CUET UG Chemistry Sample Paper - 19

Duration: 1 Hour **Maximum Marks: 250**

Instructions

- This paper contains a total of 50 Multiple Choice Questions.
- Each correct answer carries **+5 marks**.
- Each incorrect answer carries **-1 mark**.
- No negative marking for unattempted questions.

Q1. Which of the following aqueous solutions will have the highest boiling point?

(A) $0.1M\ K_2SO_4$

(B) $0.1M\ NaCl$

(C) $0.1M\ Glucose$

(D) $0.1M\ Urea$

Q2. For an ideal solution, which of the following is correct?

(A) $\Delta V_{mix} \neq 0$

(B) $\Delta H_{mix} = 0$

(C) $\Delta S_{mix} = 0$

(D) $\Delta G_{mix} = 0$

Q3. A solution of acetone and ethanol shows:

(A) Positive deviation from Raoult's Law

(B) Negative deviation from Raoult's Law

(C) No deviation

(D) Ideal behavior

Q4. The value of Van't Hoff factor (i) for $K_4[Fe(CN)_6]$ assuming 100% dissociation is:

(A) 4

(B) 5

(C) 2

(D) 3

Q5. The osmotic pressure of a solution can be increased by:

(A) Increasing the temperature

(B) Decreasing the concentration

(C) Increasing the volume

(D) Decreasing the number of solute particles

Q6. According to Kohlrausch law, the molar conductivity of a strong electrolyte at infinite dilution is:

(A) Sum of ionic conductivities of cations and anions

(B) Product of ionic conductivities

(C) Equal to the conductivity of the cation

(D) Zero

Q7. In the Nernst equation, if the concentration of ions increases, the electrode potential (E):

(A) Increases

(B) Decreases

(C) Remains constant

(D) Becomes zero

Q8. Which of the following is used in a Fuel Cell?

(A) H_2 and O_2

(B) N_2 and Ar

(C) Pb and H_2SO_4

(D) Cd and Ni

Q9. How much charge (in Faraday) is required to reduce 1 mole of MnO_4^- to Mn^{2+}?

(A) 1 F

(B) 3 F

(C) 5 F

(D) 7 F

Q10. The standard reduction potential of three metals A, B, and C are $+0.5V$, $-3.0V$, and $-1.2V$ respectively. The reducing power order is:

(A) $B > C > A$

(B) $A > B > C$

(C) $C > B > A$

(D) $A > C > B$

Q11. The unit of cell constant is:

(A) cm^{-1}

(B) $\Omega \cdot cm$

(C) $S \cdot cm^2 \cdot mol^{-1}$

(D) $S \cdot cm^{-1}$

Q12. For a first-order reaction, the half-life period ($t_{1/2}$) is:

(A) Dependent on initial concentration
(B) Independent of initial concentration
(C) Directly proportional to initial concentration
(D) Inversely proportional to initial concentration

Q13. The unit of rate constant for a zero-order reaction is:

(A) s^{-1}
(B) $mol \cdot L^{-1} \cdot s^{-1}$
(C) $L \cdot mol^{-1} \cdot s^{-1}$
(D) $mol^2 \cdot L^{-2} \cdot s^{-1}$

Q14. If the rate of reaction doubles when the temperature is raised from $290K$ to $300K$, the activation energy is calculated using:

(A) Arrhenius Equation
(B) Raoult's Law
(C) Nernst Equation
(D) Faraday's Law

Q15. A catalyst increases the rate of reaction by:

(A) Decreasing activation energy
(B) Increasing activation energy
(C) Increasing enthalpy
(D) Decreasing entropy

Q16. Molecularity of a reaction can never be:

(A) 1

(B) 2

(C) 0

(D) 3

Q17. Lanthanoid contraction is due to:

(A) Poor shielding of $4f$ electrons

(B) High shielding of $4f$ electrons

(C) Increase in nuclear charge

(D) Both A and C

Q18. Which transition element does not show variable oxidation states?

(A) Fe

(B) Cu

(C) Sc

(D) Mn

Q19. The magnetic moment of Fe^{2+} (Z=26) is:

(A) $4.90BM$

(B) $5.92BM$

(C) $1.73BM$

(D) $2.84BM$

Q20. $KMnO_4$ acts as an oxidizing agent in:

(A) Acidic medium
(B) Basic medium
(C) Neutral medium
(D) All of the above

Q21. The IUPAC name of $[Co(NH_3)_5Cl]Cl_2$ is:

(A) Pentaamminechloridocobalt(III) chloride
(B) Pentaamminechlorocobalt(II) chloride
(C) Chloropentaamminecobalt(III) chloride
(D) Cobaltpentaamminechlorido chloride

Q22. Which of the following shows linkage isomerism?

(A) $[Co(NH_3)_5(NO_2)]Cl_2$
(B) $[Co(NH_3)_6]Cl_3$
(C) $[Cu(NH_3)_4]SO_4$
(D) $[Fe(H_2O)_6]Cl_3$

Q23. According to CFT, the splitting of d-orbitals in an octahedral field is:

(A) t_{2g} lower, e_g higher
(B) e_g lower, t_{2g} higher
(C) All are equal
(D) Only d_{z2} is higher

Q24. The hybridization of $[Ni(CN)_4]^{2-}$ is:

(A) sp^3

(B) dsp^2

(C) d^2sp^3

(D) sp^3d^2

Q25. A coordination compound which is used in the treatment of cancer is:

(A) Cis-platin

(B) EDTA

(C) Zeise's salt

(D) Ferrocene

Q26. The coordination number of Co in $[Co(en)_3]^{3+}$ is:

(A) 3

(B) 6

(C) 4

(D) 2

Q27. Which of the following follows S_N1 mechanism most readily?

(A) CH_3Cl

(B) $(CH_3)_3CCl$

(C) $(CH_3)_2CHCl$

(D) C_2H_5Cl

Q28. Wurtz reaction involves the use of:

(A) Na in dry ether

(B) Zn in HCl

(C) Mg in ether

(D) Ag powder

Q29. Chloroform on reaction with Ag powder gives:

(A) Methane

(B) Acetylene

(C) Ethylene

(D) Ethane

Q30. The S_N2 reaction involves:

(A) Inversion of configuration

(B) Retention of configuration

(C) Racemization

(D) None of the above

Q31. Lucas reagent is a mixture of:

(A) Conc. HCl + Anhydrous $ZnCl_2$

(B) Conc. HNO_3 + Conc. H_2SO_4

(C) $Pd/BaSO_4$

(D) Na in alcohol

Q32. Reimer-Tiemann reaction of phenol with $CHCl_3/KOH$ gives:

(A) Salicylaldehyde
(B) Salicylic acid
(C) Benzene
(D) Picric acid

Q33. Phenol is more acidic than ethanol because:

(A) Phenoxide ion is resonance stabilized
(B) Ethoxide ion is resonance stabilized
(C) Phenol has higher molecular weight
(D) Ethanol has H-bonding

Q34. Kolbe's reaction produces:

(A) Salicylic acid
(B) Salicylaldehyde
(C) Aspirin
(D) Phenol

Q35. Acid catalyzed hydration of alkene gives:

(A) Alcohol
(B) Ether
(C) Aldehyde
(D) Ketone

Q36. Which of the following does NOT give Cannizzaro reaction?

