

Unit 8 Redox

At the end of this unit, you'll be able to...

- ✓ Define and identify oxidation reactions
- ✓ Define and identify reduction reactions
- ✓ Assign oxidation numbers to elements in a compound
- ✓ Write and balance half reactions
- ✓ Identify oxidizing agents and reducing agents
- ✓ Distinguish between voltaic and electrolytic cells
- ✓ Identify the components of an electrochemical cell
- ✓ Indicate the direction of electrons and ions through an electrochemical cell
- ✓ Determine, using Table J, whether a reaction is spontaneous or not

Term	Definition
Anode	SPONTANEOUSLY LOSES ELECTRONS to cathode; the NEGATIVE electrode in a VOLTAIC CELL; electrode where OXIDATION occurs; The MORE ACTIVE of the 2 metals goes here
Cathode	SPONTANEOUSLY ATTRACTS ELECTRONS to it; the POSITIVE electrode in a VOLTAIC CELL; electrode where REDUCTION occurs; The LESS ACTIVE of the 2 metals goes here
Electrochemical Cell	Involve redox reactions and the flow of electrical energy
Electrode	(conductive surfaces where oxidation or reduction occurs
Electrolytic Cell	Cells that use ELECTRICAL ENERGY to force a NONSPONTANEOUS CHEMICAL REACTION to occur
Galvanic or Voltaic Cell	Cells that SPONTANEOUSLY convert CHEMICAL energy into ELECTRICAL energy or electric CURRENT; BATTERIES
Half reaction	allow us to show the EXCHANGE OF ELECTRONS in a redox rxn; 1 for oxidation and 1 for reduction
Oxidation Half Reaction	Loss OF ELECTRONS by an atom or ion
Oxidation Number	POSITIVE, NEGATIVE, OR NEUTRAL (ZERO) VALUES that can be assigned to atoms; used to identify how many electrons are being lost or gained by an atom/ion when they FORM BONDS
Oxidizing Agent	SPECIES that is REDUCED; species that DOES THE OXIDIZING
Redox	reactions that involve the TRANSFER OF ELECTRONS
Reducing Agent	SPECIES that is OXIDIZED; species that DOES THE REDUCING
Reduction Half Reaction	GAIN OF ELECTRONS by an atom or ion
Salt bridge	provides a path for the FLOW OF IONS between the half-cells

Assigning Oxidation Numbers

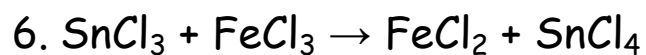
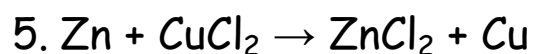
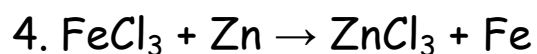
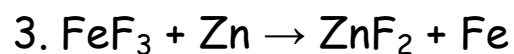
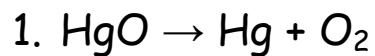
Assign Oxidation #'s to each element in the following compounds.

1. HCl	13. KMnO_4	25. MnO_4^-
2. KNO_3	14. Na	26. NH_4^+
3. Mg_3N_2	15. NH_3	27. SO_4^{2-}
4. KCl	16. SO_3	28. HSO_4^-
5. Fe_2O_3	17. MnO_2	29. $\text{Cr}_2\text{O}_7^{2-}$
6. S_8	18. FeO	30. PO_4^{3-}
7. PbO_2	19. $\text{Al}(\text{NO}_3)_3$	31. OH-
8. PbO	20. CuNO_3	32. MgH_2
9. NaHSO_4	21. CuSO_4	33. NaH
10. H_2SO_3	22. ClO^-	34. H_2O_2
11. H_2SO_3	23. ClO^{2-}	35. OF_2
12. BaO	24. ClO^{3-}	36. LiH

Redox Reactions

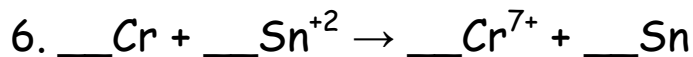
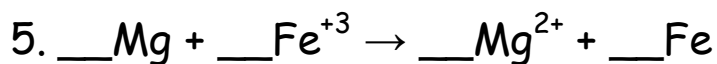
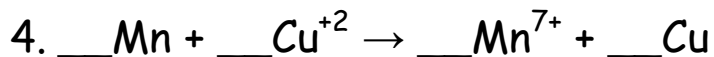
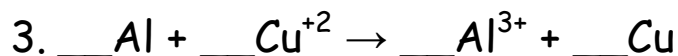
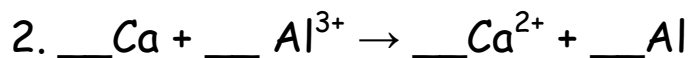
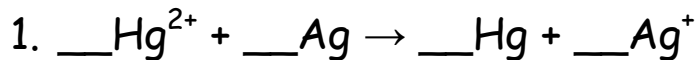
- Assign Oxidation Numbers
- Identify Red-Ox W/ Brackets & e⁻s lost / gained
- Write/Balance Half Reactions

(Hint: Think Reverse Criss-Cross method if you don't have an oxidation number rule)



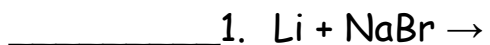
Balancing Half Reactions

- Identify Red-Ox W/ Brackets & e⁻s lost / gained
- Write/Balance Half Reactions



Single Replacement Reactions

- Complete Single Replacement Reaction (If Possible)
- Indicate Spontaneous or Non-Spontaneous
- Write Balanced Half Reactions



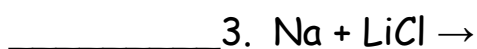
Oxidation Half Reaction: (Balanced) _____

Reduction Half Reaction: (Balanced) _____



Oxidation Half Reaction: (Balanced) _____

Reduction Half Reaction: (Balanced) _____



Oxidation Half Reaction: (Balanced) _____

Reduction Half Reaction: (Balanced) _____



Oxidation Half Reaction: (Balanced) _____

Reduction Half Reaction: (Balanced) _____



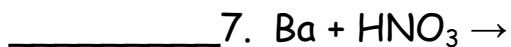
Oxidation Half Reaction: (Balanced) _____

Reduction Half Reaction: (Balanced) _____



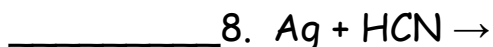
Oxidation Half Reaction: (Balanced) _____

Reduction Half Reaction: (Balanced) _____



Oxidation Half Reaction: (Balanced) _____

Reduction Half Reaction: (Balanced) _____



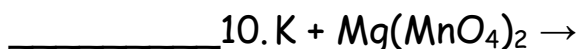
Oxidation Half Reaction: (Balanced) _____

Reduction Half Reaction: (Balanced) _____



Oxidation Half Reaction: (Balanced) _____

Reduction Half Reaction: (Balanced) _____



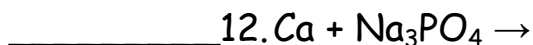
Oxidation Half Reaction: (Balanced) _____

Reduction Half Reaction: (Balanced) _____



Oxidation Half Reaction: (Balanced) _____

Reduction Half Reaction: (Balanced) _____



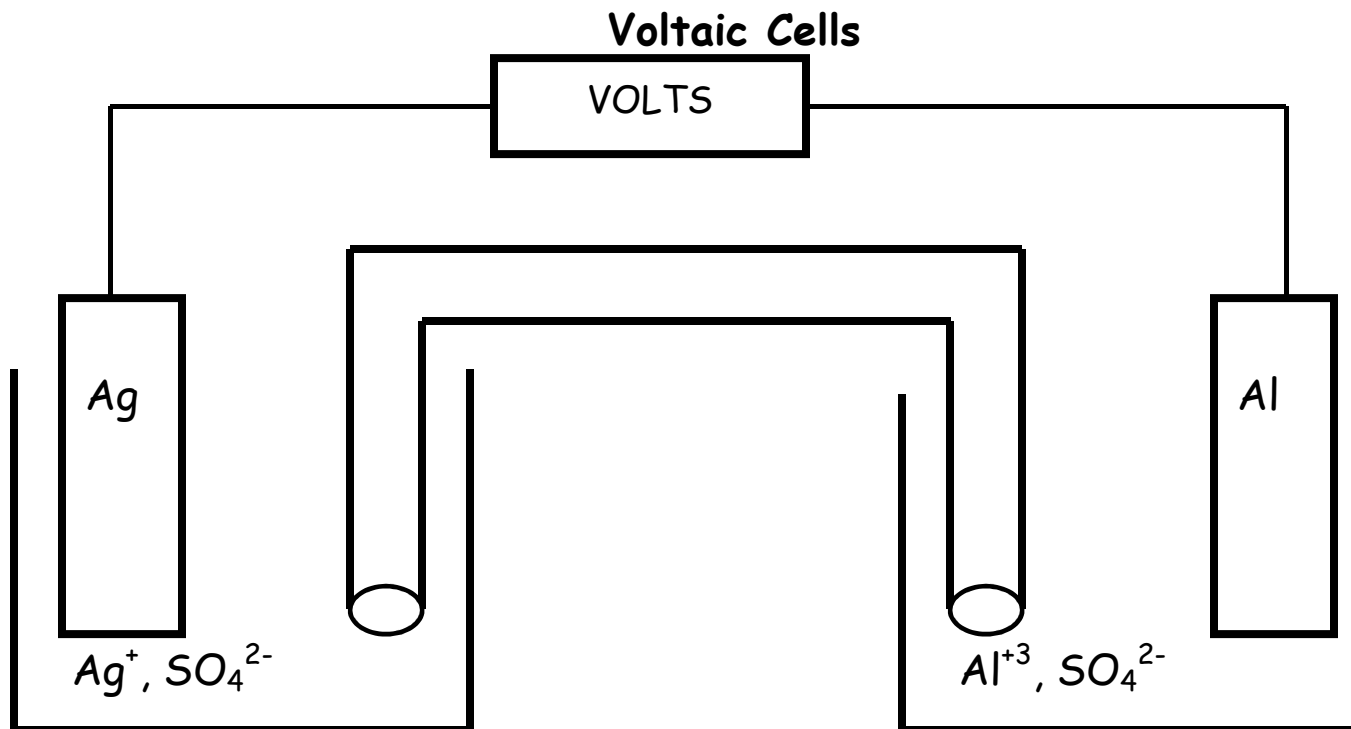
Oxidation Half Reaction: (Balanced) _____

