1
Identify oxidation.
A) Increase in oxidation number.
B) Loss of electrons.
C) Gain of electrons.
D) Decrease in oxidation number.
E) Both A and B
Answer: E

2
What element is being reduced in the following redox reaction?

\[ \text{H}_2\text{O}_2(\text{l}) + \text{ClO}_2(\text{aq}) \rightarrow \text{ClO}_2^-(\text{aq}) + \text{O}_2(\text{g}) \]

A) H
B) O
C) Cl
D) N
E) C
Answer: C

3
Balance the following redox reaction if it occurs in acidic solution. What are the coefficients in front of \( \text{H}^+ \) and \( \text{Fe}^{3+} \) in the balanced reaction?

\[ \text{Fe}^{2+}(\text{aq}) + \text{MnO}_4^- (\text{aq}) \rightarrow \text{Fe}^{3+}(\text{aq}) + \text{Mn}^{2+}(\text{aq}) \]

A) \( \text{H}^+ = 2, \text{Fe}^{3+} = 3 \)
B) \( \text{H}^+ = 8, \text{Fe}^{3+} = 5 \)
C) \( \text{H}^+ = 3, \text{Fe}^{3+} = 2 \)
D) \( \text{H}^+ = 5, \text{Fe}^{3+} = 1 \)
E) \( \text{H}^+ = 8, \text{Fe}^{3+} = 1 \)
Answer: B
4. Balance the following redox reaction if it occurs in basic solution. What are the coefficients in front of ClO₂ and H₂O in the balanced reaction?

\[ \text{H}_2\text{O}_2(\text{l}) + \text{ClO}_2(\text{aq}) \rightarrow \text{ClO}_2^-(\text{aq}) + \text{O}_2(\text{g}) \]

A) ClO₂ = 1, H₂O = 1  
B) ClO₂ = 1, H₂O = 2  
C) ClO₂ = 4, H₂O = 3  
D) ClO₂ = 4, H₂O = 2  
E) ClO₂ = 2, H₂O = 2  
Answer: E

5. Identify the location of reduction in an electrochemical cell.

A) The anode.  
B) The cathode.  
C) The electrode.  
D) The salt bridge.  
E) The socket.  
Answer: A

6. Determine the cell notation for the redox reaction given below.

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

A) Ag⁺(aq) | Ag(s) || Sn(s) | Sn²⁺(aq)  
B) Ag(s) | Ag⁺(aq) || Sn²⁺(aq) | Sn(s)  
C) Sn(s) | Sn²⁺(aq) || Ag⁺(aq) | Ag(s)  
D) Sn²⁺(aq) | Sn(s) || Ag(s) | Ag⁺(aq)  
E) Sn(s) | Ag(s) || Sn²⁺(aq) | Ag⁺(aq)  
Answer: C

7. What is undergoing reduction in the redox reaction represented by the following cell notation?

\[ \text{Fe}(\text{s}) | \text{Fe}^{3+}(\text{aq}) || \text{Cl}_2(\text{g}) | \text{Cl}^-(\text{aq}) | \text{Pt} \]

A) Fe(s)  
B) Fe³⁺(aq)  
C) Cl₂(g)  
D) Cl⁻(aq)  
E) Pt  
Answer: C
8.
What is the reducing agent in the redox reaction represented by the following cell notation?

\[ \text{Ni(s)} \mid \text{Ni}^{2+}(\text{aq}) \parallel \text{Ag}^{+}(\text{aq}) \mid \text{Ag(s)} \]

A) Ni(s)
B) Ni^{2+}(aq)
C) Ag^{+}(aq)
D) Ag(s)
E) Pt
Answer: A

9.
Which of the following is the strongest reducing agent?

A) Sn^{2+}(aq)
B) Cr^{3+}(aq)
C) Sn^{4+}(aq)
D) Cr(s)
E) Sn(s)
Answer: D

10.
Which of the following is the strongest oxidizing agent?

A) Br_2(l)
B) Au^{3+}(aq)
C) Ag(s)
D) Br^-(aq)
E) Au(s)
Answer: B

11.
Use the standard half-cell potentials listed below to calculate the standard cell potential for the following reaction occurring in an electrochemical cell at 25°C. (The equation is balanced.)

