

5. In a kinetic experiment, a student placed crystals of iodine in a closed reaction vessel, introduced a given quantity of hydrogen gas, and collected data to calculate the rate of formation of hydrogen iodide. What would be the effect obtained on the rate of the reaction, if the student takes more amount of iodine from that used in the first experiment? (1)

A. ✓ **The rate of the reaction will be constant.**

B. The formation of hydrogen iodide will be decreased.

C. It lowers the rate of the reaction.

D. It speeds up the rate of the reaction.

Answer: A

Because iodine is present as a solid in this reaction, its concentration and activity are constant and independent of the amount added; thus, adding more solid iodine has no effect on the reaction rate.

6. Which of the following CORRECTLY relates the vapor pressure of a liquid with its boiling point? Boiling point is (1)
- A. the temperature at which the kinetic energy of molecules is much less than the intermolecular force.
- B. the temperature at which molecules present in the vapor phase go back to the liquid state.
- C. ✓ **the temperature at which the vapor pressure becomes equal to the external pressure.**
- D. the temperature at which all the three physical state co-exist.

Answer: C

The boiling point of a liquid is defined as the temperature at which its vapor pressure becomes equal to the surrounding external atmospheric pressure.

7. Consider this equilibrium system: $\text{CO (g)} + \text{Fe}_3\text{O}_4 \text{ (s)} \rightleftharpoons \text{CO}_2 \text{ (g)} + 3 \text{FeO (s)}$ Which of the following disturbances shift the equilibrium position to the right? (1)
- A. Adding $\text{Fe}_3\text{O}_4 \text{ (s)}$
- B. Removing FeO (s)
- C. Removing CO (g)
- D. ✓ **Removing $\text{CO}_2 \text{ (g)}$**

Answer: D

According to Le Chatelier's principle, removing a product like $\text{CO}_2 \text{ (g)}$ from an equilibrium mixture shifts the equilibrium position to the right to produce more of that product. Adding or removing solid substances has no effect on the equilibrium position.

8. Which one of the following resulted from interaction of the atomic orbitals of bonding atoms to produce new electron distribution associated with the entire molecule? (1)
- A. Bohr orbit
- B. Electron orbit
- C. ✓ **Molecular orbital**
- D. Hybrid orbital

Answer: C

Molecular orbital theory describes the interaction of atomic orbitals to produce new molecular orbitals that are delocalized and associated with the entire molecule, rather than individual atoms.

9. Which type of organic substances would be produced by heating a mixture of a carboxylic acid and an alcohol in the presence of H_2SO_4 ? (1)
- A. Ethers
- B. ✓ **Esters**
- C. Aldehydes
- D. Ketones

Answer: B

Heating a carboxylic acid with an alcohol in the presence of an acid catalyst (like concentrated H_2SO_4) undergoes an esterification reaction to produce an ester and water.

10. The heat change at constant pressure that results when 1 mole of a compound is formed from its elements in their standard states is (1)
- A. ✓ **standard enthalpy of formation** B. standard reduction potential
C. standard enthalpy of reaction D. standard entropy of reaction

Answer: A

The standard enthalpy of formation is defined as the change in enthalpy (heat change at constant pressure) when one mole of a compound is synthesized directly from its constituent elements in their standard states.

11. What is a redox reaction? It is a reaction in which (1)
- A. an acid and a base neutralize each other.
B. atoms or ions of two compound exchange bonding partners.
C. ✓ **electrons are transferred between species.**
D. two insoluble ions in compounds form an insoluble products.

Answer: C

A redox (reduction-oxidation) reaction is characterized by the transfer of electrons from one chemical species (which is oxidized) to another (which is reduced).

12. Which one of the following explains how electroplating takes place? (1)
- A. Metal is deposited on the anode by reduction of ions in the electrolyte solution.
B. ✓ **The cations in the electrolyte are supplied either by the added salt or from oxidation of the anode.**
C. The object to be electroplated either metal or graphite-coated plastic constitutes the anode.
D. The electrolyte is an aqueous solution of a salt of the plated metal.

Answer: B

In electroplating, the metal cations in the electrolyte solution that deposit on the cathode are continuously replenished either by adding more salt to the bath or by the oxidation and dissolution of an active metal anode.

13. How does the equivalent mass of a base is obtained? (1)
- A. By dividing its number of equivalent by the number of OH⁻ ions furnished by one formula unit of a base.
B. By multiplying its number of equivalent by the number of OH⁻ ions furnished by one formula unit of a base.
C. ✓ **By dividing its molar mass by the number of OH⁻ ions furnished by one formula unit of a base.**
D. By multiplying its molar mass by the number of OH⁻ ions furnished by one formula unit of a base.

