Review# 7

1. Which value changes when a Cu atom becomes a Cu$^{2+}$ ion?
   A) mass number
   B) oxidation number
   C) number of protons
   D) number of neutrons

2. What is the oxidation number of manganese in KMnO$_4$?
   A) +7  B) +2  C) +3  D) +4

3. Which polyatomic ion has a charge of 3–?
   A) chromate ion  B) oxalate ion
   C) phosphate ion  D) thiocyanate ion

4. What is the oxidation state of nitrogen in the compound NH$_4$Br?
   A) –1  B) +2  C) –3  D) +4

5. What is the oxidation number of sulfur in Na$_2$S$_2$O$_3$?
   A) –1  B) +2  C) +6  D) +4

6. Given the balanced equation representing a reaction:
   \[ 2\text{KClO}_3(s) \rightarrow 2\text{KCl}(s) + 3\text{O}_2(g) \]
   The oxidation state of chlorine in this reaction changes from
   A) –1 to +1  B) –1 to +5
   C) +1 to –1  D) +5 to –1

7. What is the oxidation number of chromium in the chromate ion, CrO$_4^{2–}$?
   A) +6  B) +2  C) +3  D) +8

8. Which half-reaction equation represents reduction?
   A) Cu $\rightarrow$ Cu$^{2+}$ + 2e$^-$  B) Cu$^{2+}$ + 2e$^-$ $\rightarrow$ Cu
   C) Ag + e$^-$ $\rightarrow$ Ag$^+$  D) Ag$^+$ $\rightarrow$ Ag + e$^-$

9. Which metal is most easily oxidized?
   A) Ag  B) Co  C) Cu  D) Mg

10. Given the equation representing a reaction:
    \[ \text{Cd} + \text{NiO}_2 + 2\text{H}_2\text{O} \rightarrow \text{Cd(OH)}_2 + \text{Ni(OH)}_2 \]
    Which half-reaction equation represents the oxidation in the reaction?
    A) Ni$^{4+}$ + 2e$^-$ $\rightarrow$ Ni$^{2+}$  B) Ni$^{4+}$ $\rightarrow$ Ni$^{2+}$ + 2e$^-$
    C) Cd $\rightarrow$ Cd$^{2+}$ + 2e$^-$  D) Cd + 2e$^-$ $\rightarrow$ Cd$^{2+}$

11. Which process involves the transfer of electrons?
    A) double replacement  B) neutralization
    C) oxidation-reduction  D) sublimation

12. During an oxidation-reduction reaction, the number of electrons gained is
    A) equal to the number of electrons lost
    B) equal to the number of protons gained
    C) less than the number of electrons lost
    D) less than the number of protons gained

13. What occurs when Cr$^{3+}$ ions are reduced to Cr$^{2+}$ ions?
    A) alpha decay  B) double replacement
    C) neutralization  D) oxidation-reduction

14. Which type of reaction involves the transfer of electrons?
    A) alpha decay  B) double replacement
    C) neutralization  D) oxidation-reduction

15. Given the balanced equation representing a reaction:
    \[ 2\text{Al}(s) + 3\text{Cu}^{2+}(aq) \rightarrow 2\text{Al}^{3+}(aq) + 3\text{Cu}(s) \]
    Which particles are transferred in this reaction?
    A) electrons  B) neutrons
    C) positrons  D) protons
16. The chemical process in which electrons are gained by an atom or an ion is called
   A) addition  B) oxidation  C) reduction  D) substitution

17. Given the equation representing a reaction:
   \( \text{Sn}^{4+}(aq) + 2e^- \rightarrow \text{Sn}^{2+}(aq) \)

   Which term best describes this reaction?
   A) ionization  B) neutralization  C) oxidation  D) reduction

18. Which ion is most easily reduced?
   A) \( \text{Zn}^{2+} \)  B) \( \text{Mg}^{2+} \)  C) \( \text{Co}^{2+} \)  D) \( \text{Ca}^{2+} \)