(A) $HCHO$

(B) C_6H_5CHO

(C) CH_3CHO

(D) $(CH_3)_3CCHO$

Q37. Aldol condensation is given by:

(A) Aldehydes with α-hydrogen

(B) Aldehydes without α-hydrogen

(C) All ketones

(D) Formaldehyde

Q38. Tollens' reagent is:

(A) Ammoniacal silver nitrate

(B) Alkaline $CuSO_4$

(C) $K_2Cr_2O_7/H^+$

(D) $FeCl_3$

Q39. Which is the strongest acid?

(A) $HCOOH$

(B) CH_3COOH

(C) $ClCH_2COOH$

(D) $Cl_2CHCOOH$

Q40. Wolf-Kishner reduction reduces $C = O$ group to:

(A) $-CH_2-$

(B) $-CHOH-$

(C) $-CHO$

(D) $-COOH$

Q41. Rosenmund reduction is used for synthesis of:

(A) Aldehydes

(B) Ketones

(C) Carboxylic acids

(D) Ethers

Q42. The correct order of basic strength of methyl amines in aqueous solution is:

(A) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$

(B) $(CH_3)_3N > (CH_3)_2NH > CH_3NH_2 > NH_3$

(C) $NH_3 > CH_3NH_2 > (CH_3)_2NH > (CH_3)_3N$

(D) $(CH_3)_2NH > (CH_3)_3N > CH_3NH_2 > NH_3$

Q43. Gabriel Phthalimide synthesis is used to prepare:

(A) Primary aliphatic amines

(B) Primary aromatic amines

(C) Secondary amines

(D) Tertiary amines

Q44. Hoffmann Bromamide degradation reaction converts:

(A) Amide to amine with one less carbon

(B) Amide to amine with one more carbon

(C) Nitrile to amine

(D) Amide to alcohol

Q45. Benzene diazonium chloride on reaction with $CuCl/HCl$ gives:

(A) Chlorobenzene

(B) Benzene

(C) Phenol

(D) Aniline

Q46. Which of the following is a non-reducing sugar?

(A) Glucose

(B) Fructose

(C) Sucrose

(D) Lactose

Q47. Denaturation of proteins leads to loss of:

(A) Primary structure

(B) Secondary and Tertiary structures

(C) Peptide bonds

(D) Sequence of amino acids

Q48. Which of the following reagents is used to confirm the presence of five $-OH$ groups in a glucose molecule?:

(A) HI/Red P

(B) NH_2OH (Hydroxylamine)

(C) $Acetic\ anhydride$

(D) $Bromine\ water$

Q49. The helical structure of proteins is stabilized by:

(A) Hydrogen bonds

(B) Ionic bonds

(C) Covalent bonds

(D) Van der Waals forces

Q50. Which base is present in RNA but not in DNA?

(A) Adenine

(B) Guanine

(C) Uracil

(D) Thymine

Detailed Solutions

Q1.

Solution

Concept: Elevation in boiling point is a colligative property and depends on the number of solute particles:

$$\Delta T_b = iK_b m$$

where i is the van't Hoff factor (number of particles formed after dissociation).

Solution:

For same concentration ($0.1\ M$), boiling point elevation depends on i.

- $K_2SO_4 \longrightarrow 2K^+ + SO_4^{2-} \quad (i = 3)$
- $NaCl \longrightarrow Na^+ + Cl^- \quad (i = 2)$
- Glucose (non-electrolyte) $\quad (i = 1)$
- Urea (non-electrolyte) $\quad (i = 1)$

Higher $i \Rightarrow$ greater boiling point elevation.

Thus, K_2SO_4 has the highest boiling point.

$$\boxed{K_2SO_4}$$

Answer: (A)

Q2.

Solution

Concept: An ideal solution is a mixture where the interaction between different components is identical to the interactions between the molecules of each component alone. For an ideal solution:

- $\Delta V_{mix} = 0$ (No volume change upon mixing)
- $\Delta H_{mix} = 0$ (No heat is evolved or absorbed)
- $\Delta S_{mix} > 0$ (Entropy always increases for spontaneous mixing)
- $\Delta G_{mix} < 0$ (Gibbs free energy decreases for spontaneous process)

Solution: Based on the thermodynamic properties of ideal solutions, the change in enthalpy (ΔH) upon mixing is zero because the intermolecular forces between the solute and solvent ($A - B$) are equal to those between solute-solute ($A - A$) and solvent-solvent ($B - B$).Therefore:

$$\Delta H_{mix} = 0$$

$$\Delta V_{mix} = 0$$

Comparing this with the given options:Option A is incorrect because ΔV_{mix} should be 0.Option B is correct.Option C and D are incorrect because mixing is a spontaneous process, meaning $\Delta S > 0$ and $\Delta G < 0$.

Answer: (B)

Q3.

Solution

Concept: Deviations from Raoult's Law occur due to differences in intermolecular forces:

- **Positive Deviation:** $A - B$ interactions are weaker than $A - A$ and $B - B$ interactions. This leads to higher vapor pressure and $\Delta H_{mix} > 0$.
- **Negative Deviation:** $A - B$ interactions are stronger than $A - A$ and $B - B$ interactions. This leads to lower vapor pressure and $\Delta H_{mix} < 0$.

Solution: Pure ethanol molecules are held together by strong hydrogen bonding. When acetone is added to ethanol, the acetone molecules get between the ethanol molecules and disrupt some of these hydrogen bonds.Since the new interactions between acetone and ethanol are weaker than the original hydrogen bonds in pure ethanol, the molecules can escape into the vapor phase more easily. This results in a higher vapor pressure than predicted by Raoult's Law.Consequently, the mixture shows a positive deviation.

Answer: (A)

Q4.

Solution

Concept: The Van't Hoff factor (i) represents the number of particles produced in a solution from a single formula unit of the solute. For a salt that undergoes 100% dissociation (strong electrolyte):

$$i = \text{total number of ions produced per formula unit}$$

Solution: The coordination compound $K_4[Fe(CN)_6]$, known as Potassium ferrocyanide, dissociates in aqueous solution as follows:

$$K_4[Fe(CN)_6] \longrightarrow 4K^+ + [Fe(CN)_6]^{4-}$$

Note that the species inside the square brackets (the coordination sphere) remains intact and does not dissociate further into individual iron or cyanide ions.Counting the total number of ions produced:

- 4 Potassium ions (K^+)
- 1 Ferrocyanide complex ion ($[Fe(CN)_6]^{4-}$)

Total number of particles (n) = $4 + 1 = 5$.Since the degree of dissociation (α) is 100% (or 1):

$$i = 1 + (n-1)\alpha = 1 + (5-1)(1) = 5$$

Answer: (B)

Q5.

Solution

Concept: Osmotic pressure (π) is a colligative property that depends on the number of solute particles in a solution. According to the van't Hoff equation:

$$\pi = iCRT$$

Where:

- i = Van't Hoff factor
- C = Molar concentration (Molarity)
- R = Gas constant
- T = Absolute temperature (in Kelvin)

Solution

Solution: From the formula $\pi = iCRT$, we can observe the following relationships:

i. $\pi \propto T$: Osmotic pressure is directly proportional to the absolute temperature.

ii. $\pi \propto C$: Osmotic pressure is directly proportional to the concentration. Since $C = \frac{n}{V}$, decreasing the volume or increasing the number of solute particles (n) would increase the pressure.