Answer: C

The equivalent mass of a base is calculated by dividing its molar mass by its acidity, which is the number of hydroxide (OH⁻) ions that one formula unit of the base can furnish in solution.

14. Which one of the following reactions would occur spontaneously in an aqueous solution at 25°C? Assume that the initial concentrations of the dissolved species are all 1.0 M. Half reaction E°(V) Sn²⁺ + (aq) + 2e⁻ → Sn(s) -0.14 Br₂(l) + 2e⁻ → 2Br⁻(aq) +1.07 Ag⁺(aq) + e⁻ → Ag(s) +0.80 Ni²⁺(aq) + 2e⁻ → Ni(s) -0.25 Ca²⁺(aq) + 2e⁻ → Ca(s) -2.87 Cd²⁺(aq) + 2e⁻ → Cd(s) -0.40 Cu²⁺(aq) + e⁻ → Cu⁺(aq) +0.15 Fe³⁺(aq) → Fe²⁺(aq) +0.77 (1)
- A. ✓ **Ca(s) + Cd²⁺(aq) → Ca²⁺(aq) + Cd(s)**
B. Cu²⁺(aq) + Fe²⁺(aq) → Cu⁺(aq) + Fe³⁺(aq)
C. 2Br⁻(aq) + Sn²⁺(aq) → Br₂(l) + Sn(s)
D. 2Ag(s) + Ni²⁺(aq) → 2Ag⁺(aq) + Ni(s)

Answer: A

For a redox reaction to be spontaneous at standard conditions, its standard cell potential (E°_{cell}) must be positive. For option A, E°_{cell} = E°(reduction) - E°(oxidation) = -0.40 V - (-2.87 V) = +2.47 V, which is highly spontaneous.

15. Which one of the following is the main reason for the large difference in dipole-moment between the triatomic molecules water (H_2O) and carbon dioxide (CO_2)? (1)
- A. The bonds in carbon dioxide (CO_2) are directed 180° and bond polarity reinforces each other.
 - B. The presence of multiple bonds in carbon dioxide (CO_2) while single bonds in water.
 - C. The higher electronegativity difference among atoms in water (H_2O) than in carbon dioxide (CO_2).
 - D. ✓ **The presence of lone pairs of electrons in water (H_2O) partially reinforces bond polarities.**

Answer: D

Water (H_2O) has a bent geometry due to the two lone pairs on the oxygen atom, which partially reinforce the O-H bond dipoles, resulting in a large net dipole moment. In contrast, carbon dioxide (CO_2) is linear, causing its bond dipoles to cancel each other completely.

16. How many non-bonding pairs of electrons are present in the valence shell of the central atom in ClF_3 ? (1)
- A. ✓ **2**
 - B. 3
 - C. 0
 - D. 1

Answer: A

Chlorine (the central atom in ClF_3) has 7 valence electrons. Three electrons are used to form single bonds with three fluorine atoms, leaving four non-bonding electrons, which correspond to exactly 2 non-bonding (lone) pairs.

17. Which one would be observed in a laboratory activity that is applied on naphthalene? (1)
- A. It is soluble in water.
 - B. It shows relatively high melting point.
 - C. It conducts electricity in molten state.
 - D. ✓ **It is soluble in benzene.**

Answer: D

Naphthalene is a non-polar, molecular organic compound. Based on the principle of 'like dissolves like', it is highly soluble in non-polar solvents like benzene, but insoluble in polar solvents like water.

18. Which one of the following statements is CORRECT? (1)
- A. ✓ **Valence bond model explain molecular shape from the interaction of atomic orbitals.**
 - B. In Lewis model, electrons repel one another and a pair of bonding electrons lies far apart as possible.
 - C. Lewis model predicts the shapes, of molecules based on electron-pair repulsions around a central atom.
 - D. Valence bond model simply shows the linkage between atoms and the presence of lone pairs.

Answer: A

The valence bond model explains molecular shapes and bond strengths by looking at the overlap and hybridization of atomic orbitals, while VSEPR model (not Lewis) is based on electron-pair repulsions.

19. The energy required to completely separate one mole of a solid ionic compound into gaseous ions is a/an (1)
- A. Bond energy
 - B. ✓ **Lattice energy**
 - C. Chemical potential
 - D. Boiling Point

Answer: B

Lattice energy is the quantitative measure of the energy released when gaseous ions combine to form one mole of a solid ionic compound, or conversely, the energy required to separate them completely into gaseous ions.

20. Which of the properties of solvents WOULD NOT be affected by the formation of a solution with a non-volatile solute? (1)

- A. Freezing Point
B. ✓ **Chemical identity**
C. Chemical potential
D. Boiling Point

Answer: B

Adding a non-volatile solute affects the physical properties of the solvent (such as freezing point, boiling point, and chemical potential) via colligative effects, but it does not alter the chemical identity of the solvent molecules.

