- 1. What is the oxidation state of nitrogen in NaNO₂?
 - A) +1
- B) +2
- C) +3
- D) +4
- 2. Given the reaction that occurs in an electrochemical cell:

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

During this reaction, the oxidation number of Zn changes from

- A) 0 to +2
- B) 0 to -2
- C) +2 to 0
- D) -2 to 0
- 3. What is the oxidation number of carbon in NaHCO₃?
 - A) -2
- B) +2
- C) -4
- D) +4
- 4. The oxidation number of nitrogen in N2 is
 - A) +1
- **B**) 0
- C) +3
- D) -3
- 5. What is the oxidation number of sulfur in H₂SO₄?
 - A) 0
- B) -2
- C) +6
- D) +4
- 6. In which substance does sulfur have a negative oxidation number?
 - A) Na₂S
- B) CaSO₄

C) S

- D) SO₂
- 7. In which compound does chlorine have an oxidation number of ±5?
 - A) HClO
- B) HClO₂
- C) HClO₃
- D) HClO4
- 8. If element *X* forms the oxides *XO* and *X*₂O₃, the oxidation numbers of element *X* are
 - A) +1 and +2
- B) +2 and +3
- C) +1 and +3
- D) +2 and +4
- 9. What is the oxidation number of sulfur in Na₂S₂O₃?
 - A) -2
- B) +2
- C) +6
- D) 0
- 10. What is the oxidation number of oxygen in hydrogen sulfate ion, HSO₄-?
 - A) +1
- B) -2
- C) +6
- D) -4

11. Given the balanced ionic equation:

$$\operatorname{Zn}(s) + \operatorname{Cu}^{2+}(\operatorname{aq}) \to \operatorname{Zn}^{2+}(\operatorname{aq}) + \operatorname{Cu}(s)$$

Which equation represents the oxidation half-reaction?

- A) $Zn(s) + 2e^{-} Zn^{2+}(aq)$
- B) $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^{-}$
- C) $Cu^{2+}(aq) \rightarrow Cu(s) + 2e^{-}$
- D) $Cu^{2+}(aq) + 2e^{-} Cu(s)$
- 12. In a redox reaction, how does the total number of electrons lost by the oxidized substance compare to the total number of electrons gained by the reduced substance?
 - A) The number lost is always greater than the number gained.
 - B) The number lost is always equal to the number gained.
 - C) The number lost is sometimes equal to the number gained.
 - D) The number lost is sometimes less than the number gained.
- 13. When a neutral atom undergoes oxidation, the atom's oxidation state
 - A) decreases as it gains electrons
 - B) decreases as it loses electrons
 - C) increases as it gains electrons
 - D) increases as it loses electrons
- 14. Given the reaction:

$$Mg(s)$$
 + 2 $H^+(aq)$ + 2 $Cl^-(aq)$ \rightarrow $Mg^{2+}(aq)$ + 2 $Cl^-(aq)$ + $H_2(g)$

Which species undergoes oxidation?

- A) Mg(s)
- B) H⁺(aq)
- C) Cl-(aq)
- D) H₂(g)

15. What occurs during the reaction below?

$$4 \text{ HCl} + \text{MnO}_2 \rightarrow \text{MnCl}_2 + 2 \text{ H}_2\text{O} + \text{Cl}_2$$

- A) The manganese is reduced and its oxidation number changes from +4 to +2.
- B) The manganese is oxidized and its oxidation number changes from +4 to +2.
- C) The manganese is reduced and its oxidation number changes from +2 to +4.
- D) The manganese is oxidized and its oxidation number changes from +2 to +4.
- 16. Given the reaction:

$$F_2(g) + 2 Br(aq) \rightarrow Br_2(\ell) + 2 F(aq)$$

Which species is reduced?

- A) $F_2(g)$
- B) Br-(aq)
- C) Br₂(ℓ)
- D) $F^{-}(aq)$
- 17. Given the cell reaction:

$$Ca(s) + Mg^{2+}(aq) \rightarrow Ca^{2+}(aq) + Mg(s)$$

Which substance was oxidized?