Evaluating the options:

- **A) Increasing the temperature:** This will increase π because molecules move faster and exert more pressure against the semi-permeable membrane.
- **B) Decreasing the concentration:** This will decrease π.
- **C) Increasing the volume:** This decreases concentration ($C = n/V$), thus decreasing π.
- **D) Decreasing the number of solute particles:** This decreases concentration, thus decreasing π.

Hence, increasing the temperature is the correct method to increase osmotic pressure.

$\boxed{\textbf{Answer: (A)}}$

Q6.

Solution

Concept: Kohlrausch's Law of Independent Migration of Ions states that at infinite dilution, where dissociation is complete and inter-ionic effects are negligible, each ion migrates independently of its co-ion. The total molar conductivity of an electrolyte is the sum of the individual contributions of its constituent ions. **Solution:**Mathematically, Kohlrausch's Law for an electrolyte A_xB_y is expressed as:

$$\Lambda_m^\infty = x\lambda_+^\infty + y\lambda_-^\infty$$

Where:

- Λ_m^∞ is the limiting molar conductivity of the electrolyte.
- λ_+^∞ and λ_-^∞ are the limiting molar conductivities of the cation and anion, respectively.
- x and y are the number of cations and anions per formula unit.

Since the law defines the total conductivity as the sum of the conductivities of the cations and anions, option A is the correct description.

Answer: (A)

Q7.

Solution

Concept: The Nernst equation relates the reduction potential of an electrochemical cell to the standard electrode potential, temperature, and activities (often approximated by concentrations) of the chemical species undergoing oxidation and reduction. For a general reduction reaction $M^{n+}(aq) + ne^- \rightarrow M(s)$, the equation is:

$$E = E^\circ - \frac{RT}{nF} \ln \frac{1}{[M^{n+}]}$$

At $25°C$ (298 K), this simplifies to:

$$E = E^\circ + \frac{0.0591}{n} \log[M^{n+}]$$

Solution: From the simplified form of the Nernst equation:

$$E = E^\circ + \frac{0.0591}{n} \log[M^{n+}]$$

We can see that the electrode potential (E) is directly related to the logarithm of the concentration of the metal ions $[M^{n+}]$.When the concentration of ions $[M^{n+}]$ increases:

i. The value of $\log[M^{n+}]$ increases.

ii. Consequently, the term $\frac{0.0591}{n} \log[M^{n+}]$ becomes more positive.

iii. Adding this larger positive value to E° results in an overall increase in the electrode potential (E).

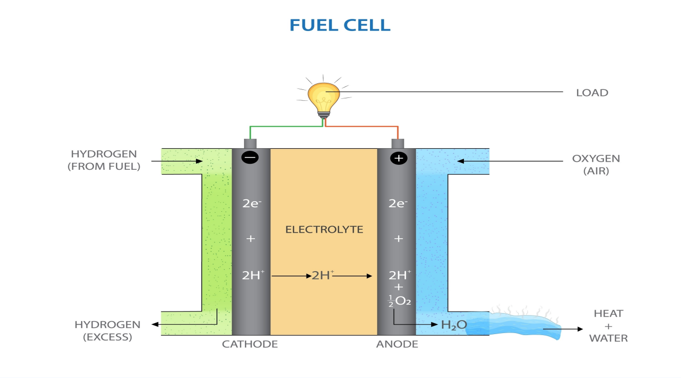
Thus, increasing the concentration of ions increases the electrode potential.

Answer: (A)

Q8.

Solution

Concept: A fuel cell is an electrochemical cell that converts the chemical energy of a fuel (often hydrogen) and an oxidizing agent (often oxygen) into electricity through a pair of redox reactions. Unlike batteries, fuel cells require a continuous source of fuel and oxygen to sustain the chemical reaction.



Solution: The most common and widely used fuel cell is the Hydrogen-Oxygen fuel cell. In this cell:

Solution

- **At Anode:** Hydrogen gas is oxidized.

$$2H_2(g) + 4OH^-(aq) \rightarrow 4H_2O(l) + 4e^-$$

- **At Cathode:** Oxygen gas is reduced.

$$O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$$

- **Overall Reaction:**

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$$

Evaluating the other options:

- **B)** N_2 **and** Ar**:** These are inert gases and do not undergo redox reactions in a cell.
- **C)** Pb **and** H_2SO_4**:** These are components of a Lead-acid storage battery.
- **D)** Cd **and** Ni**:** These are components of a Nickel-Cadmium (Ni-Cd) rechargeable battery.

Thus, H_2 and O_2 are the primary reactants used in a standard fuel cell.

Answer: (A)

Q9.

Solution

Concept: According to Faraday's First Law of Electrolysis, the amount of charge (Q) required for an oxidation or reduction process is directly proportional to the number of moles of electrons transferred. Q=nF Where:

- n is the number of moles of electrons per mole of substance.
- F is the Faraday constant (96500 C/mol), representing the charge of 1 mole of electrons.

Solution: First, we determine the change in the oxidation state of Manganese (Mn) in the given reduction half-reaction.
In MnO 4 (Permanganate ion): Let the oxidation state of Mn be x.
x+4(2)=1 x8=1x=+7 In Mn 2+ : The oxidation state of Mn is +2.
The balanced reduction half-reaction in acidic medium is:
MnO 4 +8H + +5e →Mn 2+ +4H 2 O From the balanced equation, it is clear that 5 moles of electrons are required to reduce 1 mole of MnO 4
to Mn 2+ .
Since the charge of 1 mole of electrons is 1 Faraday (F): Charge required for 5 moles of electrons = 5 F.

Answer: (C)

Q10.

Solution

Concept: The reducing power of a metal refers to its ability to lose electrons (oxidize itself) and reduce another species. This ability is inversely related to its standard reduction potential ($E°$):

- A lower (more negative) reduction potential means the metal has a greater tendency to lose electrons, making it a stronger reducing agent.
- A higher (more positive) reduction potential means the metal has a greater tendency to gain electrons, making it a weaker reducing agent.

Solution: Given the standard reduction potentials ($E°$) for the metals:

- Metal A: $+0.5$ V
- Metal B: -3.0 V
- Metal C: -1.2 V

Comparing the values:

$$-3.0\text{ V (B)} < -1.2\text{ V (C)} < +0.5\text{ V (A)}$$

Since reducing power is inversely proportional to the standard reduction potential:

i. Metal B has the lowest reduction potential (most negative), so it is the strongest reducing agent.

ii. Metal C has the next lowest reduction potential.

iii. Metal A has the highest reduction potential, making it the weakest reducing agent.

Order of reducing power: B > C > A

Answer: (A)

Q11.

Solution

Concept: The cell constant (G^*) of a conductivity cell is a property that depends on the geometry of the electrodes. It is defined as the ratio of the distance between the electrodes (l) to the cross-sectional area of the electrodes (A).

$$G^* = \frac{l}{A}$$

Solution: To find the unit, we substitute the standard units for length and area into the formula:

- Length (l) is measured in centimeters (cm).
- Area (A) is measured in square centimeters (cm^2).

Calculation of units:

$$\text{Unit of } G^* = \frac{cm}{cm^2} = \frac{1}{cm} = cm^{-1}$$

In SI units, it would be expressed as m^{-1}, but in electrochemical practice, cm^{-1} is most commonly used.Evaluating the other options:

- **B)** $ohm \cdot cm$**:** Unit of resistivity (ρ).
- **C)** $S \cdot cm^2 \cdot mol^{-1}$**:** Unit of molar conductivity (Λ_m).
- **D)** $S \cdot cm^{-1}$**:** Unit of specific conductivity or conductivity (κ).