21. The partial pressure of acetylene, C_2H_2 , in a container is 10 atm at $25^\circ C$. What is the solubility in molarity of C_2H_2 , (1) assume that C_2H_2 obeys Henry's law? ($K_H = 1.04 \text{ mol/L atm}$)

- A. ✓ **10.4**
B. 104
C. 0.104
D. 9.62

Answer: A

According to Henry's law, the solubility of a gas is directly proportional to its partial pressure: $C = K_H \cdot P$. Here, $C = 1.04 \text{ mol/L atm} \cdot 10 \text{ atm} = 10.4 \text{ M}$.

22. What is the normality of a solution that contains 19.6 g of H_2SO_4 in 20 mL of the solution? (1)

- A. 10
B. ✓ **20**
C. 0.01
D. 0.02

Answer: B

H_2SO_4 has two equivalents per mole, so its equivalent mass is 49 g/eq. Thus, 19.6 g of H_2SO_4 corresponds to $19.6 / 49 = 0.4$ equivalents. Dissolved in 0.02 L (20 mL), the normality is $0.4 \text{ eq} / 0.02 \text{ L} = 20 \text{ N}$.

23. Which one of the following illustrates an extensive property? (1)

- A. If water in two beakers at the same temperature are mixed to make a single quantity of water and the temperature of the combined quantity of water is the same as it was in the two separate beakers.
B. Doubling the volume of a sample also doubles the mass; so the ratio of mass to volume remains the same.
C. **If a system is divided into parts and it is found that the property of the complete system has a value that is the sum of the values of the property of all the parts.**
D. The electrode potential at standard condition for the half-reaction $2 Cu^{2+} + 4 e^- \rightarrow 2 Cu$ is the same as for $Cu^{2+} + 2 e^- \rightarrow Cu$.

Answer: C

An extensive property depends on the amount of matter in a sample. Its value for an entire system is the sum of the values of that property for all individual parts of the system, such as mass or volume.

24. The point in a titration at which the number of moles of OH^- ions added to a solution is equal to the number of moles of H^+ ions originally present is (1)

- A. ✓ **Equivalence point**
B. Triple point
C. End point
D. Zero point

Answer: A

The equivalence point in an acid-base titration is the theoretical point at which the quantity of added titrant is stoichiometrically equal to the quantity of analyte originally present (i.e., moles of OH^- added equals moles of H^+ originally present).

25. Which of the following statements describes chemical industries? It is (1)
- A. **a firm that involves usage of raw material to produce desired products by using chemical reactions and refining methods.**
 - B. a process in which dissolved solute comes out of solution and forms crystals.
 - C. an expression for the chemical composition of a compound in terms of the symbols of the atoms of the elements involved.
 - D. an area of chemistry concerned with the speeds, or rates, at which chemical reactions occur.

Answer: A

Chemical industries use raw materials to manufacture desired chemical products via chemical reactions and refining processes. Option B describes crystallization, C describes a chemical formula, and D describes chemical kinetics.

26. What will be the product if phosphorus reacts with excess amount of oxygen? (1)
- A. P_4O_6
 - B. **P_4O_{10}**
 - C. H_3PO_4
 - D. H_3PO_3

Answer: B

When phosphorus reacts with excess oxygen, it undergoes complete oxidation to form phosphorus pentoxide, which exists in its dimerized form, P_4O_{10} . In limited oxygen, P_4O_6 is formed instead.

27. One of the basic differences between metallic conduction and electrolytic conduction is: (1)
- A. The conduction of electricity is due to the movement of ions in metallic conduction while the flow of mobile electrons in electrolytic conduction.
 - B. The charge carriers in metals are localized electrons while strongly held ions are in electrolytic conduction.
 - C. The charge carriers in metals are cations and anions while mobile electrons are in electrolytic conduction.
 - D. **The conduction of electricity is due to the movement of ions in an electrolytic conduction while the flow of mobile electrons in metallic conduction.**

Answer: D

In metallic conductors, electric current is carried by the flow of free, mobile electrons, whereas in electrolytic conductors, the charge is carried by the migration of cations and anions.

28. Which one of the following gases is released from combustion of a fuel in an industrial machinery causing global warming? (1)
- A. SO_2
 - B. NO
 - C. **CO_2**
 - D. CO

Answer: C

Carbon dioxide (CO_2) is a major greenhouse gas produced during the combustion of fossil fuels in industrial engines, which traps heat in the atmosphere and leads to global warming.