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

\[ \text{Mg}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Mg(s)} \quad E^\circ = -2.38 \text{ V} \]
\[ \text{Cu}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Cu(s)} \quad E^\circ = +0.34 \text{ V} \]

A) +2.04 V
B) -2.04 V
C) +2.72 V
D) -1.36 V
E) +1.36 V
Answer: C
12
How many electrons are transferred in the following reaction? (The reaction is unbalanced.)

\[ \text{Mg(s)} + \text{Al}^{3+}(\text{aq}) \rightarrow \text{Al(s)} + \text{Mg}^{2+}(\text{aq}) \]

A) 6  
B) 2  
C) 3  
D) 1  
E) 4  

Answer: A

13
Use the tabulated half-cell potentials to calculate \( \Delta G^\circ \) for the following balanced redox reaction.

\[ 3 \text{I}_2(\text{s}) + 2 \text{Fe(s)} \rightarrow 2 \text{Fe}^{3+}(\text{aq}) + 6 \text{I}^-(\text{aq}) \]

A) \(-1.1 \times 10^2 \text{ kJ}\)  
B) \(+4.9 \times 10^1 \text{ kJ}\)  
C) \(-9.7 \times 10^1 \text{ kJ}\)  
D) \(+2.3 \times 10^2 \text{ kJ}\)  
E) \(-3.3 \times 10^2 \text{ kJ}\)  

Answer: E

14
Use the tabulated half-cell potentials to calculate the equilibrium constant (K) for the following balanced redox reaction at 25°C.

\[ 2 \text{Al(s)} + 3 \text{Mg}^{2+}(\text{aq}) \rightarrow 2 \text{Al}^{3+}(\text{aq}) + 3 \text{Mg(s)} \]

A) \(1.1 \times 10^{72}\)  
B) \(8.9 \times 10^{-73}\)  
C) \(1.1 \times 10^{-72}\)  
D) \(1.0 \times 10^{24}\)  
E) \(4.6 \times 10^{31}\)  

Answer: C
15
Calculate the cell potential for the following reaction that takes place in an electrochemical cell at 25°C.

\[ \text{Sn(s)} \mid \text{Sn}^{2+}(\text{aq}, 0.022 \text{ M}) \parallel \text{Ag}^+(\text{aq}, 2.7 \text{ M}) \mid \text{Ag(s)} \]

A) +1.01 V  
B) -0.83 V  
C) +1.31 V  
D) +0.01 V  
E) -0.66 V  
Answer: A

16
Nickel can be plated from aqueous solution according to the following half reaction. How long would it take (in min) to plate 29.6 g of nickel at 4.7 A?

\[ \text{Ni}^{2+}(\text{aq}) + 2 \text{ e}^- \rightarrow \text{Ni(s)} \]

A) $1.7 \times 10^2$ min  
B) $5.9 \times 10^2$ min  
C) $3.5 \times 10^2$ min  
D) $4.8 \times 10^2$ min  
E) $6.2 \times 10^2$ min  
Answer: C

17
Which of the following statements are TRUE?
A) Gamma rays have the lowest ionizing power of any radioactivity.  
B) Alpha radiation has the highest penetrating power of any radioactivity.  
C) Beta emitters will do more damage than alpha emitters within the body.  
D) Beta radiation has the highest ionizing power of any radioactivity.  
E) None of the above are true.  
Answer: A

18
Which particle has the highest penetrating power?
A) Alpha particle.  
B) Beta particle.  
C) Gamma particle.  
D) Positron emission.  
E) Electron capture.  
Answer: C
19
Describe what changes occur during beta decay.
A) The mass number and atomic number decreases.
B) The mass number and atomic number increases.
C) The mass number is unchanged and the atomic number decreases.
D) The mass number is unchanged and the atomic number increases.
E) The mass number and atomic number do not change.
Answer: D

20
Write a nuclear equation for the alpha decay of $^{238}_{92}$U.
A) $^{238}_{92}$U $\rightarrow$ $^1_0$n + $^{237}_{92}$U
B) $^{238}_{92}$U $\rightarrow$ $^0_{-1}$e + $^{238}_{93}$Np
C) $^{238}_{92}$U $\rightarrow$ $^4_2$He + $^{234}_{90}$Th
D) $^{238}_{92}$U $\rightarrow$ $^0_{+1}$e + $^{238}_{91}$Pa
E) $^{238}_{92}$U $\rightarrow$ $^0_{-1}$e + $^{238}_{91}$Pa
Answer: C

21
Determine the identity of the daughter nuclide from the beta decay of $^{89}_{38}$Sr.
A) $^{90}_{38}$Sr
B) $^{90}_{39}$Y
C) $^{89}_{39}$Y
D) $^{85}_{36}$Kr
E) $^{87}_{34}$Se
Answer: C

22
Determine the identity of the daughter nuclide from the positron emission of $^{18}_{9}$F.
A) $^{22}_{11}$Na
B) $^{19}_{9}$F
C) $^{14}_{7}$N
D) $^{18}_{8}$O
E) $^{18}_{10}$Ne
Answer: D
Determine the identity of the daughter nuclide from the electron capture by $^{55}_{26}\text{Fe}$.