Answer: (A)

Q12.

Solution

Concept: For a chemical reaction of order n, the half-life period ($t_{1/2}$) is the time required for the concentration of a reactant to decrease to half of its initial value. The general relationship between half-life and initial concentration $[A]_0$ is:

$$t_{1/2} \propto \frac{1}{[A]_0^{n-1}}$$

Solution: For a first-order reaction ($n = 1$), the integrated rate equation is:

$$k = \frac{2.303}{t} \log \frac{[A]_0}{[A]}$$

At half-life ($t = t_{1/2}$), the concentration $[A] = \frac{[A]_0}{2}$. Substituting these values:

$$k = \frac{2.303}{t_{1/2}} \log \frac{[A]_0}{[A]_0/2}$$

$$k = \frac{2.303}{t_{1/2}} \log(2)$$

$$t_{1/2} = \frac{2.303 \times 0.3010}{k}$$

$$t_{1/2} = \frac{0.693}{k}$$

As seen from the final expression, $t_{1/2}$ depends only on the rate constant (k) and does not contain the initial concentration term $[A]_0$. Therefore, the half-life of a first-order reaction is independent of the initial concentration.

Answer: (B)

Q13.

Solution

Concept: The rate of a reaction is defined as the change in concentration per unit time. For a reaction of n^{th} order, the rate law is given by:

$$\text{Rate} = k[\text{Concentration}]^n$$

The units of the rate constant (k) vary depending on the order of the reaction and can be derived using the general formula:

$$\text{Units of } k = \frac{\text{Rate}}{[\text{Concentration}]^n} = \frac{(mol \cdot L^{-1} \cdot s^{-1})}{(mol \cdot L^{-1})^n}$$

$$\text{Units of } k = (mol \cdot L^{-1})^{1-n} \cdot s^{-1}$$

Solution: For a zero-order reaction, $n = 0$.Substituting $n = 0$ into the general formula:

$$\text{Units of } k = (mol \cdot L^{-1})^{1-0} \cdot s^{-1}$$

$$\text{Units of } k = mol \cdot L^{-1} \cdot s^{-1}$$

This means that for a zero-order reaction, the rate of the reaction is equal to the rate constant (k), and thus they share the same units.Evaluating the other options:

- **A)** s^{-1}**:** Unit for a first-order reaction.
- **C)** $L \cdot mol^{-1} \cdot s^{-1}$**:** Unit for a second-order reaction.
- **D)** $mol^2 \cdot L^{-2} \cdot s^{-1}$**:** Not a standard unit for simple integer orders.

Answer: (B)

Q14.

Solution

Concept: The dependence of the rate of a chemical reaction on temperature is expressed by the Arrhenius Equation:

$$k = Ae^{-E_a/RT}$$

Where:

- k is the rate constant.
- A is the Arrhenius factor or pre-exponential factor.
- E_a is the activation energy.
- R is the gas constant.
- T is the absolute temperature.

Solution: When the temperature changes from T_1 to T_2, the ratio of rate constants k_1 and k_2 (which corresponds to the ratio of rates) is given by the logarithmic form of the Arrhenius equation:

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left(\frac{T_2 - T_1}{T_1 T_2} \right)$$

In the given problem:

- The rate doubles, so $\frac{k_2}{k_1} = 2$.
- $T_1 = 290$ K and $T_2 = 300$ K.

By substituting these values into the Arrhenius equation, the activation energy (E_a) can be calculated. The other options are unrelated to reaction rates and temperature:

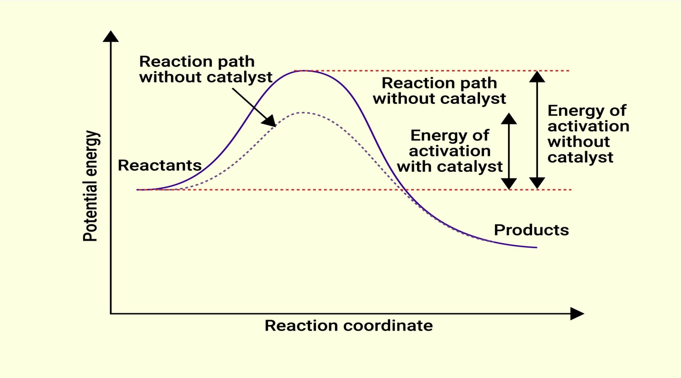
- **Raoult's Law** relates to vapor pressure of solutions.
- **Nernst Equation** relates to electrode potentials.
- **Faraday's Law** relates to electrolysis.

$\boxed{\textbf{Answer: (A)}}$

Q15.

Solution

Concept: A catalyst is a substance that increases the rate of a chemical reaction without being consumed in the process. It functions by providing an alternative reaction pathway with a lower energy barrier.



Solution: The speed of a reaction depends on the activation energy (E a

), which is the minimum energy required for reactants to transform into products. According to the Arrhenius equation, a lower E a allows a larger fraction of molecules to have enough energy to react at a given temperature.

Solution

- **A) Decreasing activation energy:** By lowering the E a , the catalyst makes it easier for the reaction to proceed, thereby increasing the rate.

- **B) Increasing activation energy:** This would actually slow down the reaction.

- **(C) Increasing enthalpy:** Catalysts do not change the enthalpy (H) of the reaction; they do not affect the energy of the reactants or products, only the transition state.

- **D) Decreasing entropy:** Catalysts generally do not function by changing the overall entropy of the reaction.

Therefore, the primary role of a catalyst is to decrease the activation energy.

$\boxed{\textbf{Answer: (A)}}$

Q16.

Solution

Concept: Molecularity is defined as the number of reacting species (atoms, ions, or molecules) that must collide simultaneously in an elementary reaction to bring about a chemical change.

- It is a theoretical concept derived from the reaction mechanism.
- It must always be a positive integer $(1, 2, 3,$ etc.).
- It cannot be zero, negative, or fractional.

Solution: The term "molecularity" refers to the actual number of particles participating in a collision.

- **A) 1:** Unimolecular reactions (e.g., decomposition of O_3).
- **B) 2:** Bimolecular reactions (e.g., $H_2 + I_2 \rightarrow 2HI$).
- **D) 3:** Trimolecular reactions (rare due to low probability of three particles colliding at once).

If the molecularity were 0, it would mean that no molecules are reacting, which contradicts the occurrence of a chemical reaction. Therefore, molecularity can never be zero.Note: While the order of reaction can be zero (meaning the rate is independent of concentration), the molecularity of an elementary step must always be at least 1.

$\boxed{\textbf{Answer: (C)}}$

Q17.

Solution

Concept: Lanthanoid contraction refers to the steady decrease in the atomic and ionic radii of lanthanoid elements ($Z = 58$ to 71) with the increase in atomic number. This phenomenon is primarily governed by the nature of the $4f$ orbitals and the increasing nuclear charge.

Solution: The contraction occurs due to two simultaneous factors:

i. **Increase in Nuclear Charge:** As we move across the lanthanoid series, the atomic number increases, meaning the number of protons (nuclear charge) increases at each step. This pulls the electron cloud closer to the nucleus.

ii. **Poor Shielding Effect of $4f$ Electrons:** The $4f$ orbitals have a very diffused shape. Because of this, they are very ineffective at shielding the outer electrons from the increasing nuclear charge.