29. The number of digits to the right of the decimal point denotes: (1)
- A. Scientific notation
 - B. Conversion factor
 - C. **Decimal places**
 - D. Significant figures

Answer: C

The number of digits located to the right of the decimal point in a measurement represents the number of decimal places, which indicates the precision of the measuring instrument.

30. Which one of the following IS TRUE about isotopes?

(1)

- A. ✓ **Isotopes of an element have the same chemical properties.**
- B. Isotopes of the same elements contain the same number of neutrons.
- C. Isotopes of an element are identical in mass number.
- D. Isotopes of an element are atoms that have different number of electrons and protons.

Answer: A

Isotopes of an element have the same atomic number (protons and electrons), which means they have identical electronic configurations and therefore identical chemical properties, though their physical properties differ.

31. Which one of the following describes the quantum mechanical model?

(1)

- A. Electrons moved around the nucleus of an atom in circular orbits.
- B. An atom is a sphere with a positively charged matter, in which electrons are embedded.
- C. An atom is represented by a solid indestructible sphere.
- D. ✓ **The locations of electrons in an atom are described in terms of probability.**

Answer: D

The quantum mechanical model describes the behavior of electrons in terms of wave mechanics, determining the probability of finding an electron in a specific region of space (orbital) rather than defined circular orbits.

32. Which one of the following is an ionic compound?

(1)

- A. H_2O_2
- B. PCl_3
- C. CO_2
- D. ✓ **CaCl_2**

Answer: D

CaCl_2 is an ionic compound formed by the transfer of electrons from a metal (calcium) to a non-metal (chlorine), resulting in ionic bonding, whereas the other options are molecular compounds with covalent bonds.

33. An element is located in Group VIIA and 3rd period of the modern periodic table. On the basis of this the element;

(1)

- A. has extremely low electron affinity.
- B. ✓ **forms an acidic oxide.**
- C. has very low ionization energy.
- D. generally forms an ion with -2 charges.

Answer: B

Chlorine, located in Group VIIA and Period 3, is a non-metal and therefore reacts with oxygen to form acidic oxides (such as Cl_2O_7 and Cl_2O).

34. Which one of the following is the reducing agent in the following reaction? $8\text{NH}_3(\text{g}) + 6\text{NO}_2(\text{g}) \rightarrow 7\text{N}_2(\text{g}) + 12\text{H}_2\text{O}(\text{l})$ (1)

- A. N_2
- B. H_2O
- C. ✓ **NH_3**
- D. NO_2

Answer: C

In the reaction, the oxidation state of nitrogen in NH_3 increases from -3 to 0, meaning it is oxidized and acts as the reducing agent, while nitrogen in NO_2 is reduced from +4 to 0.

35. Carbon forms two stable compounds with oxygen, namely, carbon monoxide and carbon dioxide. For a fixed mass of carbon, the ratio of oxygen in carbon monoxide to oxygen in carbon dioxide is 1:2. This result is consistent with the law of (1)

- A. ✓ **multiple proportion.** B. constant composition.
C. conservation of mass. D. definite proportion.

Answer: A

The law of multiple proportions states that when two elements combine to form more than one compound, the masses of one element that combine with a fixed mass of the other are in a ratio of small whole numbers (1:2 for CO and CO₂).

36. When a system at equilibrium is disturbed by a change of variable, the system shifts the equilibrium position in a way that tends to counteract this change of variable. This is a statement for (1)

- A. ✓ **Le Chatelier Principle** B. Heisenberg uncertainty principle
C. Aufbau principle D. Pauli's exclusion principle

Answer: A

Le Chatelier's Principle states that if a dynamic equilibrium is disturbed by changing the conditions, the position of equilibrium shifts in a direction that counteracts the change to re-establish an equilibrium.

37. Which one of the following gas laws states the volume of a fixed amount of gas maintained at constant pressure is directly proportional to the absolute temperature of the gas? (1)

- A. Combined gas law B. Avogadro's law
C. Boyle's law D. ✓ **Charles' law**

Answer: D

Charles's law states that, at constant pressure, the volume of a given mass of gas is directly proportional to its absolute temperature ($V \propto T$).

38. Which one of the following is an example of molecular crystals? (1)

- A. Magnesium B. ✓ **Solid carbon dioxide**
C. Sodium Chloride D. Diamond

Answer: B

Solid carbon dioxide (dry ice) consists of individual CO₂ molecules held together in a crystal lattice by weak London dispersion forces, making it a molecular crystal.

39. Which one of the following COULD NOT be considered as factor influencing the rate of chemical reaction? (1)

- A. Temperature of reactants B. ✓ **The rate constant of the reaction**
C. Surface area of reactants D. Presence of catalyst

Answer: B

The rate constant (k) is an inherent kinetic parameter of a reaction at a given temperature; it is not an external factor (such as temperature, catalyst, or surface area) that can be manipulated to change the rate.

