The Galvanic Cell Game

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Subject: Chemistry
Level: High School
Standards: New York State-Physical Setting/Chemistry Standard:
3.1i Each electron in an atom has its own distinct amount of energy.
3.2j In an electrochemical cell, oxidation occurs at the anode and reduction at the cathode.
3.2k A voltaic cell spontaneously converts chemical energy to electrical energy.
3.3a In all chemical reactions there is a conservation of mass, energy, and charge.
Schedule: One Hour

Objectives:

Build on students' understanding of oxidation/reduction reactions and electrochemistry. Illustrate how all the pieces of an electrochemical cell come together to produce a charge.

Students will:

- Play a game to build understanding of the chemistry involved in galvanic cells.
- Strategize and make choices about galvanic cell components to optimize efficiency.
- Build on understanding of Galvanic cell chemistry by using the standards Electrode Potentials table.
- Practice calculating E^o and setting up balanced chemical equations from half reactions.

Vocabulary:

Anode
Cathode
Oxidation
Reduction
Oxidizing agent
Reducing agent
Galvanic cell (Electrochemical cell)
Salt bridge
Half-reaction
Standard electrode potential (E°)
Spontaneous reactions
Voltmeter

Materials:

For Each Student:
A Scorecard

For Each pair:
Game Board
Game pieces
"How to play the game" print out
Standard Electrode Potentials table (from NYS physical science reference table)
Scissors and tape

For The Teacher:
Dice
Teacher secrets

Safety:

No safety concerns

Science Content for the Teacher:

Preparation:

- Print, cut out and organize game pieces.
- Distribute game pieces to student pairs
- Give students reading material that will go over the Galvanic Cell

Classroom Procedure:

Engage (15 mins.)

- Review prior knowledge of electrochemistry by asking students to read a small article on Galvanic cells and answer questions. (You may want a component of the review to include writing and balance equations using half reactions).
- Discuss questions and answers
- As a class label a galvanic cell diagram on the board.
- Explain the rules of the game (See Explore section) without giving away the "answer" or best strategy.
- Allow teams to go over the game on their own and to strategize.

Explore *(30 mins.)*

Game pre-requisite:
In order to play the game your students must have a working understanding of oxidation-reduction reactions (half-reactions), circuits, and should be able to balance and set up chemical equations.

Game Objective:
The objective of the game is to accumulate the most charge. The winner needs to back up their win with an impeccable scorecard. The group with the most charge and best record will win the game.

players: 2 players per team are highly recommended

How to play the game:

1. All teams must have one board, pieces to be purchased, charge units, Standard Electrode Potentials table, and two scoreboards (one for each player).
2. All teams start with 4 units of charge stored in their voltmeter
3. Use your charge to purchase items that will make up your cell
    a. *If you purchased two metals look at steps 4-6*
    b. *If you purchase one metal or another item look at step 4*

4. Decide whether the metal will be an oxidizing agent or reducing agent. Place in the correct beaker (anode or cathode) and write in the correct half–reaction for your metal.
5. Make a balanced net reaction between your two metals
6. Find the E^o of you reaction and record
7. Wait for the role of the dice to see what your next move will be
8. Your cell only creates charge on each role of the dice
    a. When a reaction occurs and you produced charge you need to:
        i. Use your score card to keep record of the reaction
        ii. Show what happens to the mass of your metals with each reaction

Things to know for the game:

Role	Consequence
1	You may switch your cathode and anode metals, or trade in for equal charge price
2	Can make a purchase
3	Can make a purchase
4	Your salt bridge has collapsed
5	Can make a purchase
6	The switch is turned off

Raw Voltage	Charge earned on each turn
≥ 1	**2**
≥ 2	**4**
≥ 3	**6**
< 3	**8**

Charge price	Item
4	**Au Metal**
4	**Ag Metal**
2	**Cu Metal (Cu+)**
2	**Cu' Metal**
2	**Ni Metal**
2	**Zn Metal**
4	**Al Metal**
4	**Ba Metal**
3	**Salt Bridge (NH_4NO_3)**
6	**Salt Bridge (**

Teacher Secrets:

1. Purchases may be made after reactions occur.

2. When the switch is off (roll 6), or the salt bridge is collapsed (roll 4), no charge can be produced.
3. Students who create cells that have a negative E^o will loose half of all the charge they produce to maintaining the reaction (non-spontaneous reaction).
4. Students without a salt bridge will only be able to create charge for two rounds of the game, at which point the reactions on their beakers would have reached equilibrium.
5. After 8 turns student's with low poor oxidizing agents (like Al and Ba) and or poor reducing agents like (Ag and Au) wear out their metals.

Reflect:

- Lead a discussion (small or large group) about strategies used in the game and their relative success.

Discussion questions might include:

1. *Who used a strategy that was successful in the game? Why was it successful?*

2. *What were some problems you ran into during the game? How would you play differently next time?*

3. *How did the role of the die affect the game? How is the roll of the die an accurate or inaccurate analogy to "real life" galvanic cells?*

4. *What is the optimal combination of anode and cathode materials? Why?*

5. *Why do you think the game included a salt bridge? Why might this be important?"*

6. *What could you add to this game to make it more realistic?*

Assessment:

The following rubric can be used to assess students during each part of the activity. The term "expectations" here refers to the content, process and attitudinal goals for this activity. Evidence for understanding may be in the form of oral as well as written communication, both with the teacher as well as observed communication with other students. Specifics are listed in the table below.

1= exceeds expectations
2= meets expectations consistently
3= meets expectations occasionally
4= not meeting expectations

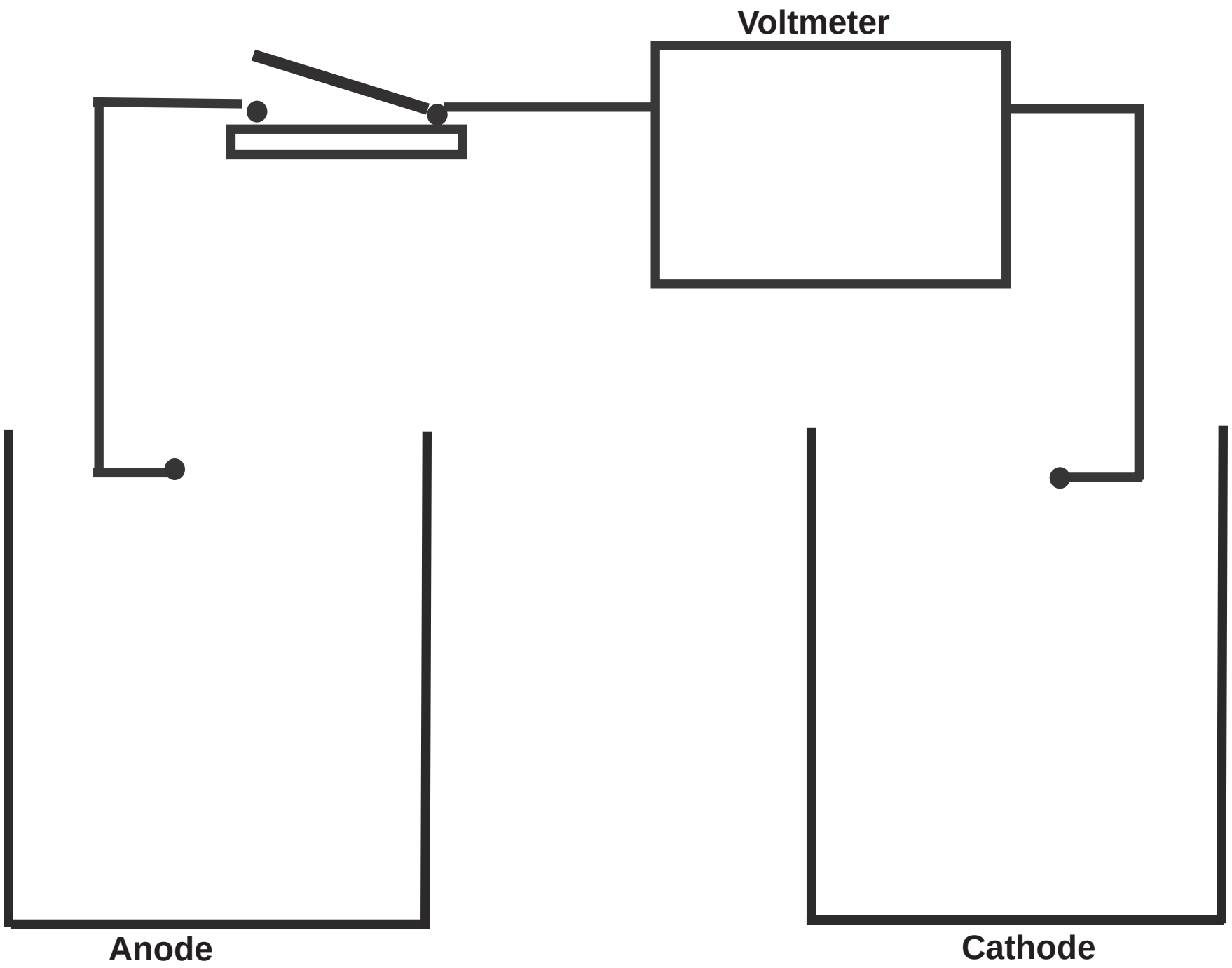
	Engage	Explore	Explain	Expand/Synthesis
1	Shows leadership in the discussion and group problem solving activity.			
2				
3				
4				

Extension Activities:

This activity can be used to reinforce student's knowledge on electrochemistry and is a great spring board for looking into Fuel cells. This activity correlates very well with another game, "The Fuel Cell Game", which is used to teach students

Supplemental Information:

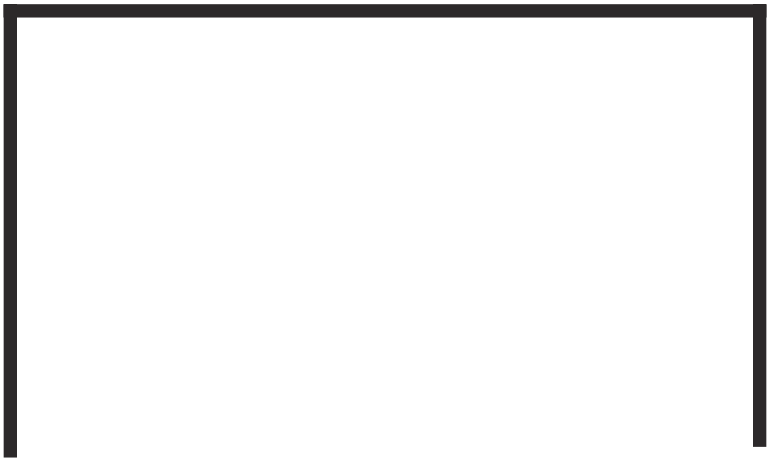
Acknowledgments:


Voltmeter
Anode
Cathode

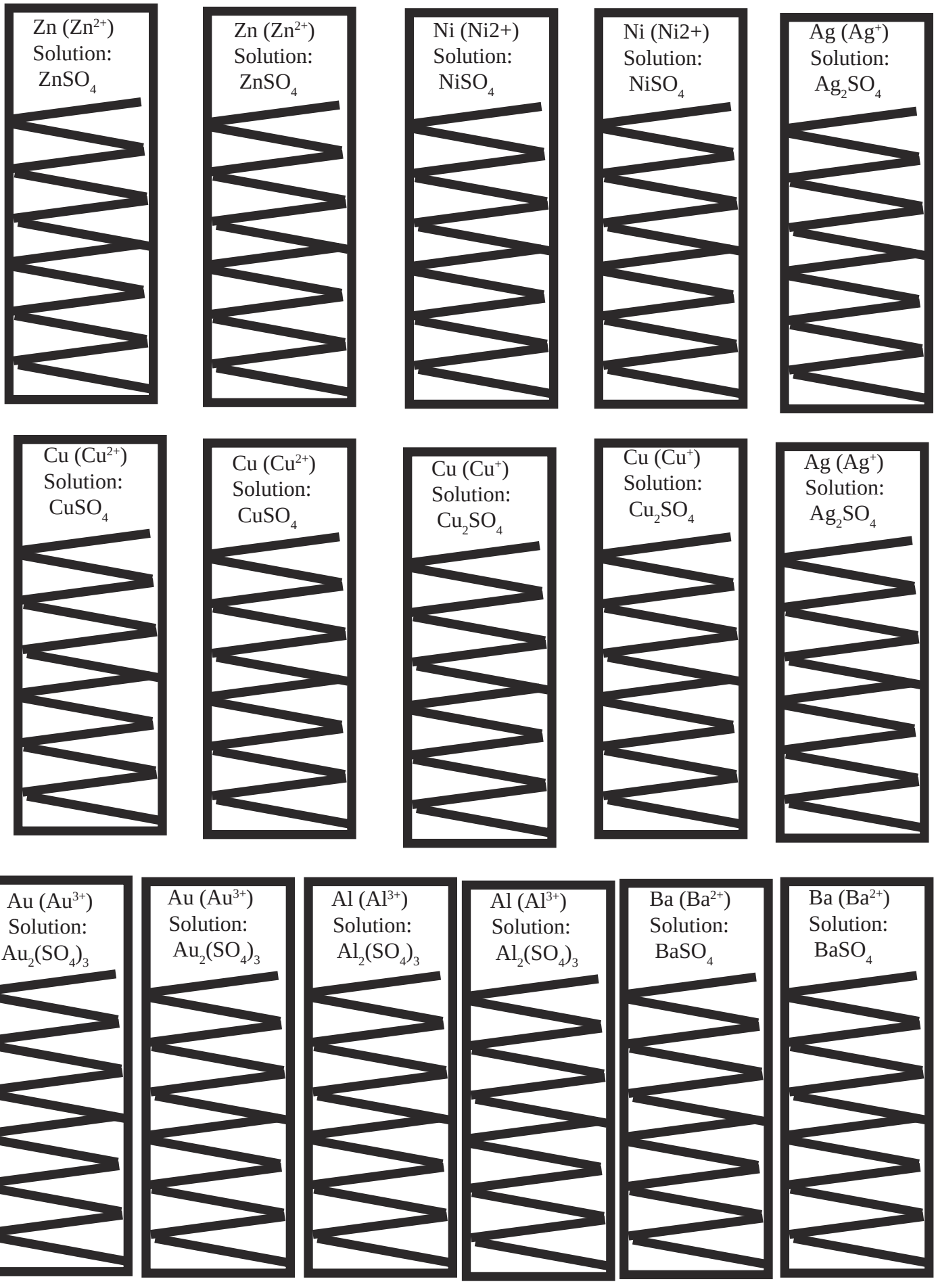
Salt Bridge made of NH_4NO_3

Salt Bridge made of KNO_3 (Durable)

Salt Bridge made of NH_4NO_3



Salt Bridge made of KNO_3 (Durable)


Zn (Zn^{2+}) Solution: $ZnSO_4$
Zn (Zn^{2+}) Solution: $ZnSO_4$
Ni (Ni2+) Solution: $NiSO_4$
Ni (Ni2+) Solution: $NiSO_4$
Ag (Ag^{+}) Solution: Ag_2SO_4
Cu (Cu^{2+}) Solution: $CuSO_4$
Cu (Cu^{2+}) Solution: $CuSO_4$
Cu (Cu^{+}) Solution: Cu_2SO_4
Cu (Cu^{+}) Solution: Cu_2SO_4
Ag (Ag^{+}) Solution: Ag_2SO_4
Au (Au^{3+}) Solution: $Au_2(SO_4)_3$
Au (Au^{3+}) Solution: $Au_2(SO_4)_3$
Al (Al^{3+}) Solution: $Al_2(SO_4)_3$
Al (Al^{3+}) Solution: $Al_2(SO_4)_3$
Ba (Ba^{2+}) Solution: $BaSO_4$
Ba (Ba^{2+}) Solution: $BaSO_4$