Reduction Half Reaction: (Balanced) _____

Activity Series

1. Which ion is most easily reduced?
 A) Ca^{2+} B) Mg^{2+}
 C) Zn^{2+} D) Co^{2+}
2. Which element in Period 3 of the Periodic Table is the strongest reducing agent?
 A) Na B) S C) Cl D) Al
3. Which of the following elements is the poorest reducing agent?
 A) Al B) Zn C) Ba D) H_2
4. Which metal will spontaneously react with Zn^{2+} (aq), but will *not* spontaneously react with Mg^{2+} (aq)?
 A) Ni(s) B) Ba(s)
 C) Mn(s) D) Cu(s)
5. Which reaction occurs spontaneously?
 A) $\text{Cl}_2(\text{g}) + 2\text{NaBr}(\text{aq}) \rightarrow \text{Br}_2(\ell) + 2\text{NaCl}(\text{aq})$
 B) $\text{I}_2(\text{s}) + 2\text{NaF}(\text{aq}) \rightarrow \text{F}_2(\text{g}) + 2\text{NaI}(\text{aq})$
 C) $\text{I}_2(\text{s}) + 2\text{NaBr}(\text{aq}) \rightarrow \text{Br}_2(\ell) + 2\text{NaI}(\text{aq})$
 D) $\text{Cl}_2(\text{g}) + 2\text{NaF}(\text{aq}) \rightarrow \text{F}_2(\text{g}) + 2\text{NaCl}(\text{aq})$
6. Which metal reacts spontaneously with a solution containing zinc ions?
 A) copper B) nickel
 C) silver D) magnesium
7. According to Reference Table J, which of these metals will react most readily with 1.0 M HCl to produce $\text{H}_2(\text{g})$?
 A) K B) Ca C) Zn D) Mg
8. Which metal can replace Cr in Cr_2O_3 ?
 A) nickel B) copper
 C) aluminum D) lead
9. According to Reference Table J, which of these ions is most easily reduced?
 A) Ca^{2+} B) Cu^+ C) Ag^+ D) Cr^{3+}
10. Based on Reference Table J, which metal will react spontaneously with Al^{3+} ?
 A) Ca(s) B) Cu(s)
 C) Cr(s) D) Co(s)
11. Under standard conditions, which metal will react with 0.1 M HCl to liberate hydrogen gas?
 A) Mg B) Ag C) Cu D) Au
12. Referring to Reference Table J, which reaction will not occur under standard conditions?
 A) $\text{Cu}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CuCl}_2(\text{aq}) + \text{H}_2(\text{g})$
 B) $\text{Ba}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{BaCl}_2(\text{aq}) + \text{H}_2(\text{g})$
 C) $\text{Mg}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{MgCl}_2(\text{aq}) + \text{H}_2(\text{g})$
 D) $\text{Sn}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{SnCl}_2(\text{aq}) + \text{H}_2(\text{g})$
13. According to the Activity Series, which metal will react spontaneously with hydrochloric acid?
 A) Ag B) Cu C) Ni D) Hg
14. According to Reference Table J, which redox reaction occurs spontaneously?
 A) $2\text{Ag}(\text{s}) + 2\text{H}^+ \rightarrow 2\text{Ag} + \text{H}_2(\text{g})$
 B) $2\text{Ag}(\text{s}) + 2\text{H}^+ \rightarrow 2\text{Ag}^{2+} + \text{H}_2(\text{g})$
 C) $\text{Cu}(\text{s}) + 2\text{H}^+ \rightarrow \text{Cu}^{2+} + \text{H}_2(\text{g})$
 D) $\text{Mg}(\text{s}) + 2\text{H}^+ \rightarrow \text{Mg}^{2+} + \text{H}_2(\text{g})$
15. Based on Reference Table J, which of the following elements will replace Pb from $\text{Pb}(\text{NO}_3)_2(\text{aq})$?
 A) Au(s) B) Mg(s)
 C) Ag(s) D) Cu(s)
16. Due to it having a low activity, which element can be found in nature in the free (uncombined) state?
 A) Ba B) Al C) Ca D) Au
17. According to Reference Table J, which reaction will take place spontaneously?
 A) $\text{Au}^{3+} + \text{Al}(\text{s}) \rightarrow \text{Au}(\text{s}) + \text{Al}^{3+}$
 B) $\text{Fe}^{2+} + \text{Cu}(\text{s}) \rightarrow \text{Fe}(\text{s}) + \text{Cu}^{2+}$
 C) $\text{Ni}^{2+} + \text{Pb}(\text{s}) \rightarrow \text{Ni}(\text{s}) + \text{Pb}^{2+}$
 D) $\text{Sr}^{2+} + \text{Sn}(\text{s}) \rightarrow \text{Sr}(\text{s}) + \text{Sn}^{2+}$
18. Based on Reference Table J, which molecule-ion pair will react spontaneously at 298 K?
 A) $\text{Br}_2 + \text{Cl}^-$ B) $\text{F}_2 + \text{I}^-$
 C) $\text{I}_2 + \text{Br}^-$ D) $\text{Cl}_2 + \text{F}^-$

19. According to Reference Table J, which pair will react spontaneously at 298K?
- A) $\text{Cu} + \text{H}_2\text{O}$ B) $\text{Au} + \text{H}_2\text{O}$
C) $\text{Ca} + \text{H}_2\text{O}$ D) $\text{Ag} + \text{H}_2\text{O}$
20. Based on Reference Table J, which reaction will take place spontaneously?
- A) $\text{Ba}(\text{s}) + 2 \text{Na}^+(\text{aq}) \rightarrow \text{Ba}^{2+}(\text{aq}) + 2 \text{Na}(\text{s})$
B) $\text{Mg}(\text{s}) + \text{Ca}^{2+}(\text{aq}) \rightarrow \text{Mg}^{2+}(\text{aq}) + \text{Ca}(\text{s})$
C) $\text{I}_2(\text{g}) + 2 \text{Br}^-(\text{aq}) \rightarrow 2 \text{I}^-(\text{aq}) + \text{Br}_2(\text{g})$
D) $\text{Cl}_2(\text{g}) + 2 \text{F}^-(\text{aq}) \rightarrow 2 \text{Cl}^-(\text{aq}) + \text{F}_2(\text{g})$
21. According to Reference Table J, which atom-ion pair will react spontaneously?
- A) $\text{Zn} + \text{Ca}^{2+}$ B) $\text{Ag} + \text{Au}^{3+}$
C) $\text{Pb} + \text{Co}^{2+}$ D) $\text{Ni} + \text{Al}^{3+}$
22. According to Reference Table J, which species is the strongest oxidizing agent?
- A) $\text{F}_2(\text{g})$ B) Li^+
C) F^- D) $\text{Li}(\text{s})$
23. Based on Reference Table J, which metal will *not* react with 1 M HCl?
- A) $\text{Zn}(\text{s})$ B) $\text{Au}(\text{s})$
C) $\text{Ni}(\text{s})$ D) $\text{Sn}(\text{s})$
24. Based on Reference Table J, which of the following ions in aqueous solution is most easily oxidized?
- A) Br^- B) I^- C) F^- D) Cl^-
25. According to Reference Table J, which species can reduce Cr^{3+} ions?
- A) Al B) Fe^{2+} C) Ni D) Sn^{2+}
26. According to reference Table J, which reaction will occur spontaneously?
- A) $\text{Ag}^+ + \text{Cu}(\text{s}) \rightarrow \text{Ag}(\text{s}) + \text{Cu}^+$
B) $\text{Fe}^{2+} + \text{Hg}(\text{e}) \rightarrow \text{Fe}(\text{s}) + \text{Hg}^{2+}$
C) $\text{Co}^{2+} + \text{Cu}(\text{s}) \rightarrow \text{Co}(\text{s}) + \text{Cu}^{2+}$
D) $\text{Mg}^{2+} + \text{Sn}^{2+} \rightarrow \text{Mg}(\text{s}) + \text{Sn}^{4+}$
27. According to Reference Table J, which ion is most easily reduced?
- A) Ni^{2+} B) Au^{3+}
C) Mg^{2+} D) Al^{3+}
28. According to Reference Table J, which metal will react spontaneously with H^+ ?
- A) Cr B) Au C) Cu D) Ag
29. Lead is a product of the reaction between a solution of lead (II) nitrate and
- A) Cu B) Fe C) Au D) Ag
30. Based on Reference Table J, which oxidation is most likely to occur?
- A) $\text{Au} \rightarrow \text{Au}^{3+} + 3\text{e}^-$
B) $\text{Ag} \rightarrow \text{Ag}^{1+} + 1\text{e}^-$
C) $\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^-$
D) $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$
31. According to Reference Table J, which ion will oxidize Fe?
- A) Ca^{2+} B) Mg^{2+}
C) Zn^{2+} D) Cu^{2+}
32. Based on Reference Table J, which of the following elements is the most actively oxidized?
- A) Sr B) Cr C) Fe D) Cu
33. The half-reaction
- $$2 \text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$$
- will occur when $\text{H}^+(\text{aq})$ reacts with
- A) $\text{Hg}(\ell)$ B) $\text{Ag}(\text{s})$
C) $\text{Cu}(\text{s})$ D) $\text{Pb}(\text{s})$
34. Based on Reference Table J, which reaction will take place spontaneously?
- A) $2 \text{Au} + 6 \text{H}^+ \rightarrow 2 \text{Au}^{3+} + 3 \text{H}_2$
B) $\text{Cu} + 2 \text{H}^+ \rightarrow \text{Cu}^{2+} + \text{H}_2$
C) $\text{Pb} + 2 \text{H}^+ \rightarrow \text{Pb}^{2+} + \text{H}_2$
D) $2 \text{Ag} + 2 \text{H}^+ \rightarrow 2 \text{Ag}^+ + \text{H}_2$
35. According to Reference Table J, which halogen will react spontaneously with $\text{Au}(\text{s})$ to produce Au^{3+} ?
- A) F_2 B) I_2 C) Cl_2 D) Br_2



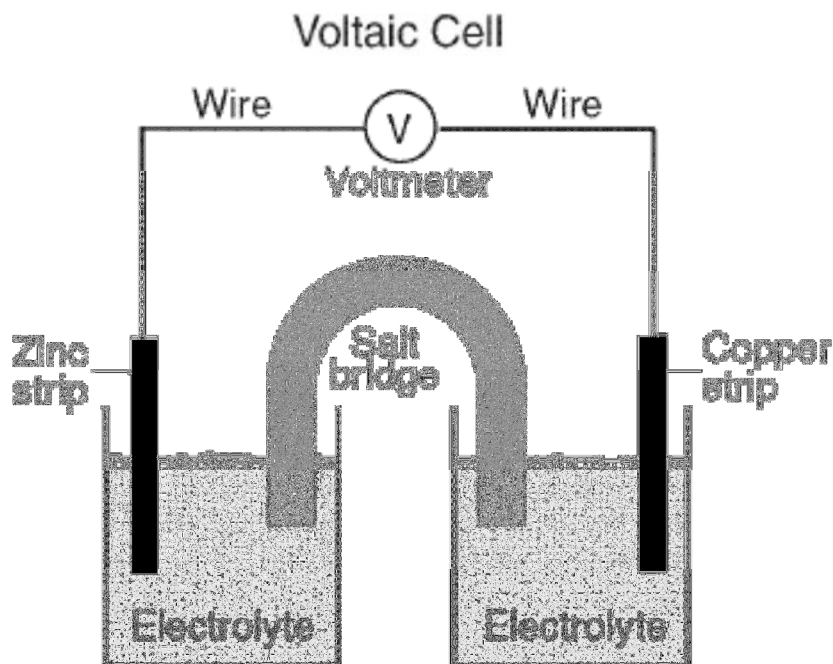
1. What is the purpose of the salt bridge? _____
2. What is the purpose of the wire? _____
3. Which way do electrons flow in the cell? _____
4. Which electrode is the cathode? _____
5. Which electrode is the anode? _____
6. Which electrode gains mass? _____
7. Which electrode lost mass? _____

- Write the **balanced half reactions** for the cathode and anode:
- Include **ALL Phases**

Reduction: _____

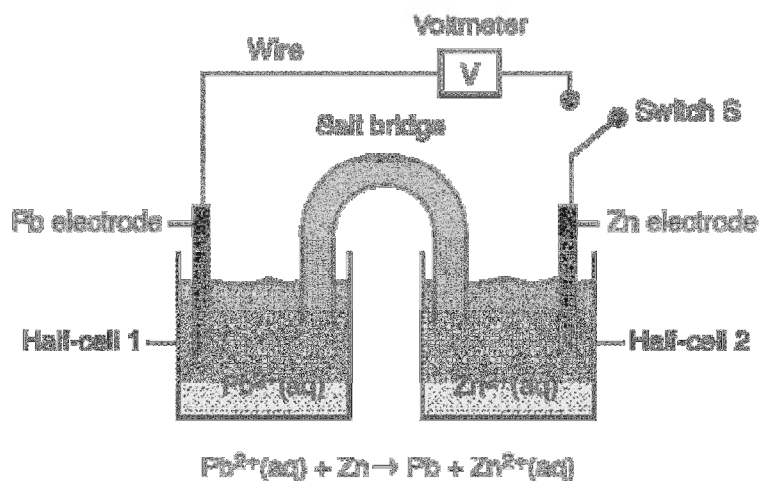
Oxidation: _____

Base your answers to questions 4 through 6 on the diagram of a voltaic cell provided below.