- A) Ca(s)
- B) $Mg^{2+}(aq)$
- C) $Ca^{2+}(aq)$
- D) Mg(s)
- 18. Given the redox reaction:

$$2 \text{ I-(aq)} + \text{Br2}(\ell) \rightarrow 2 \text{ Br-(aq)} + \text{I2(s)}$$

What occurs during this reaction?

- A) The I- ion is oxidized, and its oxidation number increases.
- B) The I⁻ ion is oxidized, and its oxidation number decreases.
- C) The I⁻ ion is reduced, and its oxidation number increases.
- D) The I⁻ ion is reduced, and its oxidation number decreases.

19. In the reaction

$$Ca + NiCl_2 \rightarrow CaCl_2 + Ni$$

the oxidation number of the chlorine

- A) decreases
- B) increases
- C) remains the same
- 20. Which half-reaction correctly represents oxidation?
 - A) $F_2 \rightarrow 2 F^- + 2e^-$ B) $F_2 + 2e^- \rightarrow 2 F^-$
 - C) $H_2 \rightarrow 2 H^+ + 2e^-$ D) $H_2 + 2e^- \rightarrow 2 H^+$
- 21. Given the balanced equation representing a redox reaction:

$$2A1 + 3Cu^{2+} \rightarrow 2A1^{3+} + 3Cu$$

Which statement is true about this reaction?

- A) Each Al loses 2e⁻ and each Cu²⁺ gains 3e⁻.
- B) Each Al loses 3e⁻ and each Cu²⁺ gains 2e⁻.
- C) Each Al³⁺ gains 2e⁻ and each Cu loses 3e⁻.
- D) Each Al³⁺ gains 3e⁻ and each Cu loses 2e⁻.
- 22. Given the equation:

$$C(s) + H_2O(g) \rightarrow CO(g) + H_2(g)$$

Which species undergoes reduction?

- A) C(s)
- B) H⁺
- C) C^{2+}
- D) $H_2(g)$
- 23. Given the reaction:

$$2 \text{ Al}^{0}(s) + 3 \text{ Ni}^{2+}(aq) \rightarrow 2 \text{ Al}^{3+}(aq) + 3 \text{ Ni}^{0}(s)$$

What is the total number of moles of electrons lost by 2 moles of $Al^0(s)$?

- A) 6
- B) 2
- C) 3
- D) 8
- 24. Given the cell reaction:

$$Sn(s) + Pb^{2+}(aq) \rightarrow Sn^{2+}(aq) + Pb(s)$$

The reduction half-reaction for this cell is

- A) $Pb^{2+}(aq) + 2e^{-} \rightarrow Pb(s)$
- B) $Pb(s) \rightarrow Pb^{2+}(aq) + 2e^{-}$
- C) $\operatorname{Sn^{2+}(aq)} + 2e^{-} \rightarrow \operatorname{Sn(s)}$
- D) $Sn(s) \rightarrow Sn^{2+}(aq) + 2e^{-}$

- 25. In the reaction $Mg + Cl_2 \rightarrow MgCl_2$, the correct half-reaction for the oxidation that occurs is
 - A) $Mg + 2e^- \rightarrow Mg^{2+}$
 - B) $Cl_2 + 2e^- \rightarrow 2Cl^-$
 - C) Mg \rightarrow Mg²⁺ + 2e⁻
 - D) $Cl_2 \rightarrow 2Cl^- + 2e^-$
- 26. Which reaction is an example of oxidation-reduction?
 - A) $KOH + HCl \rightarrow KCl + H_2O$
 - B) $2 \text{ KCl} \rightarrow 2 \text{ K} + \text{Cl}_2$
 - C) $BaCl_2 + K_2SO_4 \rightarrow 2 KCl + BaSO_4$
 - D) $KCl + AgNO_3 \rightarrow AgCl + KNO_3$
- 27. Which is a redox reaction?
 - A) $2 \text{ KBr} + \text{F}_2 \rightarrow 2 \text{ KF} + \text{Br}_2$
 - B) $2 \text{ HCl} + \text{Mg(OH)}_2 \rightarrow 2 \text{ HOH} + \text{MgCl}_2$
 - C) $2 \text{ NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2 \text{ HCl}$
 - D) $Ca(OH)_2 + Pb(NO_3)_2 \rightarrow Ca(NO_3)_2 + Pb(OH)_2$
- 28. Based on Reference Table J, which metal will react spontaneously with Al³⁺?
 - A) Co(s)
- B) Cr(s)
- C) Cu(s)
- D) Ca(s)
- 29. According to Reference Table J, which redox reaction occurs spontaneously?
 - A) $Cu(s) + 2 H^+ \rightarrow Cu^{2+} + H_2(g)$
 - B) $Mg(s) + 2 H^+ \rightarrow Mg^{2+} + H_2(g)$
 - C) $2 \text{ Ag(s)} + 2 \text{ H}^+ \rightarrow 2 \text{ Ag} + \text{H}_2(g)$
 - D) $2 \text{ Ag(s)} + 2 \text{ H}^+ \rightarrow 2 \text{ Ag}^{2+} + \text{H}_2(g)$
- 30. Based on Reference Table J, which oxidation is most likely to occur?
 - A) $Cu \rightarrow Cu^{2+} + 2e^{-}$
 - B) $Mg \rightarrow Mg^{2+} + 2e^{-}$
 - C) $Ag \to Ag^{1+} + 1e^{-}$
 - D) $Au \rightarrow Au^{3+} + 3e^{-}$
- 31. In the reaction

