Laboratory Investigation Name _____

Chemistry: Form L10.3A Date _____ Period _____

Constructing an Electrochemical Cell

PROBLEM

What produces the voltage of an electrochemical cell?

INTRODUCTION

Metals tend to lose electrons during chemical reactions, but when an active metal replaces a less active metal, the less active metal ***gains*** the electrons the more active metal loses. This what happens, for example when a piece of zinc is dropped into copper II sulfate solution. The zinc slowly forms zinc sulfate and dissolves. In the meantime copper crystals begin to form. The zinc is losing electrons and becoming oxidized while the copper is gaining electrons and becoming reduced. The two half reactions are as follows:

$$Zn^{0} \rightarrow Zn^{+2} + 2e^{-}$$

$$Cu^{2+} + 2e^{-} \rightarrow Cu^{0}$$

During the reaction, electrons are transferred from the zinc to the copper. When the zinc strip is in contact with the copper solution, the reaction occurs at the zinc's surface. If the zinc is not in direct contact with the copper, but they are connected by a wire instead, the electrons can flow through the wire from the zinc to the copper. The force or voltage that makes the electrons move can be measured. In this laboratory investigation, you will measure the voltages that drive chemical reactions in which electrons are transferred.

MATERIALS (*per group*)

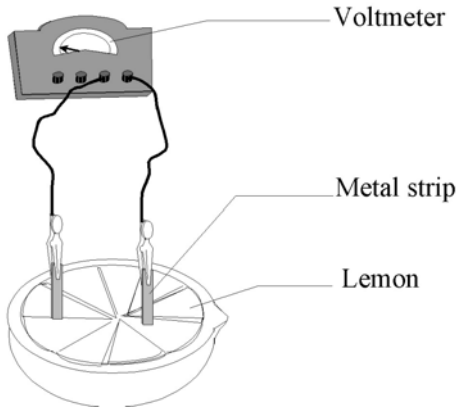
250 mL beakers (3); copper strips; copper II nitrate solution; glass wool or cotton; lead nitrate solution; lead strips; lemon; potassium nitrate solution; steel wool; U-tube; voltmeter (0-3v); wire connectors with alligator clips; zinc strips; zinc nitrate solution

PROCEDURE

1. Push a strip of lead and a strip of zinc into a lemon leaving part of each metal strip sticking out.

2. Attach wire connectors with alligator clips at one end to the terminals of a voltmeter.

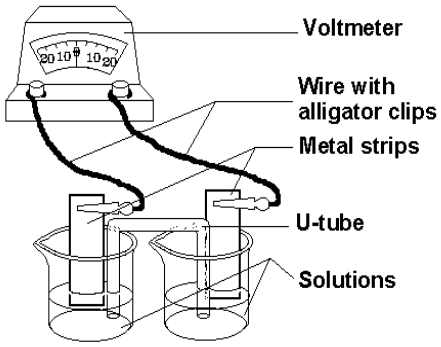
3. Connect the alligator clips to the metal strips as shown in the diagram to the right.



4. The needle of the voltmeter moves in the same direction the electrons flow. If there is no voltage, switch the connections to the voltmeter. Note the voltage and the direction of flow (zinc to lead or lead to zinc). Record your observations in the data table on the next page.

5. Use different combinations of electrodes. Each time, note the direction in which the needle of the voltmeter moves. This shows the direction of electron flow. Record your observations data table on the next page.

6. Set up an electrochemical cell as pictured. Put about 150 mL of copper II nitrate solution and 150 mL of zinc nitrate solution into separate beakers.



7. Polish a copper strip and a zinc strip with steel wool. Place the copper strip into the copper II nitrate solution and the zinc strip into the zinc nitrate solution. Attach the metal strips to the voltmeter with wire connectors and alligator clips.

8. Fill a U-tube with potassium nitrate and plug the ends with cotton or glass wool. Place the U-tube into the beakers to make a bridge as shown in the diagram.

9. Watch the voltmeter. If there is no voltage, switch the connections to the voltmeter. Note the size and direction of the voltage. Record your observations.

10. Set up an electrochemical cell as in steps 7-9 using lead nitrate and zinc nitrate solutions with lead and zinc strips. Set up an electrochemical cell as in steps 7-9 using copper II nitrate and lead nitrate solutions with copper and lead strips. Record your observations in the data table below.

OBSERVATIONS

Lemon Battery

Electrodes	Voltage	Direction of Flow
Lead-zinc		
Copper-Zinc		
Copper-Lead		

Electrochemical Cell

Electrodes	Voltage	Direction of Flow
Copper-Zinc		
Lead-zinc		
Copper-Lead		

CONCLUSIONS

1. For each pair of electrodes, which metal is being oxidized? _____

_____

2. Which pair of electrodes gives the highest voltage? Is there a relationship between the voltages and the activity series? _____

_____

3. How do the voltages you obtained compared to those obtained using standard reduction potentials? Why? _____

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