19. The oxidation number of a reducing agent can change from
   A) \(-1\) to \(-3\)  B) \(-2\) to \(-1\)  C) \(3\) to \(-1\)  D) \(4\) to \(-3\)

20. In a redox reaction, the reducing agent will
   A) lose electrons and be reduced  B) lose electrons and be oxidized  
   C) gain electrons and be reduced  D) gain electrons and be oxidized

21. Given the redox reaction:
   \( \text{Fe}^{2+}(aq) + \text{Zn}(s) \rightarrow \text{Zn}^{2+}(aq) + \text{Fe}(s) \)

   Which species acts as a reducing agent?
   A) \( \text{Fe}(s) \)  B) \( \text{Fe}^{2+}(aq) \)  C) \( \text{Zn}(s) \)  D) \( \text{Zn}^{2+}(aq) \)

22. In a redox reaction, the species reduced
   A) gains electrons and is the oxidizing agent  B) gains electrons and is the reducing agent  
   C) loses electrons and is the oxidizing agent  D) loses electrons and is the reducing agent

23. In the reaction
   \( \text{Pb} + 2 \text{Ag}^+ \rightarrow \text{Pb}^{2+} + 2 \text{Ag} \)

   the oxidizing agent is
   A) \( \text{Ag}^+ \)  B) \( \text{Ag} \)  C) \( \text{Pb} \)  D) \( \text{Pb}^{2+} \)

24. Which metal reacts spontaneously with \( \text{Sr}^{2+} \) ions?
   A) \( \text{Ca}(s) \)  B) \( \text{Co}(s) \)  C) \( \text{Cs}(s) \)  D) \( \text{Cu}(s) \)

25. Given the balanced ionic equation representing a reaction:
   \( \text{Cu}(s) + 2\text{Ag}^+(aq) \rightarrow \text{Cu}^{2+}(aq) + 2\text{Ag}(s) \)

   During this reaction, electrons are transferred from
   A) \( \text{Cu}(s) \) to \( \text{Ag}^+(aq) \)  B) \( \text{Cu}^{2+}(aq) \) to \( \text{Ag}(s) \)  
   C) \( \text{Ag}(s) \) to \( \text{Cu}^{2+}(aq) \)  D) \( \text{Ag}^+(aq) \) to \( \text{Cu}(s) \)

26. Given the balanced equation representing a reaction:
   \( \text{Ni}(s) + 2\text{HCl}(aq) \rightarrow \text{NiCl}_2(aq) + \text{H}_2(g) \)

   In this reaction, each \( \text{Ni} \) atom
   A) loses 1 electron  B) loses 2 electrons  C) gains 1 electron  D) gains 2 electrons

27. Which process requires energy for a nonspontaneous redox reaction to occur?
   A) deposition  B) electrolysis  C) alpha decay  D) chromatography

28. Which balanced equation represents a redox reaction?
   A) \( \text{Mg} + \text{Cl}_2 \rightarrow \text{MgCl}_2 \)  B) \( \text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2 \)  
   C) \( \text{HNO}_3 + \text{NaOH} \rightarrow \text{NaNO}_3 + \text{H}_2\text{O} \)  D) \( \text{NaCl} + \text{AgNO}_3 \rightarrow \text{AgCl} + \text{NaNO}_3 \)

29. Which balanced equation represents an oxidation-reduction reaction?
   A) \( \text{Ba(NO}_3)_2 + \text{Na}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + 2\text{NaNO}_3 \)  B) \( \text{H}_3\text{PO}_4 + 3\text{KOH} \rightarrow \text{K}_3\text{PO}_4 + 3\text{H}_2\text{O} \)  
   C) \( \text{Fe}(s) + \text{S}(s) \rightarrow \text{FeS}(s) \)  D) \( \text{NH}_3(g) + \text{HCl}(g) \rightarrow \text{NH}_4\text{Cl}(s) \)