A) $^{55}_{27}\text{Co}$  
B) $^{55}_{25}\text{Mn}$  
C) $^{56}_{27}\text{Co}$  
D) $^{54}_{25}\text{Mn}$  
E) $^{51}_{24}\text{Cr}$  
Answer: B

Identify the missing particle in the following nuclear equation:

$^3_1\text{H} + ^2_1\text{H} \rightarrow ^4_2\text{He} + ? + ^0_0\text{g}$

A) $^0_{-1}\text{e}$  
B) $^1_0\text{n}$  
C) $^0_{+1}\text{e}$  
D) $^1_1\text{H}$  
E) $^0_0\text{g}$  
Answer: B

The following reaction represents what nuclear process?

$^{241}_{95}\text{Am} \rightarrow ^4_2\text{He} + ^{327}_{93}\text{Np}$

A) beta emission  
B) neutron bombardment  
C) alpha emission  
D) electron capture  
E) positron emission  
Answer: C

Above what atomic number are there no stable isotopes of any element?

A) 20  
B) 92  
C) 83  
D) 40  
E) 89  
Answer: C
Fluorine-18 undergoes positron emission with a half-life of $1.10 \times 10^2$ minutes. If a patient is given a 248 mg dose for a PET scan, how long will it take for the amount of fluorine-18 to drop to 83 mg? (Assume that none of the fluorine is excreted from the body.)

A) 99 minutes  
B) $1.74 \times 10^2$ minutes  
C) $1.32 \times 10^2$ minutes  
D) $3.00 \times 10^2$ minutes  
E) $2.11 \times 10^2$ minutes  
Answer: B

Calculate the mass defect in Fe-56 if the mass of an Fe-56 nucleus is 55.921 amu. The mass of a proton is 1.00728 amu and the mass of a neutron is 1.008665 amu.

A) 0.528 amu  
B) 3.507 amu  
C) 0.564 amu  
D) 1.056 amu  
E) 0.079 amu  
Answer: A

What is the nuclear binding energy for a Fe-56 nucleus (see problem 28)? A proton has a mass of 1.00728 amu, a neutron has a mass of 1.008665 amu, and 1 amu is equivalent to 931.5 MeV of energy.

A) 492 MeV  
B) 3267 MeV  
C) 525 MeV  
D) 984 MeV  
E) 73.6 MeV  
Answer: A

Identify the symptom that is not from radiation exposure.

A) Increased white cell count.  
B) Increased cancer risk.  
C) Death.  
D) Genetic effects.  
E) Weaker immune systems.  
Answer: A

Give the number of covalent bonds that a carbon atom can form.

A) 1  
B) 2  
C) 3  
D) 4  
E) 5  
Answer: D
32
Identify the formula for an alkane.
A) $C_nH_{2n+2}$
B) $C_nH_{2n-2}$
C) $C_nH_{2n}$
D) $C_nH_{2n-4}$
E) $C_nH_{2n+4}$
Answer: A

33
How many of the carbons in the following compound are chiral center(s)?

![Chemical structure]

A) 0
B) 1
C) 2
D) 3
E) 4 or more
Answer: D

34
Name the following compound.

![Chemical structure]

A) 3-ethyl-3-methylhexane
B) 3-methyl-3-propylpentane
C) 3-ethyl-3-propylbutane
D) nonane
E) 2-ethylheptane
Answer: A

35
Name the following compound.

![Chemical structure]
A) 2-methyl-4-pentene  
B) 1,1-dimethyl-3-butene  
C) 4-methyl-1-pentene  
D) hexene  
E) 2-methylpentane  
Answer: C

36
For the molecule shown in question 35; how many carbons are chiral centers?

A) 0  
B) 1  
C) 2  
D) 3  
E) 4  
Answer: A

37
Name the following compound.

\[
\begin{array}{c}
\text{CH}_2\text{CH}_3 \\
\text{CH}_3\text{CHCH}_2\text{CH}≡\text{CHCH}_3
\end{array}
\]
A) 2-ethyl-4-hexene  
B) 4-isobutyl-2-butane  
C) 3-methyl-5-heptane  
D) 4-isopropyl-2-butene  
E) 5-methyl-2-heptene  
Answer: E