40. In which of the following order of a reaction, a plot of $\ln [A]_t$ versus time is a straight line whose slope is $-k$? (1)

- A. Second B. Third
C. Zero D. ✓ **First**

Answer: D

The integrated rate law for a first-order reaction is $\ln[A]_t = -kt + \ln[A]_0$, which represents a straight-line equation ($y = mx + c$) where a plot of $\ln[A]_t$ vs. time has a slope of $-k$.

Radioactive decay is the spontaneous process in which an unstable atomic nucleus undergoes breakdown and emits radiation (particles or electromagnetic waves) to achieve stability.

46. Which statement describes valence shell electron pair repulsion (VSEPR) theory? (1)
- A. A covalent bond is formed when orbitals of two atoms overlap and the overlap region is occupied by a pair of electrons.
 - B. Atomic orbitals are capable of combining to produce new electron distribution.
 - C. ✓ **Electron pairs will be as far apart from each other in three dimensional spaces as possible.**
 - D. Each degenerate orbitals are occupied by a single electron before the second electrons of opposite spin enters the orbitals.

Answer: C

VSEPR theory states that electron pairs around a central atom arrange themselves in three-dimensional space to minimize electrostatic repulsion, keeping them as far apart as possible.

47. Which of the following compounds reacts with basic oxide to form salt and water? (1)
- A. Neutral oxide
 - B. Base
 - C. Acidic oxide
 - D. ✓ **Acid**

Answer: D

An acid (such as HCl) reacts with a basic oxide (such as CuO) to form a salt and water through a neutralization-like reaction.

48. Which one of the following reaction represents formation of an acid from its salt? (1)
- A. $\text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq}) \rightarrow \text{NaNO}_3(\text{aq}) + \text{AgCl}(\text{s})$
 - B. ✓ **$\text{NaNO}_3(\text{s}) + \text{H}_2\text{SO}_4(\text{l}) \rightarrow \text{NaHSO}_4(\text{s}) + \text{HNO}_3(\text{l})$**
 - C. $\text{P}_2\text{O}_5(\text{s}) + 6\text{NaOH}(\text{aq}) \rightarrow 2\text{Na}_3\text{PO}_4(\text{s}) + 3\text{H}_2\text{O}(\text{l})$
 - D. $\text{CH}_3\text{COOH}(\text{aq}) + \text{CH}_3\text{OH}(\text{aq}) \rightarrow \text{CH}_3\text{CO}_2\text{CH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l})$

Answer: B

The reaction of sodium nitrate (a salt) with concentrated sulfuric acid produces nitric acid (a volatile acid), demonstrating the preparation of a volatile acid from its salt.

49. The negative logarithm of the molar concentration of hydrogen ion to the base ten is known as ----- (1)
- A. pOH
 - B. K_a
 - C. K_w
 - D. ✓ **pH**

Answer: D

By definition, pH is the negative logarithm (to the base 10) of the hydrogen ion concentration, represented as $\text{pH} = -\log[\text{H}^+]$.

50. Which one of the following galvanic cell is an example of secondary cell? (1)
- A. Zinc-carbon dry cell
 - B. Leclanche dry cell
 - C. ✓ **Lead storage cell**
 - D. Daniel's cell

Answer: C

A lead storage cell is a secondary cell because the electrochemical reactions are reversible, making it rechargeable, whereas dry cells are primary cells.

51. Which one of the following is responsible for electrolytic conductivity? (1)
- A. ✓ **Movement of ions.** B. Electrons held in a fixed position.
C. Free electrons. D. Ions strongly held in a fixed position.

Answer: A

Electrolytic conductivity relies on the movement of free ions toward the electrodes, unlike metallic conductivity which depends on free electrons.

52. The pH of a 0.1 M solution of formic acid (HCOOH) is 3. What is the K_a of the acid? (1)
- A. 9.99×10^{-5} B. 9.99×10^{-4}
C. 1.01×10^{-7} D. ✓ **1.01×10^{-5}**

Answer: D

With pH = 3, $[H^+] = 10^{-3}$ M. Using $K_a = [H^+][HCOO^-] / [HCOOH] = (10^{-3})^2 / (0.1 - 10^{-3}) = 10^{-6} / 0.099 = 1.01 \times 10^{-5}$.

53. A system does 15 J of work and no other changes take place. Which of the following function has fallen by 15 J? (1)
- A. Entropy B. Enthalpy
C. Specific heat D. ✓ **Internal energy**

Answer: D

According to the First Law of Thermodynamics ($\Delta U = q + w$), if a system does 15 J of work ($w = -15$ J) and no heat is exchanged ($q = 0$), its internal energy falls by 15 J.