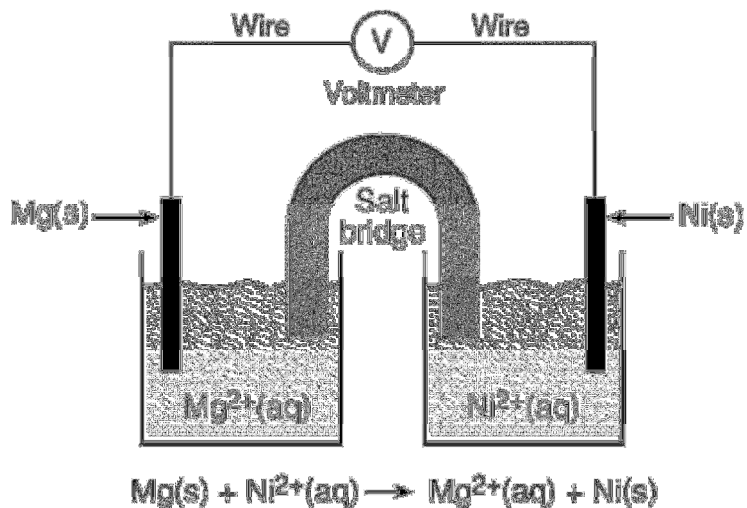
4. Indicate with one or more arrows the direction of electron flow through the wire.
5. Write an equation for the half-reaction that occurs at the zinc electrode.
6. Explain the function of the salt bridge.

Base your answers to questions 7 through 9 on the diagram below, which represents a voltaic cell at 298 K and 1 atm.



7. In which half-cell will oxidation occur when switch *S* is closed?
8. Write the balanced half-reaction equation that will occur in half-cell 1 when switch *S* is closed.
9. Describe the direction of electron flow between the electrodes when switch *S* is closed.

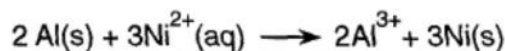
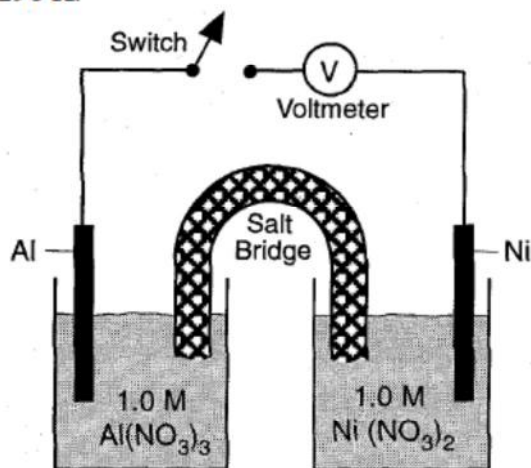
Base your answers to questions 10 and 11 on the diagram of a voltaic cell and the balanced ionic equation below.



10. What is the total number of moles of electrons needed to completely reduce 6.0 moles of Ni²⁺(aq) ions?
11. Explain the function of the salt bridge in the voltaic cell.

Voltaic Cells MC

- Which component of an electrochemical cell is correctly paired with its function?
 - salt bridge – allows the solutions to mix
 - external conductor – permits the migration of ions
 - external conductor – allows the solutions to mix
 - salt bridge – permits the migration of ions
- Discharging a battery involves the process of
 - redox reactions that produce electricity
 - hydrolysis reactions that produce energy
 - hydrolysis reactions that require energy
 - redox reactions that require electricity
- The diagram below represents a chemical cell at 298 K.

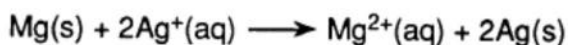
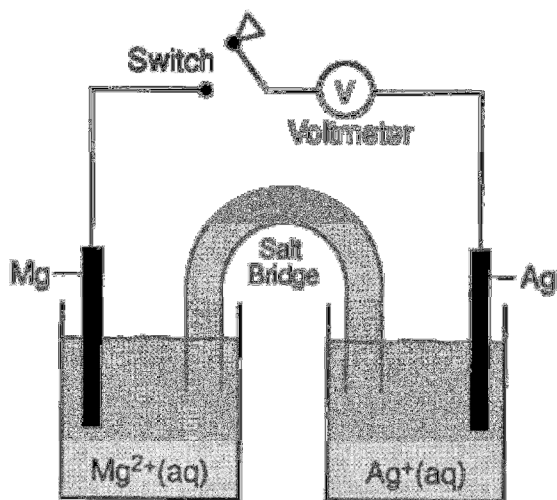


When the switch is closed, electrons flow from

- Al(s) to Ni(s)
 - Ni(s) to Al(s)
 - $\text{Ni}^{2+}(\text{aq})$ to $\text{Al}^{3+}(\text{aq})$
 - $\text{Al}^{3+}(\text{aq})$ to $\text{Ni}^{2+}(\text{aq})$
- Reduction occurs at the cathode in
 - electrolytic cells, only
 - both electrolytic cells and voltaic cells
 - neither electrolytic cells nor voltaic cells
 - voltaic cells, only

- $\text{Zn}^0 - 2e^- \rightarrow \text{Zn}^{2+}$
 - $\text{Zn}^{2+} + 2e^- \rightarrow \text{Zn}^0$
 - $\text{Cu}^0 - 2e^- \rightarrow \text{Cu}^{2+}$
 - $\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}^0$
- A standard zinc half-cell is connected to a standard copper half cell by means of a wire and a salt bridge. Which electronic equation represents the oxidation reaction that takes place?
 - electroplating
 - electrolytic
 - electromagnetic
 - electrochemical
 - The redox reaction in a battery during discharge can best be described as
 - non-spontaneous and occurring in an electrolytic cell
 - non-spontaneous and occurring in a chemical cell
 - spontaneous and occurring in a chemical cell
 - spontaneous and occurring in an electrolytic cell
 - The type of reaction in an electrochemical cell is best described as a
 - non-spontaneous oxidation reaction, only
 - spontaneous oxidation reaction, only
 - spontaneous oxidation-reduction reaction
 - non-spontaneous oxidation-reduction reaction
 - Which substance functions as the electrolyte in an automobile battery?
 - PbO_2
 - H_2O
 - PbSO_4
 - H_2SO_4
 - What is the voltage for a chemical cell that has reached equilibrium?
 - 1.00 V
 - greater than 1.00 V
 - greater than 0.00 V and less than 1.00 V
 - 0.00 V

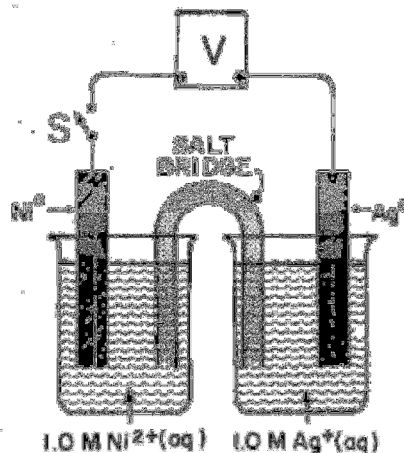
Base your answers to questions 11 and 12 on the equation and diagram below represent an electrochemical cell at 298 K and 1 atmosphere.



11. When the switch is closed, electrons flow from
 - A) $\text{Mg}^{2+}(\text{aq})$ to $\text{Ag}^+(\text{aq})$
 - B) $\text{Ag}^+(\text{aq})$ to $\text{Mg}^{2+}(\text{aq})$
 - C) Mg(s) to Ag(s)
 - D) Ag(s) to Mg(s)
12. Which species is oxidized when the switch is closed?

A) $\text{Mg}^{2+}(\text{aq})$	B) $\text{Ag}^+(\text{aq})$
C) Mg(s)	D) Ag(s)
13. Which energy change occurs in an operating voltaic cell?
 - A) electrical to chemical
 - B) chemical to electrical
 - C) nuclear to chemical
 - D) chemical to nuclear
14. Which statement best describes how a salt bridge maintains electrical neutrality in the half-cells of an electrochemical cell?
 - A) It prevents the reaction from occurring spontaneously.
 - B) It prevents the migration of electrons.
 - C) It permits the two solutions to mix completely.
 - D) It permits the migration of ions.

15. Base your answer to the following question on the diagram of the chemical cell at 298 K and on the equation below.



In the given reaction, the Ag^+ ions

- | | |
|-----------------|-------------------|
| A) gain protons | B) lose electrons |
| C) lose protons | D) gain electrons |
16. A voltaic cell differs from an electrolytic cell in that in a voltaic cell
 - A) neither oxidation nor reduction occurs
 - B) energy is produced when the reaction occurs
 - C) energy is required for the reaction to occur
 - D) both oxidation and reduction occur
 17. A student collects the materials and equipment below to construct a voltaic cell:
 - two 250-mL beakers
 - wire and a switch
 - one strip of magnesium
 - one strip of copper
 - 125 mL of 0.20 M $\text{Mg}(\text{NO}_3)_2(\text{aq})$
 - 125 mL of 0.20 M $\text{Cu}(\text{NO}_3)_2(\text{aq})$
 Which additional item is required for the construction of the voltaic cell?

