Name:_____

Date:_____ Period:_____

Solution Conductivity Part 1: Pre-Lab

Introduction: In this lab you will test the conductivity of different solutions. In order to complete this lab you will need to understand vocabulary and concepts related to the properties of elements, bonding, solutions, as well as the basic principles of circuits. Before completing Parts 2-4, you MUST complete the pre-lab so you are able to complete this assignment correctly and on time.

1. Describe the physical properties of metals nonmetal and semimetal atoms.

Metal	Nonmetal	Semimetal
• *Middle-Left section of periodic table* • *Almost always solids* • *Ductile and malleable* • *Good electrical and thermal conductors*	• *Upper right corner of periodic table* • *Exist as solids, liquids and gases* • *Brittle* • *Poor electrical and thermal conductors*	• *Staircase separating metals and nonmetals* • *Share properties of metals and nonmetals*

2. Fill in the table below describing how atoms form bonds.

	Compound	Molecule	Metal
Type of bond?	*Ionic*	*Covalent*	*Metallic*
Formed with what types of atoms?	*Metal + Nonmetal*	*Nonmetals only*	*Metals*
How do electrons form bond?	*Transfer electrons*	*Share electrons*	*Overlap electrons*
Draw an example showing how electrons are interacting.			
Physical Properties: • Solid, Liquid, Gas? • Conductive? • Brittle, malleable? • High/low melting and freezing points?	*Usually solids* *Conductive* *High melting and boiling points*	*Solids, liquids or gas* *Little or slightly conductive* *Low melting and boiling point*	*Solids* *Excellent conductors* *High melting and boiling point*
Mixing: • Dissolve, dissociate or nothing?	*Homogeneous*	*Homogeneous*	*Heterogeneous*

1. What makes a material a good conductor? What are the electrons able to do in a conductor that they are unable to do in a non-conductor? *Conductors need to be able to move electrons through a material. This type of electron movements may occur in an "electron sea" of metals, ionic compounds or highly conjugated covalent molecules*

Appliances in the Bathtub Video

1. What are the MythBuster guys testing? *The MythBusters are trying to figure out if electrocution from an appliance in a bath tub would really kill you like in the movies.*

2. How are they testing this theory? What does their experiment look like? *The MythBusters are testing this theory by putting a dummy in a bath tub with a multimeter hooked into his heart to read the current. Different appliances, such as hair dryer, curling iron, clothes iron, toaster, etc. will be dropped into the water and current will be measured. They will then add different solutes to see if current is effected.*

3. How much current can a human survive? *The human heart can survive 6 mAmps.*

4. What happens if you use bubble bath as a solute? *(2:40 minutes) The conductivity of the water slightly decreases.*

5. What happens if you use urine as a solute? *(3:00 minutes) The conductivity of the water increases.*

6. What happens if you use epsom salt as a solute? *(3:20 minutes) The conductivity of the water increases up to 1 Amp.*

7. Why would adding something salt (ionic compound) change the amount of electricity flowing through the dummy?
Salt changes the conductivity of the water by because it is an ionic compound. Since electrons are able to move in an ionic compound electricity is able to flow through the water. Regular water does not have salt so there are no electrons carrying the electricity.

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Solution Conductivity Part 2: Conductivity Test

Objective:

- Learn how to use a multimeter
- Build a Conductivity Tester and measure conductivity of Solutions 1-6
- Explain why Solutions 1-6 are good or bad conductors using what you know about physical properties and compounds/ molecules

Predictions: What beverage would make your blood the most conductive? Diet Coke, Red Bull or Gatorade? Use science vocabulary and the Pre-Lab video to help explain your answer.

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_____

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Materials:

- 9V Battery and Battery Connector
- 14.4V Lightbulb and Lightbulb Holder
- Alligator Clips
- Aluminum Foil
- Test Solutions 1-6 in 50 mL Beakers
- Conductivity Placemat
- Beaker Lid

Procedure 1 - Battery Test

1. Measure the voltage of the 9V battery
    a. Touch the red probe to the positive side of the battery
    b. Touch the black probe to the negative side of the battery
    c. Write down the measured voltage in Data Table 1

