects current? What effect, if any, do you see?