AP CHEMISTRY

Galvanic Cell Analysis

(130 Points)

Name, Date and Lab Partner (5 Points)

Procedure (20 Points)

 Complete, step-by-step account

 of actions performed

Data (35 Points)

 Observation Table (10 Points)

 Reagent Masses (5 Points)

 Reagents Volumes (5 Points)

 Reagent Concentrations (5 Points)

 Cell Potential Values (10 Points)

Analysis (30 Points)

 Equations (5 Points)

 Diagram (10 Points)

Standard Potential (5 Points)

Variable Change Summary (10 Points)

Conclusion (30 Points)

Overall Neatness and Organization (5 Points)

Safety (5 Points)

This part is determined by proper lab safety which includes having your goggles and lab coat on properly at all times. Each reminder by the instructor will result in a deduction of 5 or 10 points. This component of the grade can be negative.

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**INTRODUCTION TO ANALYTICAL CHEMISTRY – LAB**

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**EXPERIMENT IV**

**INVESTIGATION OF CELL POTENTIAL**

**INTRODUCTION**

The central concept to oxidation-reduction reactions is electron transfer via oxidation state changes. In a spontaneous redox reaction, electrons flow from the reactant that is oxidized (reducing agent) to the reactant that is reduced (oxidizing agent).

Single displacement reactions are the most common application of redox reactions; taking a solid metal in its elemental state and exposing it to an aqueous solution containing ions of a less reactive metal.



A redox reaction can be broken into two half reactions; one isolating the species that is being oxidized, the other showing the reduced reagent.

Cu (s) Cu2+ (aq) + 2e-

2Ag+ (aq) + 2e- 2Ag (s)

**THEORY**

If the two half–reactions are separated by a wire, the flow of electrons, instead of occurring at the surface of the metal, occurs through the external wire and an electric current is generated.

This is called a voltaic cell (or galvanic cell), and is exactly how a battery works. Batteries, like the ones found in a flashlight or calculator, contain oxidizing and reducing substances. As the electrons are transferred they are “tapped” in order to provide the voltage necessary to power the flashlight or calculator. A good analogy for the flow of electrons is the flow of water. Water flows spontaneously downhill. Dams and waterwheels are examples of ways that the energy of flowing water is tapped to generate power.

Sometimes we want water to flow uphill. In this case we need to supply energy, in the form of a pump, to make this happen. In order for a redox reaction to serve as a source of power, the reaction must be spontaneous. What if the reaction isn’t spontaneous? In this case, we can use electricity to make the reaction “go”. An electrolytic cell is a device that uses electricity to drive a non–spontaneous redox reaction. For example, water can be separated into hydrogen and oxygen gas (a non– spontaneous reaction) using electricity.

In short, the field of electrochemistry has two important applications, the use of spontaneous redox reactions to generate electricity, and the use of electricity to force non– spontaneous redox reactions to occur.

In this lab activity, you create and measure the voltage of a voltaic cell. A typical voltaic cell consists of two half-cells linked by a wire and a salt bridge. Each half-cell consists of metal electrode in contact with a solution containing a salt of that metal. One half-cell functions as the anode, where the oxidation reaction takes place, while the other functions as the cathode, where the reduction reaction occurs. Electrons flow from the anode to the cathode via the wire. The salt bridge allows migration of ions to prevent imbalance of charge from building up as electrons leave the anode and move to the cathode.

Inserting a voltmeter into the circuit between the half-cells permits a measurement of the voltage, or potential difference between the half-cells. In general, this voltage is designated by the symbol, E. When the solutions are under specific conditions, the cell is called a standard cell and its voltage is known as a standard potential, Eo. Many textbooks and references books contain tables of standard reduction potentials, which show the values of Eo for various reduction half-reactions of the type. It will be your goal to explore the variables that affect the potential of a galvanic cell.

***This lab will be performed in groups of four for efficiency. Delegate within your group so the two aqueous half-cell solutions and the salt bridge solution are being created simultaneously.***

**Safety and Disposal**

Research and consult MSDS reports for all metals and salt solutions utilized to create your galvanic cell.

**Prelab**

1) What makes a salt a good candidate for use in a salt bridge?

2) What relative concentration should a salt bridge have compared to the half-cell solutions?

3) What does it mean for a cell to have a “standard potential”?

4) What variables could be altered to take a cell out of standard conditions?

5) Choose the salts you would like to use in your half-cells and in the salt bridge. Calculate the mass of salts required to make the three solutions that make up your cell.

**PROCEDURE**

***Half-Cells***

1. Your only directive is to create a galvanic cell using copper and zinc. It is up to your group to decide how to complete this task, following the guidelines below:
	1. Only ~50mL of solution is needed for each half cell.
	2. Solid zinc and copper are provided.
	3. The salts to use for the aqueous solutions are up to you, as is the concentration of the half cells.

***Salt Bridge***

1. Your only directive is to create an effective salt bridge. It is up to your group to decide how to complete this task, following the guidelines below:
	1. The salt to use for the aqueous solution is up to you, as is the concentration of the salt bridge solution.
	2. Cotton balls will act as the permeable barrier through which the ions can transfer. Pack the ends of your u-tube with a large enough piece of cotton to prevent the solution from flowing out, but not so tight that the solution has difficulty passing through.

***Investigation***

1. Determine the potential of your cell with a voltmeter.
2. Explore variables that influence your cell potential.

**DATA ANALYSIS**

1. Write a complete balanced redox reaction that is occurring in your cell.
2. Draw a diagram of your cell, identifying the location of oxidation & reduction, the direction of electron flow, the anode & cathode, and the half reaction occurring in each half cell.
3. Calculate the standard potential of your cell.
4. Summarize the effect of changing variables of your cell.

**CONCLUSION**

Write a conclusionary paragraph that highlights your understanding of electrochemistry, galvanic cells, and how the two can be utilized produce a power source such as batteries. Discuss the results of your investigation on how altering variables of your cell affected the potential. Lastly, research and present your understanding of a battery you use every day. Relate it to redox and galvanic cells by diagraming & labeling the cell and by providing a complete balanced redox reaction that occurs in the cell.