54. Which of the following is CORRECTLY stated about the spontaneity of a reaction? (1)
- A. For an exothermic reaction with negative reaction entropy, the reaction is spontaneous at high temperature.
B. ✓ **For an endothermic reaction with positive reaction entropy, the reaction is non-spontaneous at low temperature.**
C. For an exothermic reaction with positive reaction entropy, the reaction is non-spontaneous at all temperature.
D. For an endothermic reaction with negative reaction entropy, the reaction is spontaneous at all temperature.

Answer: B

For an endothermic reaction (positive ΔH) with positive entropy change (positive ΔS), the Gibbs free energy change ($\Delta G = \Delta H - T\Delta S$) is positive at low temperatures, making it non-spontaneous.

55. In thermodynamics: solutions in a beaker, a gas in a cylinder, a reaction vessel, a biological cell are examples of (1)
- A. ✓ **thermodynamic system** B. path function
C. state function D. thermodynamic variables

Answer: A

A thermodynamic system is any specific portion of the universe under study, such as a solution in a beaker, a gas in a cylinder, or a cell.

56. Given the following: bond energies (kJ/mol) H-H 936 N-N 193 N=N 409 $N \equiv N$ 942 and the enthalpy for the reaction $1/2 N_2(g) + 3/2 H_2(g) \rightarrow NH_3(g)$; $\Delta H = -45$ kJ/mol What is the bond energy for NH_3 ? (1)
- A. 1080 B. 960
C. ✓ **1170** D. 1125

Answer: C

Using standard bond energy calculation, $\Delta H = BE(\text{reactants}) - BE(\text{products})$. Substituting the values, $-45 = [0.5 \times 942 + 1.5 \times 436] - BE(NH_3)$, giving the total bond energy of NH_3 as 1170 kJ/mol (where the 936 value in the prompt contains a typo for the H-H bond energy of 436 kJ/mol).

57. Which of the following would occur during the formation of ions? (1)
- A. ✓ **Valence electrons are transferred from one atom to another.**
 - B. The electronic configuration of an atom forming the ion remains unaffected.
 - C. Valence electrons are shared between atoms.
 - D. Inner most shell electrons are involved.

Answer: A

The formation of ionic bonds involves the complete transfer of valence electrons from a metal atom to a nonmetal atom, resulting in the formation of cations and anions.

58. In order to illustrate the structure and properties of a solid, a student put hundred marble balls in to a box that representing metal cations and the empty space between and around the marble representing the electron sea. Which one of the following bonding is represented by this model? (1)
- A. Dative bonding
 - B. ✓ **Metallic bonding**
 - C. Ionic bonding
 - D. Covalent bonding

Answer: B

The 'electron sea' model, consisting of metal cations surrounded by a pool of mobile, delocalized valence electrons, is used to describe metallic bonding.

59. Which one of the following explains dipole-dipole force? (1)
- A. An electrostatic attraction between metal ions and valence electrons.
 - B. An attractive force resulting from temporary dipoles induced in molecules.
 - C. ✓ **The intermolecular attraction between oppositely charged poles of nearby polar molecules.**
 - D. A type of intermolecular force that exists between non- polar molecules.

Answer: C

Dipole-dipole forces are electrostatic attractions between the positive end of one polar molecule and the negative end of an adjacent polar molecule.

60. Which one of the following reactions creates energy in our bodies during respiration? (1)
- A. $\text{N}_2\text{H}_4\text{CO}(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightarrow 2\text{NH}_3(\text{l}) + \text{CO}_2(\text{g})$
 - B. $\text{C}_6\text{H}_{12}\text{O}_6(\text{s}) \rightarrow 2\text{C}_2\text{H}_5\text{OH}(\text{l}) + 2\text{CO}_2(\text{g})$
 - C. $6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l}) \rightarrow \text{C}_6\text{H}_{12}\text{O}_6(\text{s}) + 6\text{O}_2(\text{g})$
 - D. ✓ **$\text{C}_6\text{H}_{12}\text{O}_6(\text{s}) + 6\text{O}_2(\text{g}) \rightarrow 6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l})$**

Answer: D

Respiration is the oxidation of glucose with oxygen in our cells to produce carbon dioxide, water, and energy in the form of ATP.

61. "A reaction that involves the exchange of positive and negative ions of each reactant". This is a definition of a (1)
- A. Single displacement reaction
 - B. ✓ **Double displacement reaction**
 - C. Combination reaction
 - D. Decomposition reaction

Answer: B

A double displacement reaction is defined as a chemical reaction in which two compounds exchange ions to form two new compounds.