A) a battery	B) a salt bridge
C) a cathode	D) an anode
 18. When an electrochemical cell is operating, it is
 - A) undergoing oxidation, only
 - B) undergoing reduction, only
 - C) approaching equilibrium
 - D) using external energy

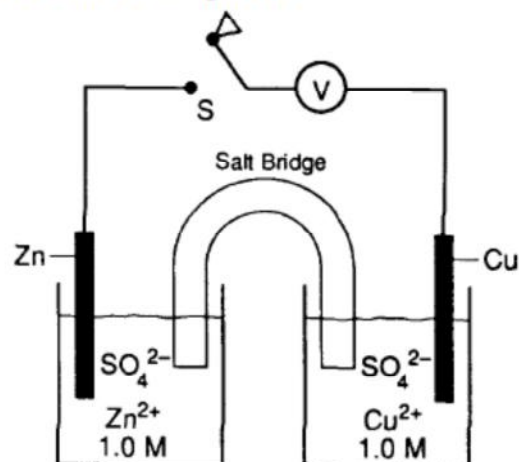
19. In a chemical cell composed of two half-cells, ions are allowed to flow from one half-cell to another by means of
- an external conductor
 - a salt bridge
 - a voltmeter
 - electrodes
20. What kind of reaction occurs during the operation of a nickel-cadmium battery?
- a non-spontaneous redox reaction
 - a spontaneous redox reaction
 - a reduction reaction, only
 - an oxidation reaction, only
21. Given the redox reaction in an electrochemical cell:



A salt bridge is used to connect

- Ni(s) and Pb(s)
 - $\text{Pb}^{2+}(\text{aq})$ and $\text{Ni}^{2+}(\text{aq})$
 - $\text{Pb}^{2+}(\text{aq})$ and Pb(s)
 - Ni(s) and $\text{Ni}^{2+}(\text{aq})$
22. In a chemical cell, electrical energy will be produced when
- only oxidation occurs
 - only reduction occurs
 - both oxidation and reduction occur
 - neither oxidation nor reduction occurs

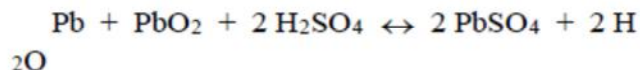
23. Base your answer to the following question on the diagram below which represents a chemical cell at 298 K and 1 atmosphere.



Which species represents the cathode?

- Cu^{2+}
 - Zn
 - Zn^{2+}
 - Cu
24. Given the nickel oxide-cadmium reaction:
- $$2 \text{NiO}(\text{OH})_3 + \text{Cd} + 2 \text{H}_2\text{O} \rightarrow 2 \text{Ni}(\text{OH})_2 + \text{Cd}(\text{OH})_2$$
- During discharge, the Cd electrode
- is oxidized
 - gains mass
 - is reduced
 - gains electrons
25. A chemical cell differs from an electrolytic cell because in a chemical cell there is
- a positive and negative electrode
 - an electric current that causes a redox reaction
 - an anode and a cathode
 - a redox reaction that produces an electric current
26. Which statement is true for any electrochemical cell?
- Reduction occurs at both the anode and the cathode.
 - Oxidation occurs at the anode, only.
 - Reduction occurs at the anode, only.
 - Oxidation occurs at both the anode and the cathode.

27. What occurs during discharge in the lead-acid battery reaction below?



- A) Both Pb and Pb⁴⁺ undergo oxidation.
- B) Both Pb and Pb⁴⁺ undergo reduction.
- C) Pb is oxidized and Pb⁴⁺ is reduced.
- D) Neither the Pb nor the Pb⁴⁺ is oxidized or reduced.

28. Which half-reaction can occur at the anode in a voltaic cell?

- A) Ni²⁺ + 2e⁻ → Ni
- B) Zn → Zn²⁺ + 2e⁻
- C) Fe³⁺ → Fe²⁺ + e⁻
- D) Sn + 2e⁻ → Sn²⁺

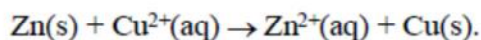
29. Given the overall cell reaction:



Which will occur as the cell operates?

- A) The concentration of Zn²⁺(aq) will increase.
- B) The amount of Zn(s) will increase.
- C) The amount of Ag(s) will decrease.
- D) The concentration of Ag⁺(aq) will increase.

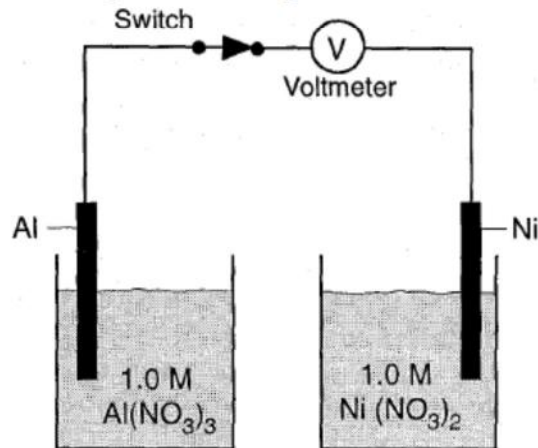
30. The overall reaction in a electrochemical cell is



As the reaction in this cell takes place, the

- A) mass of the Cu(s) electrode decreases
- B) mass of the Zn(s) electrode decreases
- C) Zn²⁺(aq) concentration remains the same
- D) Cu²⁺(aq) concentration remains the same

31. The diagram below represents a chemical cell.



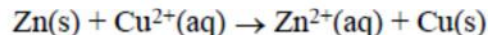
In order for the cell to operate, it should be provided with

- A) a salt bridge
- B) an external path for electrons
- C) an anode
- D) a cathode

32. Where does oxidation occur in an electrochemical cell?

- A) at the anode in both an electrolytic cell and a voltaic cell
- B) at the anode in an electrolytic cell and at the cathode in a voltaic cell
- C) at the cathode in both an electrolytic cell and a voltaic cell
- D) at the cathode in an electrolytic cell and at the anode in a voltaic cell

33. Given the balanced ionic equation representing the reaction in an operating voltaic cell:

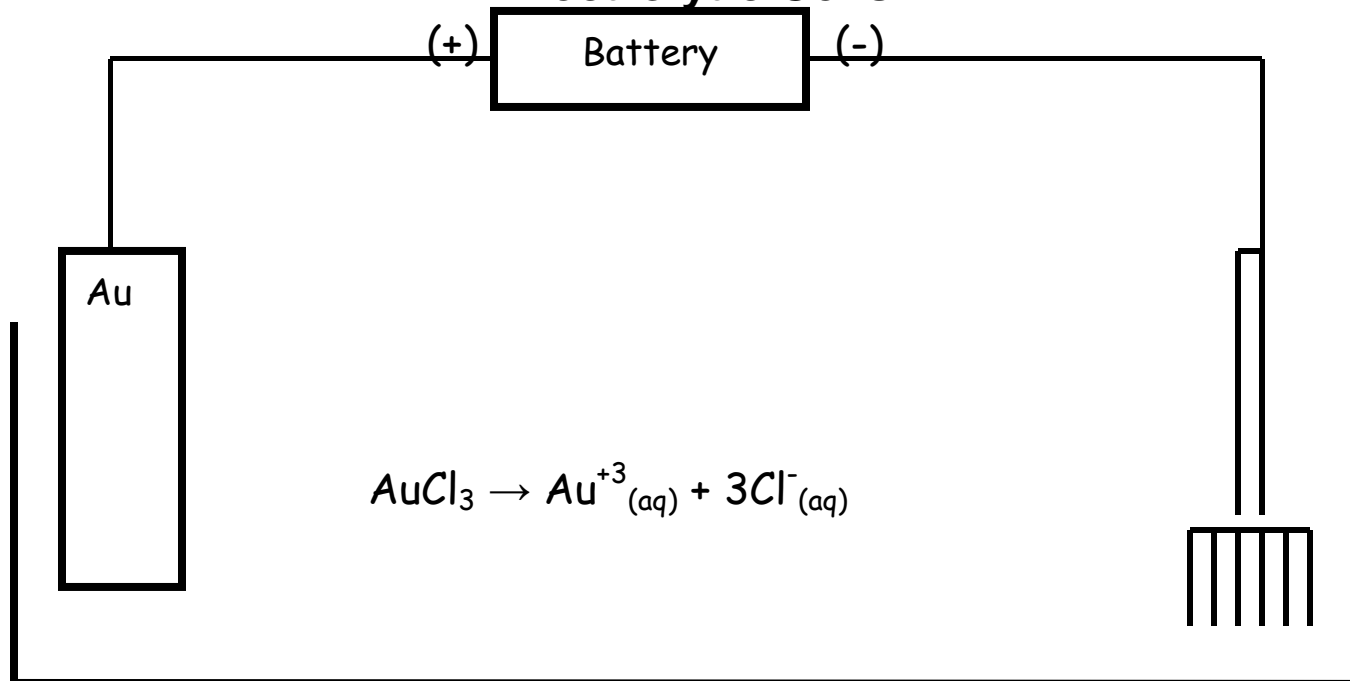


The flow of electrons through the external circuit in this cell is from the

- A) Cu cathode to the Zn anode
- B) Cu anode to the Zn cathode
- C) Zn anode to the Cu cathode
- D) Zn cathode to the Cu anode

34. A chemical cell differs from an electrolytic cell in that the chemical cell uses
- A) an applied electric current
 - B) half-reactions
 - C) a redox reaction to produce electricity
 - D) a solution of ions
35. Which statement describes where the oxidation and reduction half-reactions occur in an operating electrochemical cell?
- A) Oxidation occurs at the anode, and reduction occurs at the cathode.
 - B) Oxidation and reduction both occur at the anode.
 - C) Oxidation occurs at the cathode, and reduction occurs at the anode.
 - D) Oxidation and reduction both occur at the cathode.

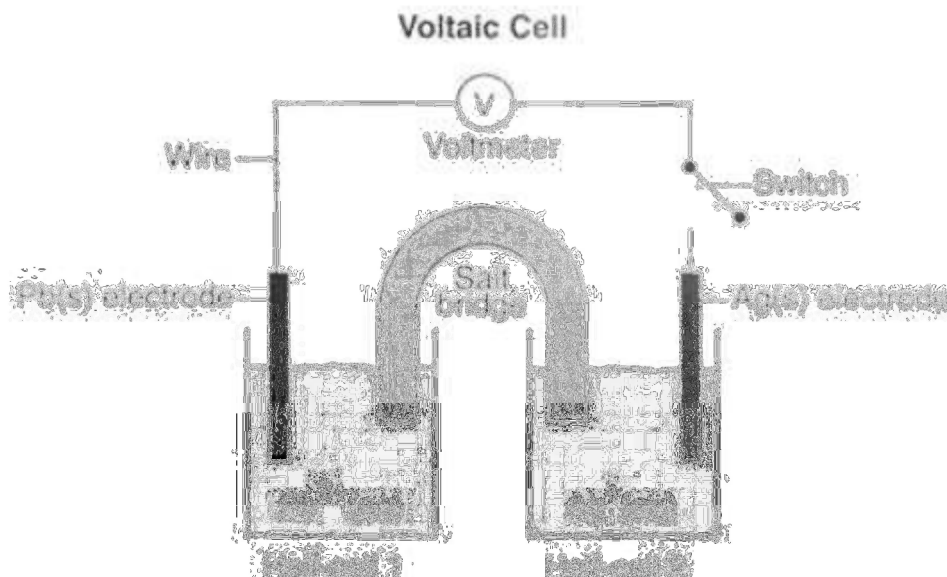
Electrolytic Cells



1. What is the name for the electrode connected to the fork? _____
 2. What is the name for the silver electrode? _____
 3. What is the charge of the terminal the fork is connected to? _____
 4. Which electrode gains mass? _____
 5. Which electrode lost mass? _____
- Write the **balanced half reactions** for the cathode and anode:
 - Include **ALL Phases**