$$Ni + 2 Ag^+ \rightarrow Ni^{2+} + 2 Ag$$

what is the total number of moles of electrons lost by 1 mole of Ni?

- A) 1
- B) 2
- C) 0.5
- D) 4

32. Given the balanced equation:

$$2 \text{ Al(s)} + 6 \text{ H}^+(\text{aq}) \rightarrow 2 \text{ Al}^{3+}(\text{aq}) + 3 \text{ H}_2(\text{g})$$

When 2 moles of Al(s) completely reacts, what is the total number of moles of electrons transferred from Al(s) to $H^+(aq)$?

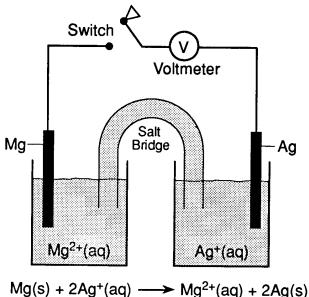
- A) 5
- **B**) 6
- C) 3
- D) 4
- 33. Given the reaction:

$$_$$
 Mg + $_$ Cr³⁺ \rightarrow $_$ Mg2+ + $_$ Cr

When the equation is correctly balanced using smallest whole numbers, the sum of the coefficients will be

- A) 10
- B) 7
- C) 5
- D) 4
- 34. A voltaic cell spontaneously converts
 - A) electrical energy to chemical energy
 - B) chemical energy to electrical energy
 - C) electrical energy to nuclear energy
 - D) nuclear energy to electrical energy

35. Base your answer to the following question on the equation and diagram below represent an electrochemical cell at 298 K and 1 atmosphere.



Which species is oxidized when the switch is closed?

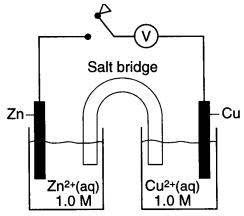
- A) Mg(s)
- B) Mg^{2+} (aq)
- C) Ag(s)
- D) $Ag^+(aq)$
- 36. The overall reaction in a electrochemical cell is

$$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$
.

As the reaction in this cell takes place, the

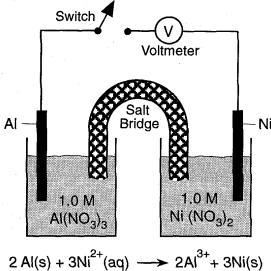
- A) mass of the Zn(s) electrode decreases
- B) mass of the Cu(s) electrode decreases
- C) $Cu^{2+}(aq)$ concentration remains the same
- D) Zn^{2+} (aq) concentration remains the same
- 37. A redox reaction is set up so that both half reactions take place in separate beakers that are connected by a salt bridge and an external conductor. A path for the transfer of ions is provided by the
 - A) anode
- B) cathode
- C) salt bridge
- D) external conductor

38. The diagram below represents an electrochemical cell.



What occurs when the switch is closed?