62. Which one of the following statement is TRUE about gases? (1)
- A. ✓ **The volume of a gas is equal to the volume of its container.**
 - B. When a gas sample is heated at constant pressure, its volume decreases.
 - C. The volume of a gas is kept constant as pressure increases.
 - D. The particles of gases are closely packed together.

Answer: A

Because gas particles have negligible volume compared to the container and move freely to fill the space, the volume of a gas always equals the volume of its container.

63. Which one of the following mathematical expressions is derived from the combination of Boyle's law, Charles' law and Avogadro's law? (1)
- A. $V \propto (P n T)$
 - B. $V \propto (n P T)$
 - C. $V \propto (T n P)$
 - D. ✓ **$V \propto (n T P)$**

Answer: D

Combining Boyle's law (V is inversely proportional to P), Charles' law (V is directly proportional to T), and Avogadro's law (V is directly proportional to n) yields V is proportional to nT/P .

64. 180 g of calcium carbonate (CaCO_3) is allowed to react with 156 gram of hydrochloric acid (HCl), according to the following reaction. Which of the following substances is the limiting reagent? (Atomic masses; $\text{Ca}=40$, $\text{Cl}=35.5$, $\text{O}=16$, $\text{C}=12$, $\text{H}=1$) $\text{CaCO}_3 + 2 \text{HCl} \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$ (1)
- A. CO_2
 - B. H_2O
 - C. ✓ **CaCO_3**
 - D. HCl

Answer: C

Molar mass of CaCO_3 is 100 g/mol, giving 1.8 moles. Molar mass of HCl is 36.5 g/mol, giving 4.27 moles. Since the stoichiometry requires 2 moles of HCl per mole of CaCO_3 , 1.8 moles of CaCO_3 would require 3.6 moles of HCl , leaving HCl in excess and making CaCO_3 the limiting reagent.

65. Which one of the following isomers differs in the arrangement of carbon atoms in the longest continuous carbon chain? (1)
- A. ✓ **Structural**
 - B. Cis-trans
 - C. Position
 - D. Geometric

Answer: A

Chain isomers, which differ in the arrangement of carbon atoms in the main chain, are a subcategory of structural (or constitutional) isomers.

66. Which one of the following methods can be used in the laboratory for the preparation of alkynes? (1)
- A. Hydrogenation of alkenes with a metal catalyst.
 - B. ✓ **Dehydrohalogenation of adjacent dihalides with sodium hydroxide.**
 - C. Heating of sodium salt of an organic acid with soda lime.
 - D. Dehydration of alcohols with concentrated sulphuric acid.

Answer: B

Dehydrohalogenation of vicinal (adjacent) dihalides using a strong base like NaOH or KOH eliminates two molecules of hydrogen halide to form a triple bond (alkyne).

67. Which one of the following is TRUE about the electrolysis of a molten hypothetical electrolyte, MX? (1)
- A. ✓ **The overall reaction is redox reaction.**
 - B. Electrons are not transferred from one species to the other.
 - C. M is produced at the anode.
 - D. X is produced at the negative electrode.

Answer: A

Electrolysis always involves oxidation at the anode and reduction at the cathode, making the overall reaction a redox reaction.

68. During the extraction of an unknown metal, the metallic ore was fused with NaOH in air and then dissolved in water to obtain the soluble unknown metal containing species. Reduction with carbon is followed after the solution is treated with HCl. Finally the obtained oxide is reduced to its metallic form by aluminum. The most probable unknown metal would be (1)
- A. Pb
 - B. ✓ **Cr**
 - C. Zn
 - D. Ca

Answer: B

Chromium extraction involves fusing chromite ore with NaOH to form soluble sodium chromate, which is then neutralized and reduced by carbon to chromium(III) oxide, followed by reduction to Cr metal using the aluminothermic process.

69. Why tin does NOT react with cold water but calcium reacts with cold water quite readily? (1)
- A. Due to the pH of water.
 - B. Due to its physical state.
 - C. Due to the formation of a thin oxide layer.
 - D. ✓ **Due to its less reactive nature.**

Answer: D

According to the activity series of metals, calcium is highly active and reacts vigorously with cold water, whereas tin is much lower in the series and is far less reactive.

70. Why is vulcanization performed in natural rubber? (1)
- A. To increase the number of monomer unit in the natural rubber.
 - B. To decrease the number of monomer unit in the natural rubber.
 - C. ✓ **To establish cross-links between polymer chain in the natural rubber.**
 - D. To convert the monomer unit in natural rubber in to polymer.

Answer: C

Vulcanization is the chemical process of heating natural rubber with sulfur to create disulfide cross-links between the polymer chains, improving its mechanical properties and elasticity.