Since the shielding provided by $4f$ electrons is poor, it cannot compensate for the increased nuclear attraction. Consequently, the effective nuclear charge experienced by the outer electrons increases, causing the entire atom to shrink.Therefore, both the poor shielding of $4f$ electrons and the increase in nuclear charge are responsible for lanthanoid contraction.

Answer: (D)

Q18.

Solution

Concept: Transition elements (d-block elements) typically show variable oxidation states because the energy difference between the $(n-1)d$ and ns orbitals is very small, allowing electrons from both subshells to participate in bond formation. However, the elements at the beginning and the end of the series often show limited oxidation states.

Solution: Let us examine the electronic configurations and common oxidation states of the given elements:

- **Fe (Iron):** $[Ar]3d^6 4s^2$. It shows +2 and +3 (most common), as well as +4 and +6 in rare cases.
- **Cu (Copper):** $[Ar]3d^{10} 4s^1$. It shows +1 and +2 oxidation states.
- **Sc (Scandium):** $[Ar]3d^1 4s^2$. When it reacts, it loses all three valence electrons (two from $4s$ and one from $3d$) to achieve a stable noble gas configuration ($[Ar]$). Consequently, it only shows the +3 oxidation state.
- **Mn (Manganese):** $[Ar]3d^5 4s^2$. It shows the maximum number of oxidation states in the $3d$ series, ranging from +2 to +7.

Because Scandium only exhibits a single oxidation state (+3) in its compounds, it does not show "variable" oxidation states like the other transition metals.

$\boxed{\textbf{Answer: (C)}}$

Q19.

Solution

Concept: The magnetic moment (μ) of a transition metal ion is calculated using the spin-only formula:

$$\mu = \sqrt{n(n+2)}\ \text{BM}$$

Where:

- n is the number of unpaired electrons.
- BM stands for Bohr Magneton, the unit of magnetic moment.

Solution: First, we determine the electronic configuration of Fe ($Z = 26$) and then for the Fe^{2+} ion:

- Fe: $[Ar]3d^6 4s^2$
- Fe^{2+}: $[Ar]3d^6$ (The two electrons are removed from the $4s$ orbital first).

Now, we fill the six electrons into the five $3d$ orbitals according to Hund's Rule:

- One orbital contains a pair of electrons (↑↓).
- Four orbitals contain a single electron each (↑, ↑, ↑, ↑).

Therefore, the number of unpaired electrons (n) = 4.Substitute $n = 4$ into the spin-only formula:

$$\mu = \sqrt{4(4+2)} = \sqrt{4 \times 6} = \sqrt{24}$$

$$\mu \approx 4.90\ \text{BM}$$

Answer: (A)

Q20.

Solution

Concept: Potassium permanganate (KMnO 4) is a powerful oxidizing agent. Its oxidizing power depends on the pH of the medium, as the Manganese (Mn) atom is reduced to different oxidation states depending on the concentration of H + or OH ions. In all cases, Mn starts at an oxidation state of +7 and gains electrons.

Solution: KMnO 4 acts as an oxidizing agent in all three media, though the specific reduction product and the number of electrons transferred vary:

i. **Acidic Medium:** Mn 7+ is reduced to Mn 2+ . This is its strongest oxidizing form (gains 5 electrons).

MnO 4 +8H + +5e →Mn 2+ +4H 2 O

ii. **Neutral or Faintly Alkaline Medium:** Mn^{7+} is reduced to Mn^{4+} (in the form of MnO_2, a brown precipitate). (Gains 3 electrons).

$$MnO_4^- + 2H_2O + 3e^- \rightarrow MnO_2 + 4OH^-$$

iii. **Strongly Basic Medium:** Mn^{7+} is reduced to Mn^{6+} (the green manganate ion MnO_4^{2-}). (Gains 1 electron).

$$MnO_4^- + e^- \rightarrow MnO_4^{2-}$$

Since KMnO 4 effectively accepts electrons and oxidizes other substances across the entire pH scale, it is versatile as an oxidizing agent.

Answer: (D)

Q21.

Solution

Concept: According to IUPAC nomenclature for coordination compounds:

- The cation is named before the anion.
- Within the coordination sphere, ligands are named in alphabetical order before the central metal atom/ion.
- Numerical prefixes (di-, tri-, tetra-, penta-, etc.) are used to indicate the number of ligands.
- The oxidation state of the metal is indicated by a Roman numeral in parentheses.
- Anionic ligands end in "-o" or "-ido" (e.g., Cl becomes chlorido).

Solution: Let's break down the complex [Co(NH 3) 5 Cl]Cl 2 :

i. **Ligands:** There are 5 ammine (NH 3) groups and 1 chlorido (Cl) group. In alphabetical order: **pentaamminechlorido**.

ii. **Central Metal:** The metal is Cobalt (**cobalt**).

iii. **Oxidation State:** Let x be the oxidation state of Co.

x+5(0)+1(1)+2(1)=0 x12=0x=+3 So, it is **cobalt(III)**.

iv. **Anion:** The species outside the bracket is chloride (**chloride**).

Combining these: Pentaamminechloridocobalt(III) chloride.
Comparing with the options: Option A follows the current IUPAC recommendation ("chlorido"). Option C uses the older "chloro" and lists the chloride before the ammine, which violates alphabetical ordering.

Answer: (A)

Q22.

Solution

Concept: Linkage isomerism occurs in coordination compounds containing ambidentate ligands. These are ligands that have two or more different donor atoms but coordinate to the central metal ion through only one of them at a time. Common examples of ambidentate ligands include:

- NO_2^- (Nitrito-N via N; Nitrito-O via O)
- SCN^- (Thiocyanato-S via S; Isothiocyanato-N via N)
- CN^- (Cyanido-C via C; Isocyanido-N via N)

Solution: Let's evaluate the given coordination complexes:

- **A) $[Co(NH_3)_5(NO_2)]Cl_2$:** This complex contains the nitro (NO_2^-) group, which is an ambidentate ligand. It can bind to the Cobalt (Co) atom through the Nitrogen atom (forming the nitro isomer) or through the Oxygen atom (forming the nitrito isomer, $[Co(NH_3)_5(ONO)]Cl_2$). Therefore, it shows linkage isomerism.
- **B) $[Co(NH_3)_6]Cl_3$:** NH_3 (ammine) is a unidentate ligand and not ambidentate.
- **C) $[Cu(NH_3)_4]SO_4$:** Contains only ammine ligands.
- **D) $[Fe(H_2O)_6]Cl_3$:** H_2O (aqua) is a unidentate ligand and not ambidentate.

Answer: (A)

Q23.

Solution

Concept: Crystal Field Theory (CFT) describes the interaction between the central metal ion and the ligands as a purely electrostatic one. In an octahedral field, six ligands approach the central metal ion along the x, y, and z axes.

Solution: The five d-orbitals are initially degenerate (equal in energy). However, when ligands approach in an octahedral geometry:

- The e g

  orbitals (d x 2 y 2

  and d z 2

) point directly toward the axes where the ligands are located. They experience greater repulsion from the ligand electrons, and their energy increases.

- The t 2g orbitals (d xy

  , d yz

  , and d zx

) point in between the axes. They experience less repulsion, and their energy decreases relative to the average energy (Barycenter).

The energy difference between these two sets is denoted as o (octahedral crystal field splitting energy).
In an octahedral complex:

i. t 2g

   set (triply degenerate) is at a lower energy level.

ii. e g

   set (doubly degenerate) is at a higher energy level.