30. Which balanced equation represents a redox reaction?
    A) \( \text{AgNO}_3(aq) + \text{NaCl}(aq) \rightarrow \text{AgCl}(s) + \text{NaNO}_3(aq) \)  B) \( \text{H}_2\text{CO}_3(aq) \rightarrow \text{H}_2\text{O}(l) + \text{CO}_2(g) \)  
    C) \( \text{NaOH}(aq) + \text{HCl}(aq) \rightarrow \text{NaCl}(aq) + \text{H}_2\text{O}(l) \)  D) \( \text{Mg}(s) + 2\text{HCl}(aq) \rightarrow \text{MgCl}_2(aq) + \text{H}_2(g) \)

31. Which metal is more active than \( \text{H}_2 \)?
    A) \( \text{Ag} \)  B) \( \text{Au} \)  C) \( \text{Cu} \)  D) \( \text{Pb} \)
32. Which metal is more active than Ni and less active than Zn?
   A) Cu   B) Cr   C) Mg   D) Pb

33. Which energy conversion occurs in an operating voltaic cell?
   A) chemical energy to electrical energy
   B) chemical energy to nuclear energy
   C) electrical energy to chemical energy
   D) electrical energy to nuclear energy

34. Which ionic equation represents a spontaneous reaction that can occur in a voltaic cell?
   A) Cu(s) + Zn(s) → Cu^{2+}(aq) + Zn^{2+}(aq)
   B) Cu(s) + Zn^{2+}(aq) → Cu^{2+}(aq) + Zn(s)
   C) Cu^{2+}(aq) + Zn(s) → Cu(s) + Zn^{2+}(aq)
   D) Cu^{2+}(aq) + Zn^{2+}(aq) → Cu(s) + Zn(s)

35. In an operating voltaic cell, reduction occurs
   A) at the anode   B) at the cathode   C) in the salt bridge   D) in the wire

36. Which statement describes where the oxidation and reduction half-reactions occur in an operating electrochemical cell?
   A) Oxidation and reduction both occur at the anode.
   B) Oxidation and reduction both occur at the cathode.
   C) Oxidation occurs at the anode, and reduction occurs at the cathode.
   D) Oxidation occurs at the cathode, and reduction occurs at the anode.

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

   \[ \text{Mg(s) + 2Ag}^+(aq) \rightarrow \text{Mg}^{2+}(aq) + 2\text{Ag(s)} \]

Which species is oxidized when the switch is closed?
   A) Mg(s)   B) Mg^{2+} (aq)   C) Ag(s)   D) Ag^{+}(aq)

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

   \[ \text{Ni}^0(s) + 2\text{Ag}^+(aq) \rightarrow \text{Ni}^{2+}(aq) + 2\text{Ag}^0(s) \]

In the given reaction, the Ag^{+} ions
   A) gain electrons   B) lose electrons   C) gain protons   D) lose protons
39. When a voltaic cell operates, ions move through the
A) anode B) cathode
C) salt bridge D) external circuit

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

\[ \text{Zn(s)} + \text{Cu}^{2+}(aq) \rightarrow \text{Zn}^{2+}(aq) + \text{Cu(s)} \]

The flow of electrons through the external circuit in this cell is from the
A) Cu anode to the Zn cathode
B) Cu cathode to the Zn anode
C) Zn anode to the Cu cathode
D) Zn cathode to the Cu anode

41. 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 Mg(NO_3)_2(aq)
• 125 mL of 0.20 M Cu(NO_3)_2(aq)
Which additional item is required for the construction of the voltaic cell?
A) an anode B) a battery
C) a cathode D) a salt bridge

42. Which device requires electrical energy to produce a chemical change?
A) electrolytic cell B) salt bridge
C) voltaic cell D) voltmeter

43. An electrolytic cell differs from a voltaic cell because an electrolytic cell
A) generates its own energy from a spontaneous physical reaction
B) generates its own energy from a nonspontaneous physical reaction
C) requires an outside energy source for a spontaneous chemical reaction to occur
D) requires an outside energy source for a nonspontaneous chemical reaction to occur

44. Where do reduction and oxidation occur in an electrolytic cell?
A) Both occur at the anode.
B) Both occur at the cathode.
C) Reduction occurs at the anode, and oxidation occurs at the cathode.
D) Reduction occurs at the cathode, and oxidation occurs at the anode.