- A) Zn is reduced.
- B) Cu is oxidized.
- C) Electrons flow from Cu to Zn.
- D) Electrons flow from Zn to Cu.
- 39. The diagram below represents a chemical cell at 298 K.

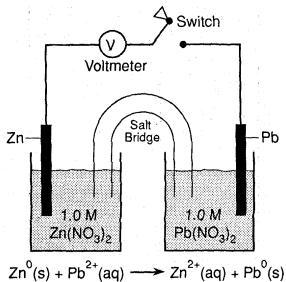


$$2 \text{ Al(s)} + 3 \text{Ni}^{2+} (\text{aq}) \longrightarrow 2 \text{Al}^{3+} + 3 \text{Ni(s)}$$

When the switch is closed, electrons flow from

- A) Al(s) to Ni(s)
- B) Ni(s) to Al(s)
- C) $Al^{3+}(aq)$ to $Ni^{2+}(aq)$
- D) $Ni^{2+}(aq)$ to $Al^{3+}(aq)$

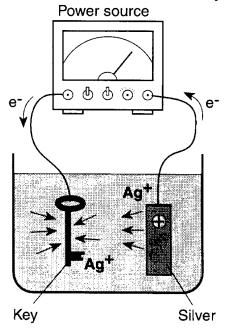
40. Base your answer to the following question on the diagram of the chemical cell shown below. The reaction occurs at 1 atmosphere and 298 K.



When the switch is closed, what occurs?

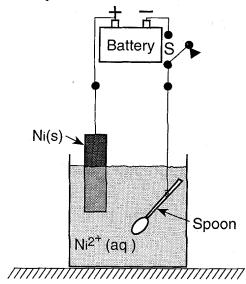
- A) Pb is oxidized and electrons flow to the Zn electrode.
- B) Pb is reduced and electrons flow to the Zn electrode.
- C) Zn is oxidized and electrons flow to the Pb electrode.
- D) Zn is reduced and electrons flow to the Pb electrode.

41. Which statement best describes the key?



- A) It acts as the cathode and is negative.
- B) It acts as the cathode and is positive.
- C) It acts as the anode and is negative.
- D) It acts as the anode and is positive.

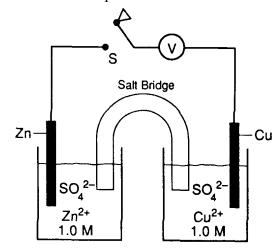
42. The diagram below shows a spoon that will be electroplated with nickel metal.



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 lose 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 gain mass, and the Ni(s) will be oxidized.
- 43. Where does oxidation occur in an electrochemical cell?
 - A) at the cathode in both an electrolytic cell and a voltaic cell
 - B) at the cathode in an electrolytic cell and at the anode in a voltaic cell
 - C) at the anode in both an electrolytic cell and a voltaic cell
 - D) at the anode in an electrolytic cell and at the cathode in a voltaic cell

- 44. An electrochemical cell that generates electricity contains half-cells that produce
 - A) oxidation half-reactions, only
 - B) reduction half-reactions, only
 - C) spontaneous redox reactions
 - D) non-spontaneous redox reactions
- 45. 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?

- A) Zn
- B) Zn²⁺ C) Cu
- D) Cu²⁺

Answer Key Unit 13 Electrochemistry Review

- 1. <u>C</u>
- 2. **A**
- 3. **D**
- 4. **B**
- 5. **C**
- 6. **A**
- 7. <u>C</u>
- 8. **B**
- 9. **B**
- 10. **B**
- 11. **B**
- 12. **B**
- 13. **D**
- 14. **A**
- 15. **A**
- 16. **A**
- 17. **A**
- 18. **A**
- 19. <u>C</u>
- 20. <u>C</u>
- 21. **B**
- 22. **B**
- 23. **A**
- 24. **A**
- 25. <u>C</u>
- 26. **B**
- 27. **A**
- 28. **D**
- 29. **B**
- ____
- 30. <u>B</u>
- 31. **B**
- 32. **B**
- 33. **A**
- 34. **B**
- 35. **A**

- 36. **A**
- 37. <u>C</u>
- 38. **D**
- 39. **A**
- 40. **C**
- 41. **A**
- 42. **D**
- 43. <u>C</u>
- 44. <u>C</u>
- 45. <u>C</u>