38
Name the following compound.

\[
\begin{array}{c}
\text{CH}_3\text{CHCH}_3 \\
\text{CH}_3\text{CH}_2\text{CH}_2\text{CHC}≡\text{CH}
\end{array}
\]
A) 4-propyl-5-hexyne  
B) 3-isopropyl-1-hexyne  
C) 1-nonyne  
D) 4-methyl-3-propyl-1-pentyne  
E) 2-methyl-4-pentyne  
Answer: B

39
Which of the following compounds exhibit geometric isomerism?

A) CH₂=CH₂  
B) CH₂=CCl₂  
C) CBr₂=CHBr  
D) CHCl=CHCl  
E) (CH₃)₂C=CH-CH₃  
Answer: D
40
Name the following compound.

\[
\begin{array}{c}
\text{Br} \\
\text{Br}
\end{array}
\]

A) 2,5-dibromobenzene  
B) 2,5-dibromocyclohexene  
C) 1,4-dibromobenzene  
D) 1,4-bromocyclohexene  
E) 3,6-dibromobenzene  
Answer: C

41
Name the following compound.

\[
\begin{array}{c}
\text{Br} \\
\text{Br}
\end{array}
\]

A) o-dibromobenzene  
B) m-dibromobenzene  
C) p-dibromobenzene  
D) p-bromobenzene  
E) none of the above  
Answer: C

42
Name the following compound.

\[
\begin{array}{c}
\text{Cl} \\
\text{Cl}
\end{array}
\]

A) 2,3,5-trichlorobenzene  
B) 1,3,4-trichlorobenzene  
C) trichlorostyrene  
D) 1,2,4-trichlorobenzene  
E) 1,3,4-trichlorohexene  
Answer: D

43
Which of the following compounds is an alcohol?
A) CH₃CH₂CH₂CO₂H
B) CH$_3$-O-CH$_3$
C) CH$_3$CO$_2$CH$_3$
D) CH$_3$CH$_2$CH=O
E) CH$_2$OH-CH$_2$OH
Answer: E

44 Which of the following compounds is an aldehyde?
A) CH$_3$CH$_2$CH=O
B) CH$_3$CH$_2$CH$_2$CO$_2$H
C) CH$_3$CO$_2$CH$_3$
D) CH$_3$-O-CH$_3$
E) CH$_2$OH-CH$_2$OH
Answer: A

45 Which of the following compounds is an ketone?
A) \[
\begin{array}{c}
\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}
\end{array}
\]
B) \[
\begin{array}{c}
\text{O} \\
\text{CH}_3\text{CH}_2\text{CCH}_3
\end{array}
\]
C) CH$_3$CH$_2$NH$_2$
D) \[
\begin{array}{c}
\text{O} \\
\text{CH}_3\text{CH}_2\text{C}—\text{O}—\text{CH}_3
\end{array}
\]
E) \[
\begin{array}{c}
\text{O} \\
\text{CH}_3\text{CH}_2\text{CCH}_3
\end{array}
\]
Answer: B

46 Which of the following compounds is an ester?
A) \[
\begin{array}{c}
\text{O} \\
\text{CH}_3\text{CH}_2\text{CNH}_2
\end{array}
\]
B) \[
\begin{array}{c}
\text{O} \\
\text{CH}_3\text{CH}_2\text{CCH}_3
\end{array}
\]
C) \[
\begin{array}{c}
\text{O} \\
\text{CH}_3—\text{OH}
\end{array}
\]
D)
47
Which of the following compounds is an amine?
A) \((\text{CH}_3\text{CH}_2\text{)}_2\text{NH}\)
B) \(\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CO}_2\text{CH}_3\)
C) \(\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{O}-\text{CH}_2\text{CH}_2\text{CH}_3\)
D) \(\text{CH}_3\text{CH}≡\text{O}\)
E) \(\text{CH}_3\text{COCH}_3\)
Answer: A

48
Name the following compound.

\[
\text{CH}_3−\text{CH}_2−\text{CH}_2−\text{CH}_2−\text{CH}_2−\text{C}−\text{H}
\]
A) pentanal
B) 1-pentanol
C) hexanal
D) 1-pentanone
E) 1-hexanol
Answer: C

49
Name the following compound.

\[
\text{CH}_3−\text{CH}_2−\text{CH}_2−\text{CH}_2−\text{CH}_2−\text{C}−\text{H}
\]
A) pentanal
B) 1-pentanol
C) hexanal
D) 1-pentanone
E) 1-hexanol
Answer: C

50
Name the following compound.

\[
\text{CH}_3−\text{O}−\text{CH}_2−\text{CH}_2−\text{CH}_3
\]
A) methyl propanoate
B) propyl methanoate
C) 2-butanal  
D) methyl propyl ether  
E) 1-butanoic acid  
Answer: D