Answer: (A)

Q24.

Solution

Concept: To determine the hybridization of a coordination complex, we use Valence Bond Theory (VBT). The process involves identifying the oxidation state of the central metal, its electronic configuration, and the nature of the ligands (strong field vs. weak field).

Solution: Let's analyze the complex $[Ni(CN)_4]^{2-}$ step-by-step:

i. **Oxidation State of Ni:**Let x be the oxidation state.$x + 4(-1) = -2 \Rightarrow x = +2$.The metal ion is Ni^{2+}.

ii. **Electronic Configuration:** $Ni(Z = 28) : [Ar]3d^8 4s^2$ $Ni^{2+} : [Ar]3d^8 4s^0$

iii. **Nature of Ligand:** CN^- is a **strong field ligand**. According to the spectrochemical series, strong field ligands cause the pairing of unpaired electrons in the $3d$ orbitals.

iv. **Orbital Rearrangement:** In Ni^{2+} $(3d^8)$, there are two unpaired electrons. Due to the presence of CN^-, these two electrons pair up, leaving one $3d$ orbital empty.

v. **Hybridization:** The four CN^- ligands donate electron pairs into:

  - One $3d$ orbital
  - One $4s$ orbital
  - Two $4p$ orbitals

  This results in **dsp^2 hybridization**, which gives the complex a **square planar** geometry.

If the hybridization had been sp^3, the geometry would be tetrahedral (as seen in $[NiCl_4]^{2-}$ where Cl^- is a weak field ligand).

Answer: (B)

Q25.

Solution

Concept: Coordination compounds play a vital role in medicine. Some are used as drugs due to their ability to interact with biological molecules like DNA, while others are used as chelating agents to remove toxic metals from the body.

Solution: The correct compound used in cancer chemotherapy is Cis-platin.

- **A) Cis-platin** $[Pt(NH_3)_2Cl_2]$**:** This is a square planar complex where the two chloride ligands are adjacent to each other (cis-isomer). It is highly effective in treating various types of cancer, particularly testicular and ovarian cancer. It works by binding to the DNA of cancer cells, causing cross-links that prevent the cells from replicating.

- **B) EDTA (Ethylenediaminetetraacetic acid):** This is a hexadentate chelating agent primarily used in the treatment of **lead poisoning** (chelation therapy) and to remove excess metal ions from the body.

- **C) Zeise's salt** $[PtCl_3(\eta^2 - C_2H_4)]^-$**:** This was the first organometallic compound ever synthesized, but it does not have a primary use in cancer treatment.

- **D) Ferrocene** $[Fe(C_5H_5)_2]$**:** An organometallic sandwich compound used as a fuel additive and in research, though some derivatives are being studied for medicinal properties.

Answer: (A)

Q26.

Solution

Concept: The coordination number (C.N.) of a central metal atom in a complex is the total number of ligand donor atoms to which the metal is directly bonded.

- **Unidentate ligands** bind through one donor atom (C.N. = number of ligands).
- **Didentate (Bidentate) ligands** bind through two donor atoms (C.N. = 2× number of ligands).

Solution: In the complex [Co(en) 3] 3+ :

i. The ligand is ethylenediamine (en), which is a didentate ligand (NH 2 CH 2 CH 2 NH 2).

ii. Each "en" molecule coordinates to the Cobalt (Co) center through two Nitrogen atoms.

iii. Since there are three such ligands, the total number of coordinate bonds (donor atoms) is:

Coordination Number=3×2=6

The geometry of the complex is octahedral due to these six coordination sites. Therefore, the coordination number is 6.

Answer: (B)

Q27.

Solution

Concept: S_N1 reactions proceed via formation of a carbocation intermediate. The stability of the carbocation determines the rate:

$$\text{Tertiary} > \text{Secondary} > \text{Primary} > \text{Methyl}$$

Solution:

Given compounds:

- CH_3Cl (methyl halide)
- $(CH_3)_3CCl$ (tertiary halide)
- $(CH_3)_2CHCl$ (secondary halide)
- C_2H_5Cl (primary halide)

Since tertiary carbocation is most stable, it undergoes S_N1 reaction most readily.

Answer: (B)

Q28.

Solution

Concept: The Wurtz reaction is a coupling reaction in organic chemistry used to synthesize higher alkanes from alkyl halides. In this reaction, two molecules of an alkyl halide (RX) react with a reactive metal in an anhydrous solvent to form a new carbon-carbon bond, resulting in a symmetrical alkane.

Solution:

The specific reagents required for the Wurtz reaction are:

- **Sodium (Na) metal:** Acts as the active metal to facilitate the coupling of the alkyl groups.
- **Dry Ether:** Anhydrous (dry) ether is used as a solvent because sodium is extremely reactive with water (moisture). Ether also helps in stabilizing the intermediate organosodium species.

The general chemical equation is:
2RX+2Na Dry Ether
RR+2NaX Evaluating the other options:

- **B) Zn in HCl:** This combination is typically used for the Clemmensen Reduction (reducing carbonyl groups to alkanes).
- **C) Mg in ether:** This is the standard procedure for the preparation of Grignard Reagents (RMgX).
- **D) Ag powder:** Heating alkyl halides (like chloroform) with Silver powder is used to prepare higher hydrocarbons like acetylene, but it is not the Wurtz reaction.

Since the Wurtz reaction is defined by the use of sodium in dry ether, option A is the correct answer.

Answer: (A)

Q29.

Solution

Concept: When trihalogen derivatives of alkanes like chloroform ($CHCl_3$) are heated with silver (Ag) powder, a dehalogenation reaction occurs. This results in the coupling of two molecules to form an unsaturated hydrocarbon.

Solution: In this reaction, two molecules of chloroform lose all six chlorine atoms to six atoms of silver. The resulting CH fragments join together via a triple bond.The balanced chemical equation is:

$$2CHCl_3 + 6Ag \xrightarrow{\Delta} CH \equiv CH + 6AgCl$$

Detailed breakdown:

- **Reactants:** Chloroform ($CHCl_3$) and Silver (Ag) powder.
- **By-product:** Silver chloride ($AgCl$) precipitates out.
- **Main Product:** Acetylene (also known as Ethyne, C_2H_2).

Evaluating the options:

- **A) Methane (CH_4):** This is a single-carbon saturated alkane.
- **B) Acetylene (C_2H_2):** The correct product formed by the triple-bond coupling of two methine (CH) groups.
- **C) Ethylene (C_2H_4):** Requires the reduction of acetylene or different starting materials.
- **D) Ethane (C_2H_6):** The fully saturated two-carbon alkane.

Answer: (B)

Q30.

Solution

Concept: The S_N2 reaction is a one-step bimolecular nucleophilic substitution. It involves **backside attack** of the nucleophile, leading to a **Walden inversion** (inversion of configuration).

Solution:

Nucleophile attacks from the side opposite to the leaving group Transition state forms with partial bonds Configuration at the chiral center gets inverted

Thus:

Inversion of configuration → Correct Retention → Incorrect Racemization → Occurs in S_N1, not S_N2

Answer: (A)

Q31.

Solution

Concept: Lucas reagent is used to distinguish between primary, secondary, and tertiary alcohols. It consists of concentrated hydrochloric acid and anhydrous zinc chloride, where $ZnCl_2$ acts as a Lewis acid catalyst.