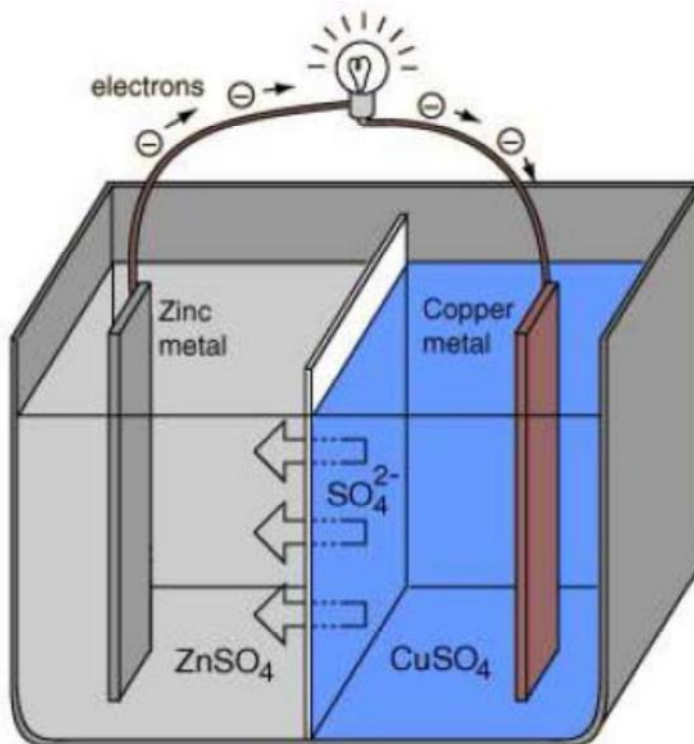
Reduction: _____

Oxidation: _____



Based on Figure 1:

- 1. Write the oxidation half-reaction for this cell.**
- 2. Write the reduction half reaction for this cell.**
- 3. Write the balanced equation that can be derived from the half reactions.**
- 4. If 1 mole of Ag reacts, how many moles of electrons will be transferred?**
- 5. Of the substances Ag, Ag⁺, Pb, Pb₂₊, which are used up as the cell is used?**
- 6. Which of the substances referred to in question 5 increases in mass as the cell is used?**



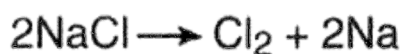
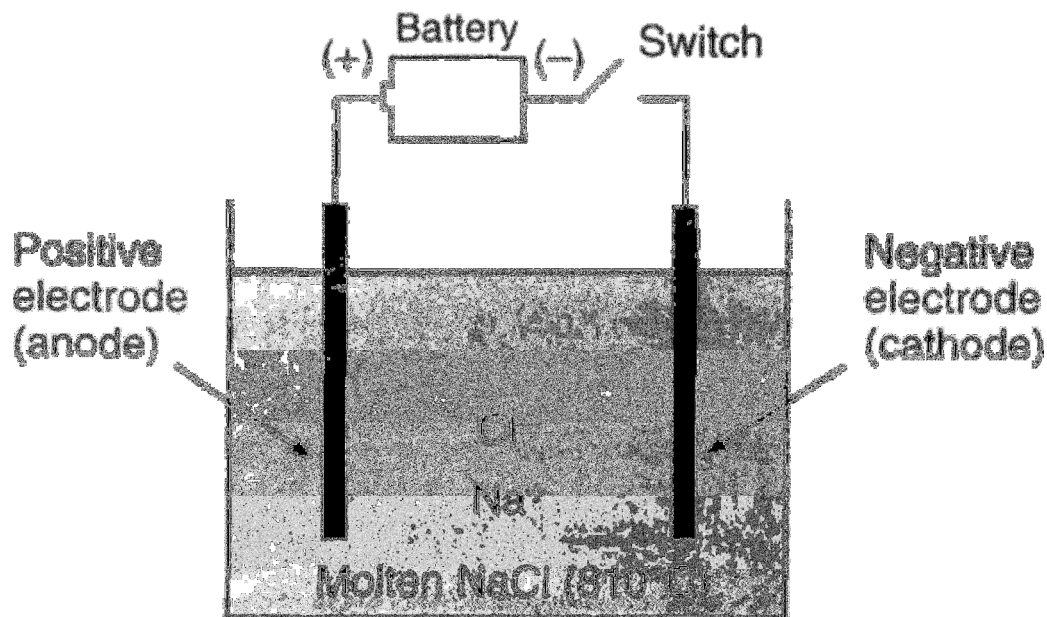
Based on Figure 2:

7. Write the half-reaction at the copper electrode.

8. Write the half-reaction at the zinc electrode.

9. If 2 moles of Zn react, how many moles of electrons are transferred?

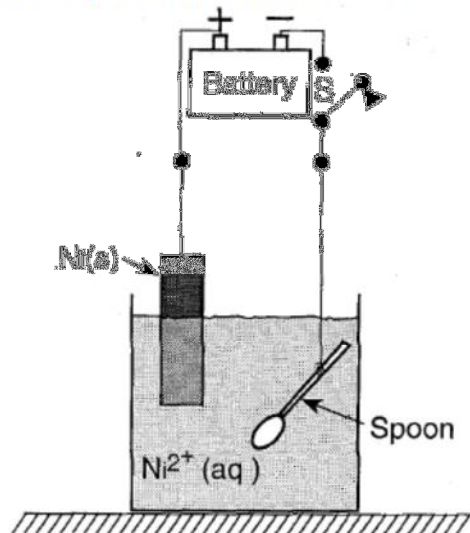
Base your answers to questions 1 through 3 on the diagram and balanced equation below, which represent the electrolysis of molten NaCl.



1. Write the balanced half-reaction for the reduction that occurs in this electrolytic cell.
2. When the switch is closed, which electrode will attract the sodium ions?
3. What is the purpose of the battery in this electrolytic cell?

Electrolytic Cell Questions

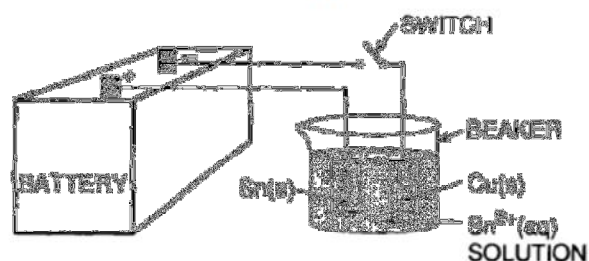
1. The diagram below shows a spoon that will be electroplated with nickel metal.



What will occur when switch S is closed?

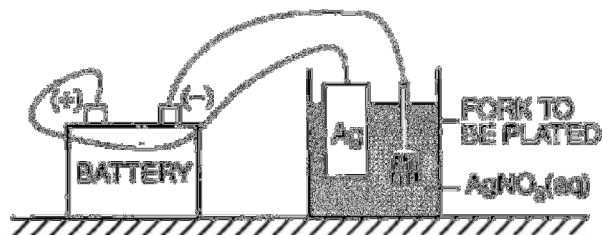
- A) The spoon will lose mass, and the Ni(s) will be reduced.
 B) The spoon will gain mass, and the Ni(s) will be oxidized.
 C) The spoon will gain mass, and the Ni(s) will be reduced.
 D) The spoon will lose mass, and the Ni(s) will be oxidized.
2. A metal object is to be electroplated with silver. Which set of electrodes should be used?
- A) a silver anode and a metal object as the cathode
 B) a silver cathode and a metal object as the anode
 C) a platinum anode and a metal object as the cathode
 D) a platinum cathode and a metal object as the anode

Base your answers to questions 3 and 4 on the diagram below of an electrolytic cell in which the electrodes are tin and copper.



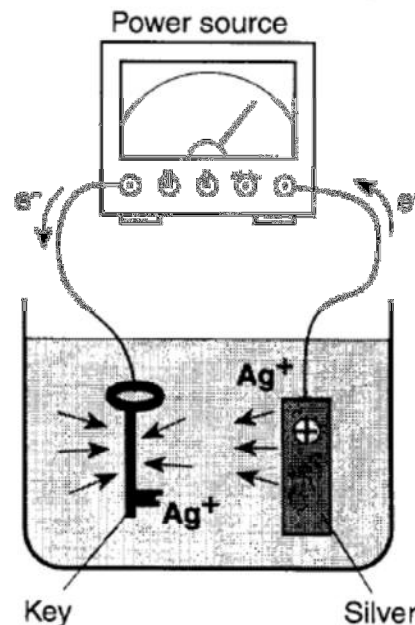
3. When the switch is closed, what will happen to the two electrodes?
- A) *A* will dissolve and *B* will become coated with copper.
 B) *B* will dissolve and *A* will become coated with copper.
 C) *A* will dissolve and *B* will become coated with tin.
 D) *B* will dissolve and *A* will become coated with tin.
4. In this electrolytic cell, electrode *A* is designated as the
- A) anode and is negative
 B) anode and is positive
 C) cathode and is positive
 D) cathode and is negative

Base your answers to questions 5 and 6 on the diagram below which represents the electroplating of a metal fork with Ag(s).



5. Which part of the electroplating system is provided by the fork?
- the cathode, which is the positive electrode
 - the cathode, which is the negative electrode
 - the anode, which is the negative electrode
 - the anode, which is the positive electrode
6. Which equation represents the half-reaction that takes place at the fork?
- $\text{AgNO}_3 \rightarrow \text{Ag}^+ + \text{NO}_3^-$
 - $\text{Ag(s)} \rightarrow \text{Ag}^+ + \text{e}^-$
 - $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag(s)}$
 - $\text{Ag}^+ + \text{NO}_3^- \rightarrow \text{AgNO}_3$
7. In an electrolytic cell, the positive electrode is the
- anode, where oxidation occurs
 - cathode, where reduction occurs
 - anode, where reduction occurs
 - cathode, where oxidation occurs

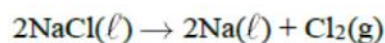
8. Which statement best describes the key?