Procedure 2 - Lightbulb Test

1. Connect the battery holder to the 9V battery
2. Connect the lightbulb holder to the red wire
3. Connect the black wire to the other side of the lightbulb holder
4. Plug in lightbulb
5. Measure the voltage traveling through the lightbulb
    a. Touch the red probe to the red side of the lightbulb holder
    b. Touch the black probe to the black side of the lightbulb holder
    c. Write down the measured voltage in Data Table 1

Data Table 1:

Test	Measured Voltage
Battery Test	*8.72*
Lightbulb Test	*8.17*

Procedure 3 - Building a *Conductivity Tester* and Testing Solutions

When you tested the 9V battery and lightbulb, you built a *closed* circuit, meaning all the wires were connected in a loop. For this part of the lab you will need to build an *open* loop device to test several different solutions.

1. Use the Conductivity Placemat to build a conductivity test
    a. Place the battery, battery connector, lightbulb box and Solution 1 on the Conductivity Placemat
    b. Attach the black wire to the lightbulb holder
    c. Attach the wire end an alligator clip other side of the lightbulb holder
    d. Connect the wire end of the other alligator clip to the red wire

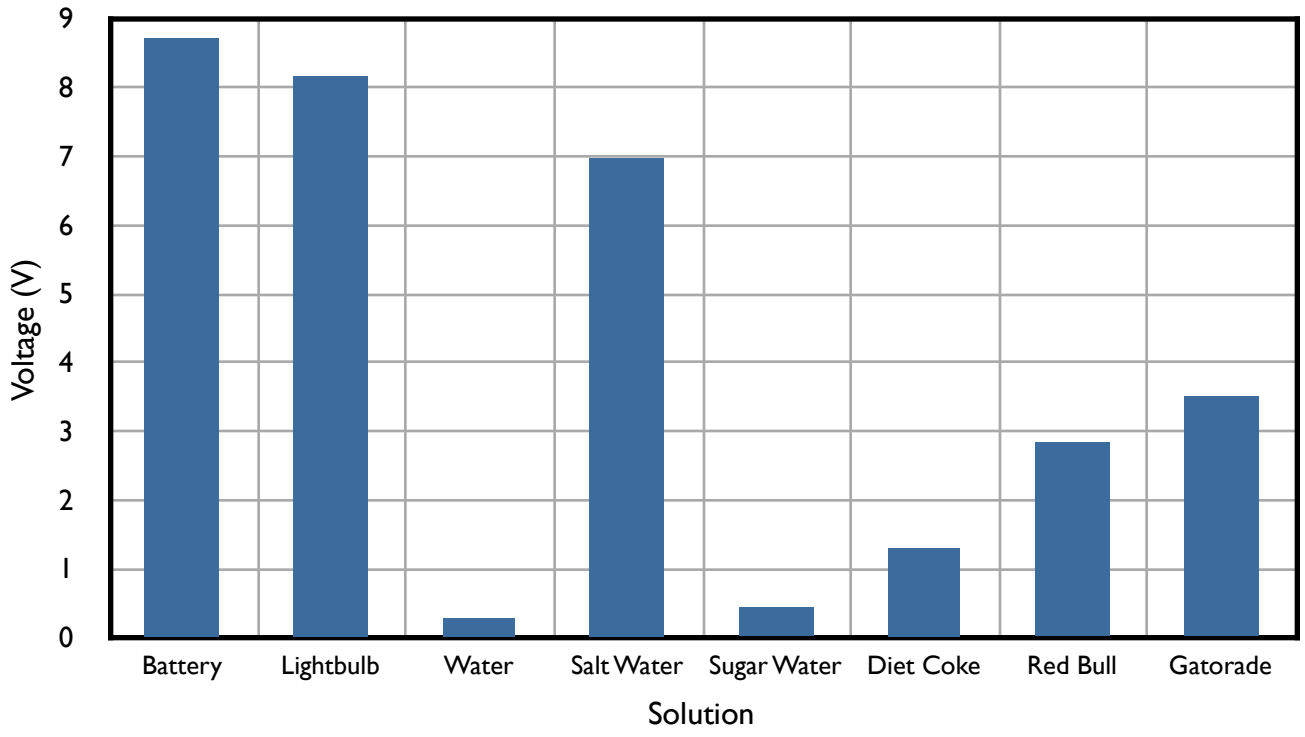
e. Fold 2 pieces of aluminum foil so they look like skinny gum wrapper
f. Attach aluminum foil pieces to beaker lid
g. Place beaker lid on top of Solution 1 so aluminum foil pieces submerged and about 0.5-1 cm apart
h. Attach an alligator clip to each piece of aluminum foil
i. Double check that aluminum foil pieces are still 1 cm apart