Solution:

Lucas reagent is a mixture of:

$$\text{Conc. } HCl + \text{Anhydrous } ZnCl_2$$

Answer: (A)

Q32.

Solution

Concept: The Reimer-Tiemann reaction is a classic organic reaction used for the ortho-formylation of phenols. When phenol is treated with chloroform ($CHCl_3$) in the presence of a strong base like potassium hydroxide (KOH) or sodium hydroxide ($NaOH$), a formyl group ($-CHO$) is introduced into the benzene ring, primarily at the ortho position.

Solution: The reaction proceeds through the following steps:

i. **Generation of Carbene:** The base (KOH) reacts with chloroform ($CHCl_3$) to generate a highly reactive intermediate called dichlorocarbene ($: CCl_2$).

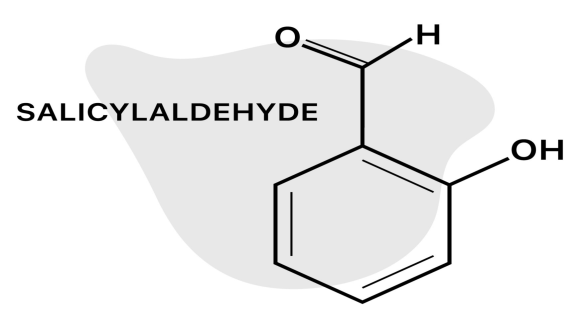
$$CHCl_3 + OH^- \rightarrow: CCl_2 + H_2O + Cl^-$$

ii. **Electrophilic Attack:** The dichlorocarbene acts as an electrophile and attacks the phenoxide ion (formed by the reaction of phenol with KOH) at the ortho position.

iii. **Hydrolysis:** Subsequent hydrolysis of the intermediate leads to the formation of an aldehyde group.

The final major product is Salicylaldehyde (2-hydroxybenzaldehyde).

Solution



Evaluating the other options:

- **B) Salicylic acid:** Formed when carbon tetrachloride (CCl_4) is used instead of chloroform ($CHCl_3$).
- **C) Benzene:** Phenol can be converted to benzene by heating with Zinc dust, not via Reimer-Tiemann.
- **D) Picric acid (2,4,6-trinitrophenol):** Formed by the nitration of phenol with concentrated HNO_3 and H_2SO_4.

Answer: (A)

Q33.

Solution

Concept: The acidity of a compound depends on the stability of its conjugate base (the anion formed after losing a proton). A more stable conjugate base implies a stronger parent acid because the equilibrium will shift more toward the ionized state. **Solution:**Let us compare the conjugate bases of phenol and ethanol:

i. **Phenoxide Ion ($C_6H_5O^-$):** When phenol loses a proton, it forms the phenoxide ion. In this ion, the negative charge on the oxygen atom is delocalized over the benzene ring through resonance. This delocalization spreads the charge, making the phenoxide ion highly stable.

ii. **Ethoxide Ion ($C_2H_5O^-$):** When ethanol loses a proton, it forms the ethoxide ion. Here, the negative charge is localized on the oxygen atom. Furthermore, the ethyl group (C_2H_5-) has an **inductive effect ($+I$)**, which pushes electron density toward the already negative oxygen, making the ion less stable.

Evaluating the options:

- **A) Phenoxide ion is resonance stabilized:** This is the correct explanation. Resonance stabilization makes phenol significantly more acidic ($pK_a \approx 10$) than ethanol ($pK_a \approx 16$).
- **B) Ethoxide ion is resonance stabilized:** This is incorrect; ethoxide ions have no resonance.
- **C) Phenol has higher molecular weight:** Molecular weight does not determine acidity.
- **D) Ethanol has H-bonding:** While ethanol exhibits hydrogen bonding, this affects its boiling point and solubility, not its inherent acidity relative to phenol.

Answer: (A)

Q34.

Solution

Concept: In **Kolbe's reaction** (Kolbe–Schmitt reaction), sodium phenoxide reacts with CO_2 under pressure and temperature, followed by acidification to give **salicylic acid** (o-hydroxybenzoic acid).

Solution:
Phenol $\xrightarrow{NaOH}$ Sodium phenoxide Sodium phenoxide + CO_2 (pressure, heat) → sodium salicylate Acidification → **salicylic acid**

$\boxed{\textbf{Answer: (A)}}$

Q35.

Solution

Concept: The acid-catalyzed hydration of an alkene is an electrophilic addition reaction. In the presence of a dilute mineral acid (usually H_2SO_4 or H_3PO_4) acting as a catalyst, a molecule of water (H_2O) adds across the carbon-carbon double bond.

Solution: The reaction follows Markovnikov's rule, which states that the hydrogen atom from the water molecule attaches to the carbon atom with the greater number of hydrogen atoms, while the hydroxyl ($-OH$) group attaches to the carbon with fewer hydrogen atoms.The step-by-step mechanism involves:

i. **Protonation:** The alkene reacts with a hydronium ion (H_3O^+) to form a stable carbocation.

ii. **Nucleophilic Attack:** A water molecule attacks the carbocation.

iii. **Deprotonation:** Loss of a proton results in the final product.

The final product of this addition is an Alcohol.Evaluating the other options:

- **B) Ether:** Formed during the dehydration of alcohols at lower temperatures or via the Williamson ether synthesis, not by simple hydration of alkenes.
- **C) Aldehyde / D) Ketone:** These are products of the hydration of alkynes (via keto-enol tautomerism) or the oxidation of alcohols, but not the direct hydration of simple alkenes.

Answer: (A)

Q36.

Solution

Concept: Cannizzaro reaction is shown by **aldehydes without α-hydrogen**.

If α-hydrogen is present $\Rightarrow$ Cannizzaro reaction does **not** occur

Solution:

Check each compound:

A) $HCHO \rightarrow$ No α-H $\Rightarrow$ Gives Cannizzaro reaction

B) $C_6H_5CHO \rightarrow$ No α-H $\Rightarrow$ Gives Cannizzaro reaction

C) $CH_3CHO \rightarrow$ Has α-H $\Rightarrow$ **Does NOT give Cannizzaro reaction**

D) $(CH_3)_3CCHO \rightarrow$ No α-H (quaternary carbon next to CHO) $\Rightarrow$ Gives Cannizzaro reaction

$\boxed{\textbf{Answer: (C)}}$

Q37.

Solution

Concept: Aldol condensation is shown by carbonyl compounds (**aldehydes or ketones**) that have at least one **α-hydrogen**. The α-hydrogen is necessary for enolate ion formation.

Solution:

Check the options:

A) Aldehydes with α-hydrogen ; $\Rightarrow$ **Correct**

B) Aldehydes without α-hydrogen ; $\Rightarrow$ Do not give aldol (they give Cannizzaro)

C) All ketones ; $\Rightarrow$ Incorrect (only those with α-H)

D) Formaldehyde ; $\Rightarrow$ No α-H, so no aldol

$\boxed{\textbf{Answer: (A)}}$

Q38.

Solution

Concept: Tollens' reagent is an **ammoniacal solution of silver nitrate**, containing the complex ion $[Ag(NH_3)_2]^+$. It is used to test aldehydes, giving a **silver mirror**.

Solution:

Check the options:

A) Ammoniacal silver nitrate ; ⇒ **Correct**

B) Alkaline $CuSO_4$; ⇒ Fehling's solution

C) $K_2Cr_2O_7/H^+$; ⇒ Oxidizing agent

D) $FeCl_3$; ⇒ Phenol test

Answer: (A)

Q39.