71. Which one of the following explains the determination of the cell potential of Zn-Cu cell using voltmeter? (1)
- A. After the experiment the mass of zinc is increased.
 - B. ✓ **Each U-tube served as a salt bridge that can be filled with saturated KCl.**
 - C. In the Zn half- cell, Zn metal will be dipped in CuSO_4 solution.
 - D. In the Cu half-cell, Cu metal will be dipped in ZnSO_4 solution.

Answer: B

In a galvanic cell, a U-tube filled with a saturated electrolyte like KCl acts as a salt bridge to allow ion migration, maintaining electrical neutrality and enabling voltage measurement.

72. The rate law for: is rate = . The accepted mechanism for the reaction is Why DOES NOT H₂O appear in the rate law? Because (1)

- A. ✓ **water is missing in the rate determining step.**
B. water exists in the liquid state in the reaction.
C. water is an intermediate species.
D. water is a catalyst in the reaction.

Answer: A

A reactant does not appear in the overall rate law if it is not involved in the rate-determining (slowest) step of the reaction mechanism.

73. Which type of substances has the following general formula? (R₁, R₂ and R₃ hydrocarbon groups.) (1)

- A. Fatty acids
B. Alcohols
C. ✓ **Fats**
D. Carboxylic acids

Answer: C

Although the formula is missing, the presence of three hydrocarbon groups (R₁, R₂, and R₃) is characteristic of a triglyceride, which represents fats and oils.

74. The rate law for this reaction $\text{CO (g)} + \text{NO}_2 \text{ (g)} \rightarrow \text{CO}_2 \text{ (g)} + \text{NO (g)}$ is rate = $k [\text{NO}_2]^2$. Which one of the following could be a plausible mechanism for the reaction? (1)

- A. $\text{NO}_2 \text{ (g)} + \text{NO}_2 \text{ (g)} \rightarrow \text{NO}_3 \text{ (g)} + \text{NO}_2 \text{ (g)}$ [fast] $\text{NO}_3 \text{ (g)} + \text{CO (g)} \rightarrow \text{NO}_2 \text{ (g)} + \text{CO}_2 \text{ (g)}$ [slow]
B. $\text{NO}_3 \text{ (g)} + \text{NO (g)} \rightarrow \text{NO}_2 \text{ (g)} + \text{NO}_2 \text{ (g)}$ [slow] $\text{NO}_2 \text{ (g)} + \text{CO}_2 \text{ (g)} \rightarrow \text{NO}_3 \text{ (g)} + \text{CO}_2 \text{ (g)}$ [fast]
C. $\text{NO}_3 \text{ (g)} + \text{NO (g)} \rightarrow \text{NO}_2 \text{ (g)} + \text{NO}_2 \text{ (g)}$ [slow] $\text{NO}_3 \text{ (g)} + \text{CO (g)} \rightarrow \text{NO}_2 \text{ (g)} + \text{CO}_2 \text{ (g)}$ [fast]
D. ✓ **$\text{NO}_2 \text{ (g)} + \text{NO}_2 \text{ (g)} \rightarrow \text{NO}_3 \text{ (g)} + \text{NO (g)}$ [slow] $\text{NO}_3 \text{ (g)} + \text{CO (g)} \rightarrow \text{NO}_2 \text{ (g)} + \text{CO}_2 \text{ (g)}$ [fast]**

Answer: D

In mechanism D, the slow rate-determining step is bimolecular with respect to NO₂, yielding the rate law rate = $k[\text{NO}_2]^2$. Summing the two steps also correctly yields the overall reaction $\text{CO} + \text{NO}_2 \rightarrow \text{CO}_2 + \text{NO}$.

75. The speed with which a solute goes into solution is (1)

- A. extent of dissolution
B. ✓ **rate of dissolution**
C. heat of solution
D. degree of solvation

Answer: B

The speed or velocity at which a process occurs is defined as its rate; therefore, the speed at which a solute dissolves is the rate of dissolution.

76. Which one of the following explains how 2 L of 1 M NaOH aqueous stock solution is converted into a 0.25 M NaOH solution? (1)

- A. Evaporating 1 L of water from the stock solution
B. Evaporating 0.25 L of water from the stock solution
C. Adding 8 L water to the stock solution
D. ✓ **Adding 6 L water to the stock solution**

Answer: D

Using the dilution equation $M_1V_1 = M_2V_2$, we have $(1 \text{ M})(2 \text{ L}) = (0.25 \text{ M})(V_2)$, which gives a final volume V_2 of 8 L. Since we start with 2 L of stock solution, we must add 6 L of water ($8 \text{ L} - 2 \text{ L} = 6 \text{ L}$).

END OF THE MARKING KEY

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