- It acts as the anode and is positive.
 - It acts as the cathode and is negative.
 - It acts as the cathode and is positive.
 - It acts as the anode and is negative.
9. Metals from which groups are obtained by the reduction of their fused salts?
- Group 11 and Group 12
 - Group 1 and Group 2
 - Group 1 and Group 12
 - Group 2 and Group 11
10. Which statement describes one characteristic of an operating electrolytic cell?
- It produces electrical energy.
 - It requires an external energy source.
 - It undergoes a spontaneous redox reaction.
 - It uses radioactive nuclides.
11. Which energy conversion occurs in an operating electrolytic cell?
- electrical energy to chemical energy
 - nuclear energy to thermal energy
 - chemical energy to electrical energy
 - thermal energy to nuclear energy

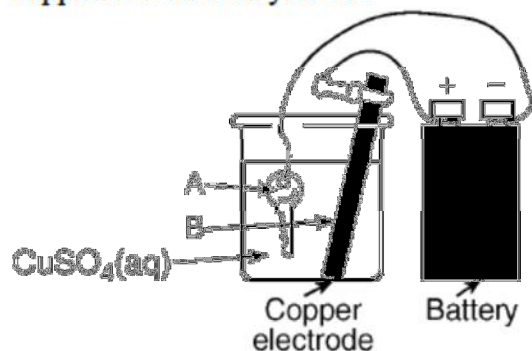
12. Which metals are obtained by electrolysis of their fused salts?
- A) K and Ca B) Cu and Zn
C) Cu and Hg D) K and Cr
13. What occurs when an electrolytic cell is used for silver-plating a spoon?
- A) A reduction reaction takes place at the anode.
B) A chemical reaction produces an electric current.
C) An electric current produces a chemical reaction.
D) An oxidation reaction takes place at the cathode.
14. Which reaction occurs at the cathode in an electrochemical cell?
- A) reduction B) combustion
C) neutralization D) oxidation
15. In an electrolytic cell, which ion would migrate through the solution to the positive electrode?
- A) a chloride ion
B) a hydronium ion
C) an ammonium ion
D) a hydrogen ion
16. In an electrolytic cell, the negative electrode is called the
- A) cathode, at which oxidation occurs
B) anode, at which oxidation occurs
C) cathode, at which reduction occurs
D) anode, at which reduction occurs
17. If fused silver chloride is electrolyzed, the Ag^+ ions are
- A) reduced at the negative electrode
B) reduced at the positive electrode
C) oxidized at the negative electrode
D) oxidized at the positive electrode
18. Which process occurs at the anode in an electrochemical cell?
- A) the gain of electrons
B) the loss of electrons
C) the loss of protons
D) the gain of protons
19. Which half-reaction occurs at the negative electrode in an electrolytic cell in which an object is being plated with silver?
- A) $\text{Ag}^+ \rightarrow \text{Ag}^0 + 1e^-$
B) $\text{Ag}^+ + 1e^- \rightarrow \text{Ag}^0$
C) $\text{Ag}^0 + 1e^- \rightarrow \text{Ag}^+$
D) $\text{Ag}^0 \rightarrow \text{Ag}^+ + 1e^-$
20. Which atom forms an ion that would migrate toward the cathode in an electrolytic cell?
- A) Na B) Cl C) I D) F
21. Which statement describes the redox reaction that occurs when an object is electroplated?
- A) It is non-spontaneous and produces an electric current.
B) It is spontaneous and produces an electric current.
C) It is non-spontaneous and requires an electric current.
D) It is spontaneous and requires an electric current.
22. An electrolytic cell is different from an electrochemical cell because in an electrolytic cell
- A) an electric current is produced
B) a spontaneous reaction occurs
C) a redox reaction occurs
D) an electric current causes a chemical reaction
23. Which statement best describes the reaction represented by the equation below?
- $$2 \text{NaCl} + 2 \text{H}_2\text{O} + \text{electricity} \rightarrow \text{Cl}_2 + \text{H}_2 + 2 \text{NaOH}$$
- A) The reaction occurs in an electrolytic cell and absorbs energy.
B) The reaction occurs in an electrolytic cell and releases energy.
C) The reaction occurs in a chemical cell and absorbs energy.
D) The reaction occurs in a chemical cell and releases energy.

24. Given the balanced equation representing a reaction occurring in an electrolytic cell:

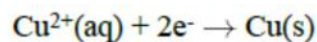


Where is $\text{Na}(\ell)$ produced in the cell?

- A) at the anode, where oxidation occurs
 B) at the anode, where reduction occurs
 C) at the cathode, where oxidation occurs
 D) at the cathode, where reduction occurs
25. In an electrolytic cell, a negative ion will migrate to and undergo oxidation at the
- A) anode, which is positively charged
 B) cathode, which is negatively charged
 C) cathode, which is positively charged
 D) anode, which is negatively charged
26. Which metal can be produced only by the electrolysis of its fused salt?
- A) Ag B) Pb C) K D) Zn
27. The diagram below shows a key being plated with copper in an electrolytic cell



Given the reduction reaction for this cell:



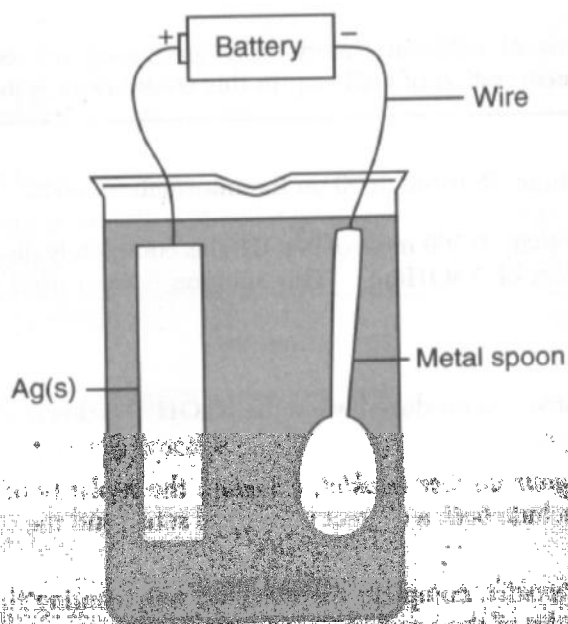
This reduction occurs at

- A) B, which is the anode
 B) A, which is the anode
 C) B, which is the cathode
 D) A, which is the cathode

Base your answers to questions 28 and 29 on the information below.

Electroplating is an electrolytic process used to coat metal objects with a more expensive and less reactive metal. The diagram below shows an electroplating cell that includes a battery connected to a silver bar and a metal spoon. The bar and spoon are submerged in $\text{AgNO}_3(\text{aq})$.

An Electroplating Cell

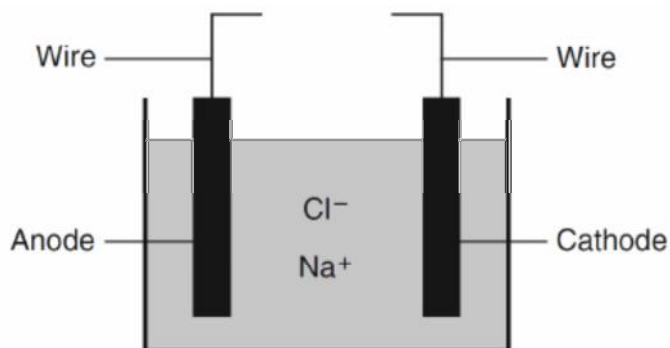


28. Explain why AgNO_3 is a better choice than AgCl for use in this electrolytic process.
29. Explain the purpose of the battery in this cell.
-

Base your answers to questions 30 through 32 on the information below.

Metallic elements are obtained from their ores by reduction. Some metals, such as zinc, lead, iron, and copper, can be obtained by heating their oxides with carbon.

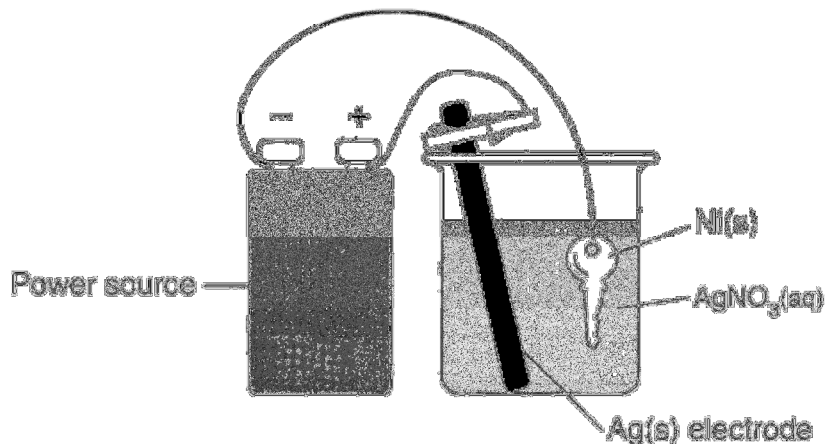
More active metals, such as aluminum, magnesium, and sodium, can not be reduced by carbon. These metals can be obtained by the electrolysis of their molten (melted) ores. The diagram below represents an incomplete cell for the electrolysis of molten NaCl. The equation below represents the reaction that occurs when the completed cell operates.



30. Identify *one* metal from the passage that is more active than carbon and *one metal from the passage that is less active than carbon*.
31. Identify the component required for the electrolysis of molten NaCl that is missing from the cell diagram.
32. Write a balanced half-reaction equation for the reduction of the iron ions in iron(III) oxide to iron atoms.

Base your answers to questions 33 through 35 on the information below.

The diagram below represents an operating electrolytic cell used to plate silver onto a nickel key. As the cell operates, oxidation occurs at the silver electrode and the mass of the silver electrode decreases.



33. Explain, in terms of Ag atoms and Ag⁺(aq) ions, why the mass of the silver electrode *decreases* as the cell operates.
34. State the purpose of the power source in the cell.
35. Identify the cathode in the cell.

Name: _____

Teacher: Mr. Roderick

Unit 8 Pretest MC

- What is the oxidation number of oxygen in HSO_4^- ?
 - +1
 - 2
 - +6
 - 4
- Which half-reaction correctly represents a reduction reaction?
 - $\text{Sn}^0 + 2\text{e}^- \rightarrow \text{Sn}^{2+}$
 - $\text{Na}^0 + \text{e}^- \rightarrow \text{Na}^+$
 - $\text{Li}^0 + \text{e}^- \rightarrow \text{Li}^+$
 - $\text{Br}_2^0 + 2\text{e}^- \rightarrow 2\text{Br}^-$
- Which change occurs when an Sn^{2+} ion is oxidized?
 - Two electrons are lost.
 - Two electrons are gained.
 - Two protons are lost.
 - Two protons are gained.
- An electrochemical cell that generates electricity contains half-cells that produce
 - oxidation half-reactions, only
 - reduction half-reactions, only
 - spontaneous redox reactions
 - nonspontaneous redox reactions
- Which equation represents a redox reaction?
 - $2\text{Na}^+ + \text{S}^{2-} \rightarrow \text{Na}_2\text{S}$
 - $\text{H}^+ + \text{C}_2\text{H}_3\text{O}_2 \rightarrow \text{HC}_2\text{H}_3\text{O}_2$
 - $\text{NH}_3 + \text{H}^+ + \text{Cl}^- \rightarrow \text{NH}_4^+ + \text{Cl}^-$
 - $\text{Cu} + 2\text{Ag}^+ + 2\text{NO}_3^- \rightarrow 2\text{Ag} + \text{Cu}^{2+} + 2\text{NO}_3^-$
- Which group contains an element that can have only a negative oxidation number (-1) in compounds?
 - 1 (IA)
 - 2 (IIA)
 - 16 (VIA)
 - 17 (VIIA)