Solution

Concept: The acidity of carboxylic acids increases with the presence of electron-withdrawing groups ($-I$ effect). More electronegative substituents stabilize the conjugate base, increasing acidity. Greater the number of electron-withdrawing groups, stronger is the acid.

Solution:

Given acids:

- $HCOOH$ (no alkyl group)
- CH_3COOH (electron-donating CH_3 group, decreases acidity)
- $ClCH_2COOH$ (one Cl, electron-withdrawing)
- $Cl_2CHCOOH$ (two Cl atoms, strong $-I$ effect)

Since Cl is an electron-withdrawing group, and more Cl atoms increase the $-I$ effect, acidity order is:

$$Cl_2CHCOOH > ClCH_2COOH > HCOOH > CH_3COOH$$

$\boxed{\textbf{Answer: (D)}}$

Q40.

Solution

Concept: In **Wolff–Kishner reduction**, aldehydes and ketones ($C = O$) are reduced to **alkanes** using hydrazine (NH_2NH_2) in the presence of strong base and heat.

Solution:

Carbonyl group ($C = O$) is completely reduced Oxygen is removed as N_2 gas Final product contains $-CH_2-$ **group**

$\boxed{\textbf{Answer: (A)}}$

Q41.

Solution

Concept: The Rosenmund reduction is a hydrogenation process used for the synthesis of aldehydes from acid chlorides. It involves the catalytic reduction of an acyl chloride using hydrogen gas in the presence of palladium supported on barium sulfate ($Pd/BaSO_4$), which is partially "poisoned" by substances like sulfur or quinoline.

Solution: In this reaction, the acid chloride (acyl chloride) is reduced to an aldehyde. The catalyst ($Pd/BaSO_4$) is poisoned to decrease its activity, preventing the further reduction of the resulting aldehyde into a primary alcohol.The general chemical equation is:

$$R - COCl + H_2 \xrightarrow{Pd/BaSO_4, \text{ Sulfur}} R - CHO + HCl$$

Detailed evaluation:

- **A) Aldehydes:** This is the correct product of the Rosenmund reduction. For example, benzoyl chloride is reduced to benzaldehyde.
- **B) Ketones:** These cannot be prepared by this method; acid chlorides react with dialkylcadmium or Grignard reagents to form ketones.
- **C) Carboxylic acids:** These are actually the precursors (via acid chlorides) rather than the products of this reduction.
- **D) Ethers:** These are synthesized via methods like the Williamson ether synthesis or dehydration of alcohols, not by Rosenmund reduction.

Since the specific purpose of the Rosenmund reduction is the preparation of aldehydes from acyl halides, option A is the correct answer.

$\boxed{\textbf{Answer: (A)}}$

Q42.

Solution

Concept: In aqueous solution, the basic strength of amines depends on both the $+I$ effect of alkyl groups and the extent of solvation of the protonated amine. Secondary amines are most basic due to a balance of strong $+I$ effect and effective solvation.

Solution:

Given amines:

- NH_3 (no alkyl group)
- CH_3NH_2 (primary amine)
- $(CH_3)_2NH$ (secondary amine)
- $(CH_3)_3N$ (tertiary amine)

In aqueous solution:

- Secondary amines are most basic (good $+I$ effect and solvation)
- Primary amines are next
- Tertiary amines are less basic than primary due to steric hindrance reducing solvation
- Ammonia is least basic

Thus, the correct order is:

$$(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$$

$\boxed{\textbf{Answer: (A)}}$

Q43.

Solution

Concept: Gabriel phthalimide synthesis is used to prepare primary amines by nucleophilic substitution of alkyl halides. It works well for aliphatic halides and avoids formation of secondary and tertiary amines.

Solution:

In Gabriel synthesis:

- Phthalimide reacts with alkyl halide ($R - X$)
- Followed by hydrolysis to give $R - NH_2$

It is effective only for **primary aliphatic amines** and does not work for aryl halides.

Answer: (A)

Q44.

Solution

Concept: Hoffmann bromamide degradation (Hofmann rearrangement) converts an amide into a primary amine with one carbon less. This involves loss of the carbonyl carbon as CO_2.

Solution:

General reaction:

$$RCONH_2 \xrightarrow{Br_2/KOH} RNH_2 + CO_2$$

Thus, the amide is converted into a primary amine with one less carbon atom.

Answer: (A)

Q45.

Solution

Concept: Benzene diazonium chloride undergoes Sandmeyer reaction with cuprous salts ($CuCl$, $CuBr$) to replace the diazonium group ($-N_2^+$) with halogen.

Solution:

Reaction:

$$C_6H_5N_2^+Cl^- \xrightarrow{CuCl/HCl} C_6H_5Cl + N_2 \uparrow$$

Thus, benzene diazonium chloride gives chlorobenzene.

Answer: (A)

Q46.

Solution

Concept: Reducing sugars have a free aldehyde or ketone group (or can form one in solution). Non-reducing sugars do not have a free carbonyl group due to involvement in glycosidic bond formation.

Solution:

- Glucose – reducing sugar
- Fructose – reducing sugar (via enolization)
- Lactose – reducing sugar (free hemiacetal group)
- Sucrose – non-reducing sugar (both anomeric carbons involved in glycosidic bond)

Answer: (C)

Q47.

Solution

Concept: Denaturation of proteins involves disruption of non-covalent interactions (like hydrogen bonds, ionic interactions), leading to loss of higher-level structures while the primary structure (peptide bonds) remains intact.

Solution:

- Primary structure (sequence of amino acids) remains unchanged
- Peptide bonds are not broken
- Secondary and tertiary structures are destroyed

Thus, denaturation leads to loss of:

$$\boxed{\text{Secondary and Tertiary structures}}$$

Answer: (B)

Q48.

Solution

Concept: The number of $-OH$ groups in a compound can be confirmed by acetylation. Each $-OH$ group reacts with acetic anhydride to form an acetate ester. The number of acetate groups formed indicates the number of hydroxyl groups present.

Solution:

Glucose reacts with acetic anhydride to form glucose pentaacetate:

$$\text{Glucose} \xrightarrow{\text{Acetic anhydride}} \text{Glucose pentaacetate}$$

Formation of pentaacetate confirms the presence of five $-OH$ groups.

Answer: (C)

Q49.

Solution

Concept: The α-helical structure (secondary structure) of proteins is stabilized by intramolecular hydrogen bonds between the $C = O$ group of one peptide bond and the $N - H$ group of another.

Solution:

In proteins:

- Hydrogen bonds maintain the helical (secondary) structure
- These bonds form between backbone groups, not side chains

Answer: (A)

Q50.

Solution

Concept: DNA and RNA differ in one nitrogenous base. DNA contains thymine, whereas RNA contains uracil in place of thymine.

Solution:

- Adenine and Guanine are present in both DNA and RNA
- Thymine is present only in DNA
- Uracil is present only in RNA

Answer: (C)

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	B	3	A	4	B	5	A
6	A	7	A	8	A	9	C	10	A
11	A	12	B	13	B	14	A	15	A
16	C	17	D	18	C	19	A	20	D
21	A	22	A	23	A	24	B	25	A
26	B	27	B	28	A	29	B	30	A
31	A	32	A	33	A	34	A	35	A
36	C	37	A	38	A	39	D	40	A
41	A	42	A	43	A	44	A	45	A
46	C	47	B	48	C	49	A	50	C