45. What occurs at one of the electrodes in both an electrolytic cell and a voltaic cell?
A) Oxidation occurs as electrons are gained at the cathode.
B) Oxidation occurs as electrons are lost at the anode.
C) Reduction occurs as electrons are gained at the anode.
D) Reduction occurs as electrons are lost at the cathode.
A student sets up a voltaic cell using magnesium and zinc electrodes. The porous barrier in the cell has the same purpose as a salt bridge. The diagram and the ionic equation below represent this operating cell.

\[
\text{Mg(s)} + \text{Zn}^{2+}(\text{aq}) \rightarrow \text{Zn(s)} + \text{Mg}^{2+}(\text{aq})
\]

46. Write a balanced half-reaction equation for the oxidation that occurs in this operating cell.

47. State, in terms of the relative activity of metals, why the reaction in this cell occurs.

48. State, in terms of ions, how the porous barrier functions as a salt bridge in this cell.

49. Determine the number of moles of Mg\(^{2+}\)(aq) ions produced when 2.5 moles of Zn\(^{2+}\)(aq) react completely in this cell.
A student constructs an electrochemical cell. A diagram of the operating cell and the unbalanced ionic equation representing the reaction occurring in the cell are shown below. The blue color of the solution in the copper half-cell indicates the presence of Cu$^{2+}$ ions. The student observes that the blue color becomes less intense as the cell operates.

50. State one inference that the student can make about the concentration of the Cu$^{2+}$ ions based on the change in intensity of the color of the Cu(NO$_3$)$_2$(aq) solution as the cell operates.

51. Identify the type of electrochemical cell represented by the diagram.
A student constructs an electrochemical cell during a laboratory investigation. When the switch is closed, electrons flow through the external circuit. The diagram and ionic equation below represent this cell and the reaction that occurs.

Base your answers to questions 52 through 55 on the information below and on your knowledge of chemistry.

52. State what happens to the mass of the Cu electrode and the mass of the Zn electrode in the operating cell.

53. Write a balanced equation for the half-reaction that occurs in the Cu half-cell when the cell operates.

54. State in terms of the Cu(s) electrode and the Zn(s) electrode, the direction of electron flow in the external circuit when the cell operates.

55. State the form of energy that is converted to electrical energy in the operating cell.

Base your answers to questions 56 through 58 on the information below and on your knowledge of chemistry.

One type of voltaic cell, called a mercury battery, uses zinc and mercury(II) oxide to generate an electric current. Mercury batteries were used because of the miniature size, even though mercury is toxic. The overall reaction for a mercury battery is given in the equation below.

\[ 	ext{Zn(s)} + \text{HgO(s)} \rightarrow \text{ZnO(s)} + \text{Hg(l)} \]

56. Using information in the passage, state one risk and one benefit of using a mercury battery.

57. Compare the number of moles of electrons lost to the number of moles of electrons gained during the reaction.

58. Determine the change in the oxidation number of zinc during the operation of the cell.
Base your answers to questions 59 through 62 on the information below and on your knowledge of chemistry.

A student develops the list shown below that includes laboratory equipment and materials for constructing a voltaic cell.

**Laboratory Equipment and Materials**

- a strip of zinc
- a strip of copper
- a 250-mL beaker containing 150 mL of 0.1 M zinc nitrate
- a 250-mL beaker containing 150 mL of 0.1 M copper (II) nitrate
- wires
- a voltmeter
- a switch
- a salt bridge

59. Identify one item of laboratory equipment required to build an electrolytic cell that is not included in the list.

60. Compare the activities of the two metals used by the student for constructing the voltaic cell.

61. Complete and balance the half-reaction equation below for the oxidation of the Zn(s) that occurs in the voltaic cell.

\[ \text{Zn}(s) \rightarrow \underline{\quad} + \underline{\quad} \]

62. State the purpose of the salt bridge in the voltaic cell.