2. Measure the voltage of Solution 1
   a. Touch the black probe to the black side of the lightbulb holder
   b. Touch the red probe to the other side of the lightbulb holder
   c. Write down the measured voltage in Data Table 2
3. Unclip one alligator clip
4. Dip the aluminum foil pieces in a beaker of fresh water and dry them off with a paper towel
5. Place aluminum foil pieces into Solution 2, reconnect the alligator clip and measure the voltage
6. Repeat these steps until you have tested Solutions 1-6

Data Table 2:

Solution	Solution 1: Fresh Water	Solution 2: Salt Water	Solution 3: Sugar Water	Solution 4: Soda	Solution 5: Gatorade	Solution 6: Red Bull
Voltage (V)	*0.29*	*6.98*	*0.44*	*1.30*	*3.51*	*2.84*

Graph: Make a bar graph showing the voltages from Data Table 1 and Data Table 2.



Conclusion Questions: Use complete sentences to answer each question.

1. What solution was the best conductor? What makes that solution a good conductor? *Salt water was the best conductor. This is because salt in an ionic compound and can easily move electrons between positive and negative ions.*

2. What solution was the worst conductor? What makes that solution a bad conductor? *Sugar water was the worst conductor. This is because sugar in a covalent molecule and the electrons are stuck in the shared bonds..*

3. What do ALL of the conducive solutions have in common? *All of the medium conductors must have some ions in their solution that are able to move electrons around. Because some solutions are better conductors than others, then there must also be different amounts of ions in solution.*

4. Look at the nutrition label of a Gatorade bottle. Use this information to explain your Gatorade data. *Gatorade had a voltage of 3.51V and was most conductive of all the drinks. The reason Gatorade is so conductive is because of the salt (electrolytes) added to the solution. These electrolytes are redesigned to help athletes replace salt they lose from sweating and salt. Since salt is an ionic compound Gatorade is conductive, but not as conductive at regular salt water.*

5. What beverage would make your blood the most conductive? Diet Coke, Red Bull or Gatorade? Use your data to explain. *Gatorade (3.51V) would make your blood more conductive than Diet Coke (1.30V) or Red Bull (2.84V). While all three drinks are conductive, Diet Coke and Red Bull are carbonated which produces carbonic acid and allows a small amount of electrons to flow. Gatorade on the other hand contains electrolytes (salts) to help athletes replace salt making it a much better conductor.*

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Solution Conductivity Part 3: Effects of Concentration

Materials:

- 9V Battery and Battery Connector
- 14.4V Lightbulb and Lightbulb Holder
- Alligator Clips
- Aluminum Foil
- 50 mL Beaker
- Plastic Pipette
- Conductivity Placemat
- Beaker Lid

Procedure:

1. Pick one Test Solution from the list below and record it in the Data Table

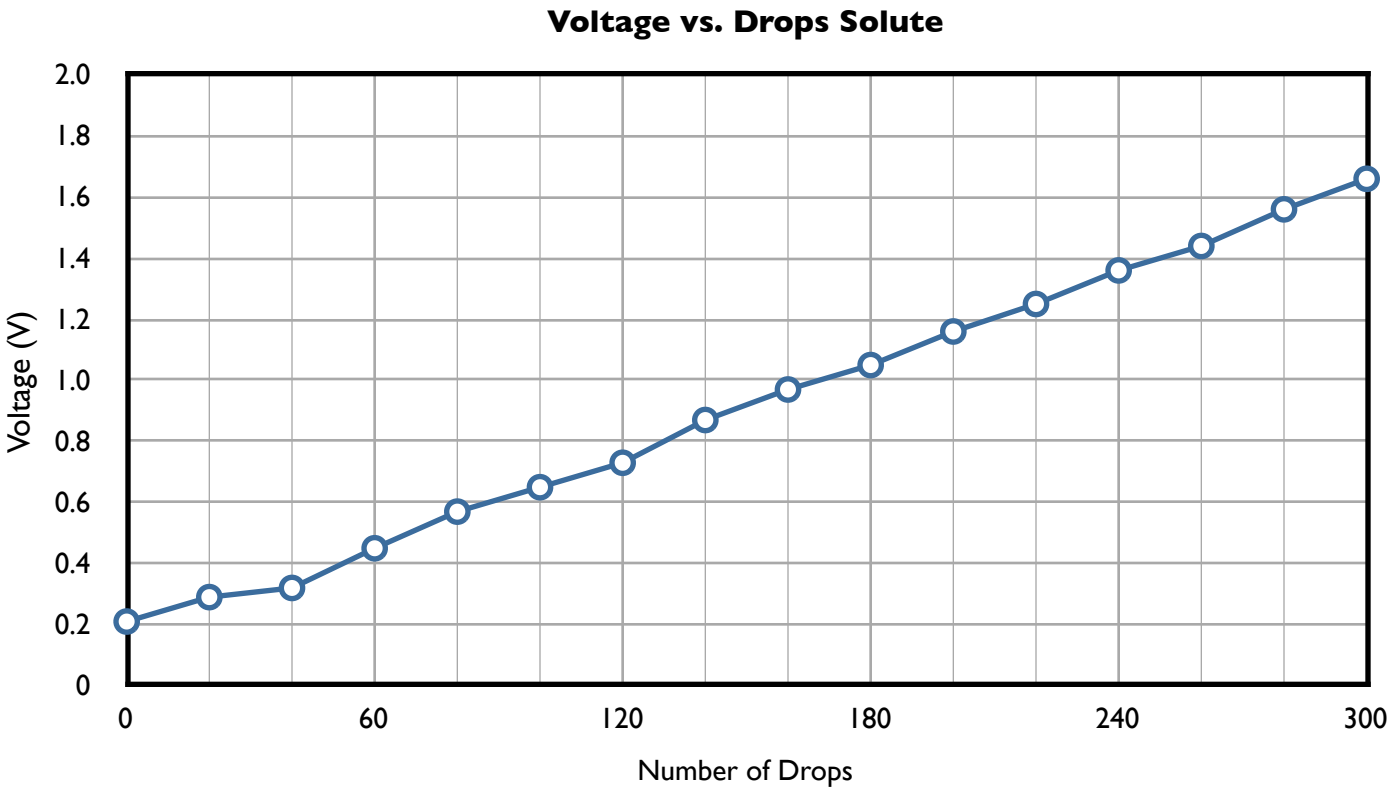
Salt Water	Lemonade	Soda
Gatorade	Vinegar	Red Bull

2. Rebuild your *Conductivity Tester* using the Conductivity Placemat
3. Add 30 mL of water to a clean 50 mL beaker
4. Measure the voltage of the plain water and record it in the Data Table
    a. Touch the black probe to the black side of the lightbulb holder
    b. Touch the red probe to the other side of the lightbulb holder
5. Carefully add 20 drops of your Test Solution to the beaker
6. Measure the new voltage of the solution and record it in the Data Table
7. Add another 20 drop of your Test Solution, measure the voltage and record it in your Data Table
8. Continue measuring voltage for every 20 drops added to your solution

Data Table:

Solution: *Vinegar*			
Number of Drops	**Voltage (V)**	**Number of Drops**	**Voltage (V)**
0	*0.21*	160	*0.97*
20	*0.29*	180	*1.05*
40	*0.32*	200	*1.16*
60	*0.45*	220	*1.25*
80	*0.57*	240	*1.36*
100	*0.65*	260	*1.44*
120	*0.73*	280	*1.56*
140	*0.87*	300	*1.66*

Graph: Make a line graph showing number of drops on the x-axis and voltage on the y-axis.



Conclusion Questions:

1. What relationship between number of drops and voltage does your graph show? *In my experiment I found that the amount of salt in solution increases the conductivity (linear relationship).*

2. Explain what happened in your experiment. Use your Pre-Lab and vocabulary in your answer:

Solute	Solvent	Solution	Concentration
Conductive	Nonconductive	Covalent	Ionic

Vinegar is covalently bonded, but it acidic which allows a small amount of ions to dissociate in water. These positive and negative ions make the water conductive by transferring electrons between the aluminum electrodes. At low concentrations there was only a slight change, however, as concentration increased past 40 drops the relationship became very linear, up to almost 2 volts.