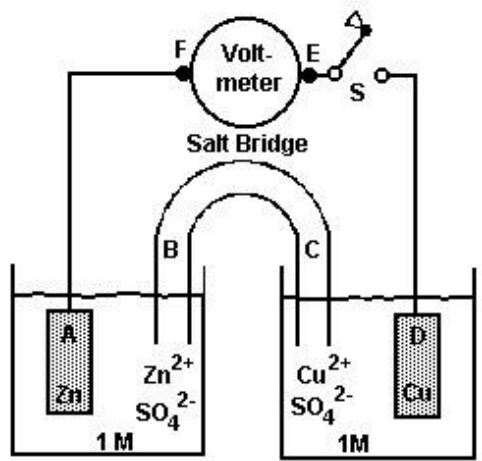
7. In which compound does sulfur have an oxidation number of -2?
- A. SO_2
 - B. SO_3
 - C. Na_2S
 - D. Na_2SO_4
8. Given the unbalanced equation which represents aluminum metals reacting with an acid:
- $$\text{Al} + \text{H}^+ \rightarrow \text{Al}^{3+} + \text{H}_2$$
- What is the total number of moles of electrons lost by 1 mole of aluminium?
- A. 6
 - B. 2
 - C. 3
 - D. 13
9. In the reaction: $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HClO} + \text{HCl}$, the hydrogen is
- A. oxidized, only
 - B. reduced, only
 - C. both oxidized and reduced
 - D. neither oxidized nor reduced
10. In an electrolytic cell, oxidation takes place at the
- A. anode, which is positive
 - B. anode, which is negative
 - C. cathode, which is positive
 - D. cathode, which is negative
11. Which half-reaction correctly represents reduction?
- A. $\text{Fe}^{2+} + 2\text{e}^- \rightarrow \text{Fe}^0$
 - B. $\text{Fe}^{2+} + \text{e}^- \rightarrow \text{Fe}^{3+}$
 - C. $\text{Fe}^0 + 2\text{e}^- \rightarrow \text{Fe}^{2+}$
 - D. $\text{Fe}^0 + \text{e}^- \rightarrow \text{Fe}^{3+}$
12. In which compound does hydrogen have an oxidation number of -1?
- A. NH_3
 - B. KH
 - C. HCl
 - D. H_2O

13. Which redox equation is correctly balanced?

- A. $\text{Cr}^{3+} + \text{Mg} \rightarrow \text{Cr} + \text{Mg}^{2+}$
 B. $\text{Al}^{3+} + \text{K} \rightarrow \text{Al} + \text{K}^+$
 C. $\text{Sn}^{4+} + \text{H}_2 \rightarrow \text{Sn} + 2\text{H}^+$
 D. $\text{Br}_2 + \text{Hg} \rightarrow \text{Hg}^{2+} + 2\text{Br}^-$

Figure 1

The diagram represents a voltaic cell.



14. [Refer to figure 1]

Which statement correctly describes the direction of flow for the ions in this cell when the switch is closed?

- A. Ions move through the salt bridge from B to C, only.
 B. Ions move through the salt bridge from C to B, only.
 C. Ions move through the salt bridge in both directions.
 D. Ions do not move through the salt bridge in either direction.

15. [Refer to figure 1]

When the switch is closed, which group of letters correctly represents the direction of electron flow?

- A. $A \rightarrow B \rightarrow C \rightarrow D$
 B. $A \rightarrow F \rightarrow E \rightarrow D$
 C. $D \rightarrow C \rightarrow B \rightarrow A$
 D. $D \rightarrow F \rightarrow E \rightarrow A$

16. Which species acts as the anode when the reaction $\text{Zn}(s) + \text{Pb}_2^+(aq) \rightarrow \text{Zn}^{2+}(aq) + \text{Pb}(s)$ occurs in an electrochemical cell?

- A. $\text{Zn}(s)$
 B. $\text{Zn}^{2+}(aq)$
 C. $\text{Pb}^{2+}(aq)$
 D. $\text{Pb}(s)$

17. Oxidation-reduction reactions occur because of the competition between particles for

- A. neutrons
- B. electrons
- C. protons
- D. positrons

18. In which compound does chlorine have an oxidation number of +7?

- A. HClO_4
- B. HClO_3
- C. HClO_2
- D. HClO

19. The type of reaction in a voltaic cell is best described as a

- A. spontaneous oxidation reaction, only
- B. nonspontaneous oxidation reaction, only
- C. spontaneous oxidation-reduction reaction
- D. nonspontaneous oxidation-reduction reaction

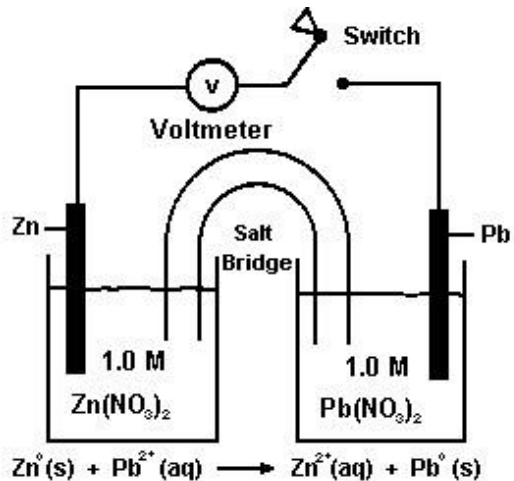
20. Given the reaction: $__\text{Hg}^{2+} + __\text{Ag}^0 \rightarrow __\text{Hg}^0 + __\text{Ag}^{1+}$

When the equation is completely balanced using the smallest whole-number coefficients, the coefficient of Hg will be

- A. 1
- B. 2
- C. 3
- D. 4

Figure 2

The diagram shows a voltaic cell. The reaction occurs at 1 atmosphere and 298 K.



21. [Refer to figure 2]

When the switch is closed, what occurs?

- A. Pb is oxidized and electrons flow to the Zn electrode.
- B. Pb is reduced and electrons flow to the Zn electrode.
- C. Zn is oxidized and electrons flow to the Pb electrode.
- D. Zn is reduced and electrons flow to the Pb electrode.

22. Which statement best describes the reaction represented by the equation below?



- A. The reaction occurs in a voltaic cell and releases energy.
- B. The reaction occurs in a voltaic cell and absorbs energy.
- C. The reaction occurs in an electrolytic cell and releases energy.
- D. The reaction occurs in an electrolytic cell and absorbs energy.

23. Given the reaction: $\text{Ca}(\text{s}) + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Ca}^{2+}(\text{aq}) + \text{Cu}(\text{s})$

What is the correct reduction half-reaction?

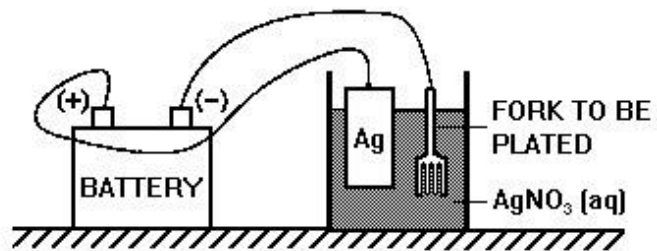
- A. $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu}(\text{s})$
- B. $\text{Cu}^{2+}(\text{aq}) \rightarrow \text{Cu}(\text{s}) + 2\text{e}^{-}$
- C. $\text{Cu}(\text{s}) + 2\text{e}^{-} \rightarrow \text{Cu}^{2+}(\text{aq})$
- D. $\text{Cu}(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-}$

24. Oxygen will have a positive oxidation number when combined with

- A. fluorine
- B. chlorine
- C. bromine
- D. iodine

Figure 3

The diagram represents the electroplating of a metal fork with Ag(s).



25. [Refer to figure 3]

Which equation represents the half-reaction that takes place at the fork?

- A. $\text{Ag}^+ + \text{NO}_3^- \rightarrow \text{AgNO}_3$
- B. $\text{AgNO}_3 \rightarrow \text{Ag}^+ + \text{NO}_3^-$
- C. $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}(s)$
- D. $\text{Ag}(s) \rightarrow \text{Ag}^+ + \text{e}^-$

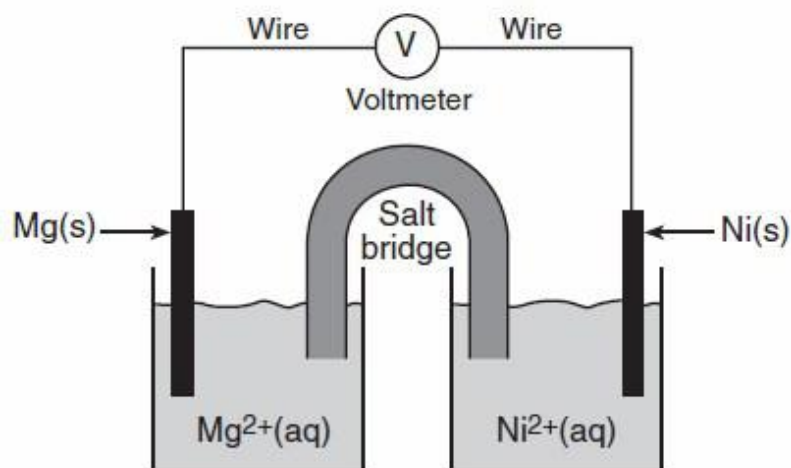
Name: _____

Teacher: Mr. Roderick

Unit 8 Pretest CR

Figure 1

Base your answer to the question on the diagram of a voltaic cell and the balanced ionic equation.



1. [Refer to figure 1]

What is the total number of moles of electrons needed to completely reduce 6.0 moles of $\text{Ni}^{2+}(\text{aq})$ ions?

Answer: mol

Figure 2

Base your answer to the question on the information below.

Aluminum is one of the most abundant metals in Earth's crust. The aluminum compound found in bauxite ore is Al_2O_3 .

Over one hundred years ago, it was difficult and expensive to isolate aluminum from bauxite ore. In 1886, a brother and sister team, Charles and Julia Hall, found that molten (melted) cryolite, Na_3AlF_6 , would dissolve bauxite ore. Electrolysis of the resulting mixture caused the aluminum ions in the Al_2O_3 to be reduced to molten aluminum metal. This less expensive process is known as the Hall process.

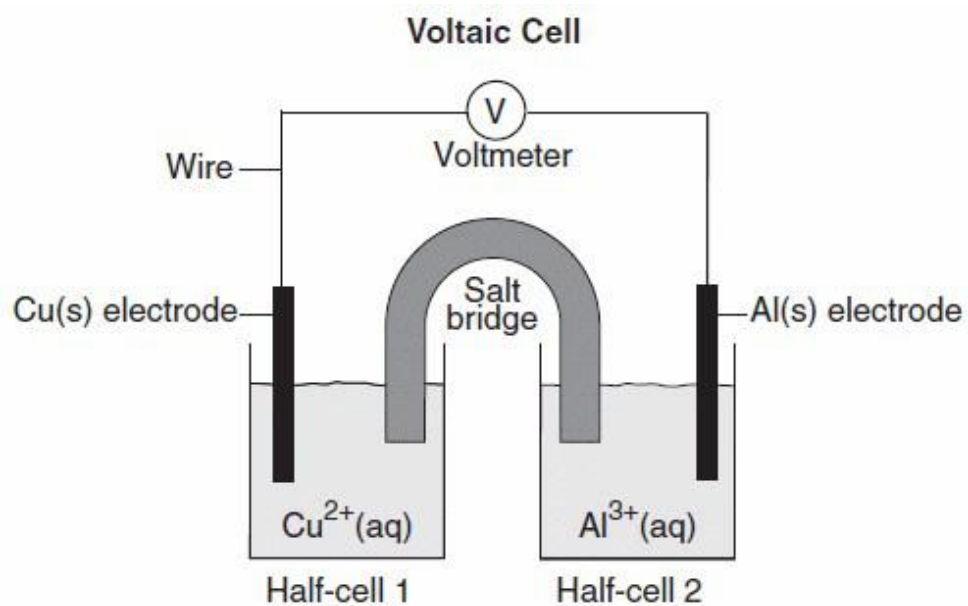
2. [Refer to figure 2]

Write the oxidation state for *each* of the elements in cryolite, Na_3AlF_6 :

Na: Al: F:

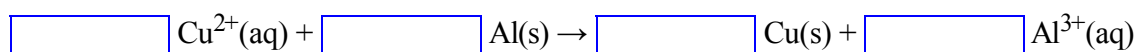
Figure 3

Base your answer to the question on the diagram below. The diagram shows a voltaic cell with copper and aluminum electrodes immediately after the external circuit is completed.



3. [Refer to figure 3]

Balance the redox equation using the smallest whole-number coefficients.



4. The unbalanced equation below represents the decomposition of potassium chlorate.



Determine the oxidation number of chlorine in the reactant.

Answer:

5. What is the oxidation number of nitrogen in NO(g)?

Answer:

Figure 4

Base your answer to the question on the information below.

“Hand Blasters” is a toy that consists of a set of two ceramic balls, each coated with a mixture of sulfur and potassium chlorate, KClO_3 . When the two balls are struck together, a loud popping noise is produced as sulfur and potassium chlorate react with each other.

6. **[Refer to figure 4]**

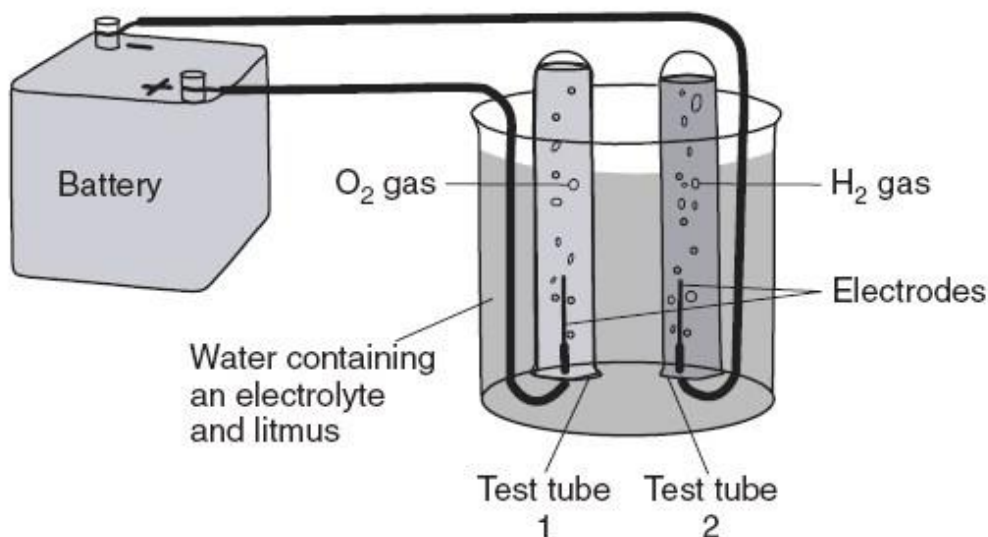
Determine the oxidation number of chlorine in the reactant that contains chlorine (KClO_3).

Answer:

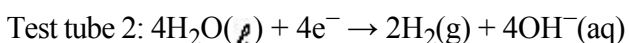
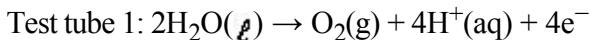
Figure 5

Base your answer to this question on the information below.

The diagram below shows a system in which water is being decomposed into oxygen gas and hydrogen gas. Litmus is used as an indicator in the water. The litmus turns red in test tube 1 and blue in test tube 2.



The oxidation and reduction occurring in the test tubes are represented by the balanced equations below.



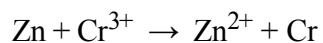
7. [Refer to figure 5]

Determine the change in oxidation number of oxygen during the reaction in test tube 1.

Answer: From to

8.

Base your answer on the following redox reaction, which occurs spontaneously in an electrochemical cell.

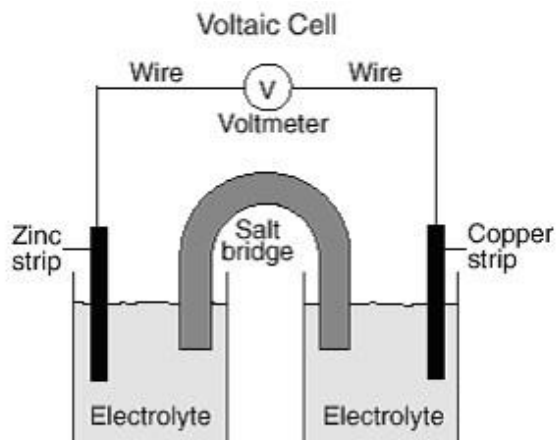


State what happens to the number of protons in a Zn atom when it changes to Zn^{2+} as the redox reaction occurs.

Answer for #8:

9.

Base your answer on the diagram of a voltaic cell and on your knowledge of chemistry.



Explain the function of the salt bridge.

Answer for #9:

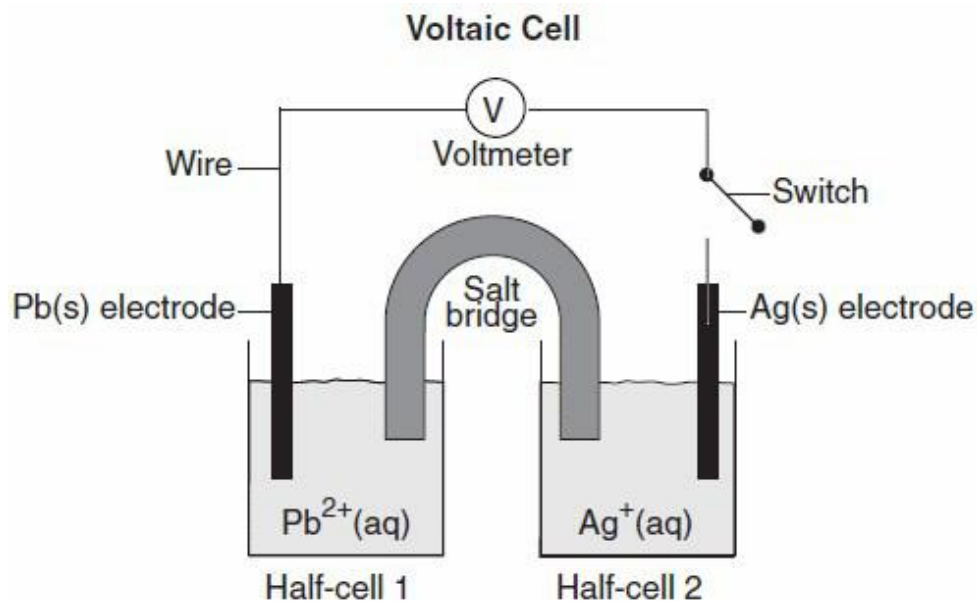
10.

State one difference between voltaic cells and electrolytic cells. Include information about *both* types of cells in your answer.

Answer for #10:

Figure 6

Base your answer to the question on the diagram of the voltaic cell.



11. [Refer to figure 6]

When the switch is closed, in which half-cell does oxidation occur?

Answer for #11:

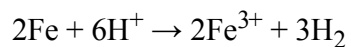
12. [Refer to figure 6]

When the switch is closed, state the direction that electrons will flow through the wire.

Answer for #12:

13.

Because tap water is slightly acidic, water pipes made of iron corrode over time, as shown by the balanced ionic equation below:

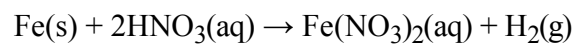


Explain, in terms of chemical reactivity, why copper pipes are *less* likely to corrode than iron pipes.

Answer for #13:

Figure 7

Base your answer to the question on the balanced equation below.



14. [Refer to figure 7]

Explain, using information from Reference Table *J*, why this reaction is spontaneous.

Answer for #14:

15. [Refer to figure 3]

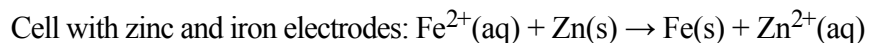
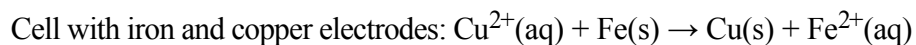
As this voltaic cell operates, the mass of the Al(s) electrode decreases. Explain, in terms of particles, why this decrease in mass occurs.

Answer for #15:

Figure 8

Base your answer to this question on the information below.

In a laboratory investigation, a student constructs a voltaic cell with iron and copper electrodes. Another student constructs a voltaic cell with zinc and iron electrodes. Testing the cells during operation enables the students to write the balanced ionic equations below.



16. **[Refer to figure 8]**

Identify the particles transferred between Fe^{2+} and Zn during the reaction in the cell with zinc and iron electrodes.

Answer for #16:

17. **[Refer to figure 8]**

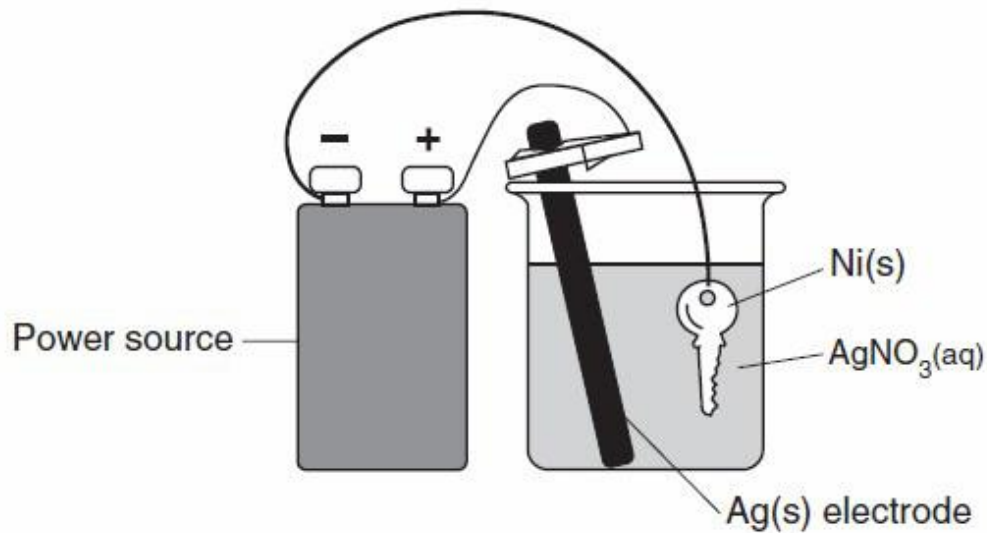
State the relative activity of the three metals used in these two voltaic cells.

Answer for #17:

Figure 9

Base your answer to the question on the information below.

The diagram below represents an operating electrolytic cell used to plate silver onto a nickel key. As the cell operates, oxidation occurs at the silver electrode and the mass of the silver electrode decreases.



18. [Refer to figure 9]

Identify the cathode in the cell.

Answer for #18:

19. [Refer to figure 9]

State the purpose of the power source in the cell.

Answer for #19: