UP Board 12 Chemistry (347 (GA)) Question Paper with Solutions

Time Allowed :3 hours	**Maximum Marks :**70	**Total questions :**33

General Instructions

Read the following instructions very carefully and strictly follow them:

1. First 15 minutes are allotted for the candidates to read the question paper.
2. All questions are compulsory. Marks allotted to each question are given against it.
3. Give relevant answers to the questions.
4. Give chemical equations, wherever necessary.

1. Four alternatives are given in each part of this question. Write the correct alternative in your answer-book.

(a) Fe is:

(i) s-block element

(ii) p-block element

(iii) d-block element

(iv) f-block element

Correct Answer: (iii) d-block element

Solution: Iron (Fe) belongs to the d-block elements because its valence electrons are present in the d-orbital. The electronic configuration of Fe is $[Ar]\,3d^6 4s^2$.

Quick Tip

d-block elements are also called transition metals and typically have partially filled d-orbitals.

(b) The configuration showing maximum oxidation state is:

(i) $3d^3, 4s^2$

(ii) $3d^5, 4s^2$

(iii) $3d^5, 4s^1$

(iv) $3d^6, 4s^2$

Correct Answer: (ii) $3d^5, 4s^2$

Solution: The configuration $3d^5, 4s^2$ corresponds to elements like manganese (Mn), which shows the maximum oxidation state of +7 due to the loss of all 4s and 3d electrons.

Quick Tip

Elements with half-filled or fully filled d-orbitals can exhibit maximum oxidation states.

(c) After eliminating salt bridge of any Galvanic cell, voltage of the cell:

(i) Suddenly becomes zero

(ii) Goes down slowly

(iii) Increases rapidly

(iv) Remains unchanged

Correct Answer: (i) Suddenly becomes zero

Solution: The salt bridge maintains ionic balance and completes the circuit in a galvanic cell. Removing it stops ion flow, making the cell voltage drop to zero instantly.

Quick Tip

A salt bridge prevents charge buildup and ensures the flow of current in a galvanic cell.

(d) Electrode potential of standard hydrogen electrode is:

(i) 0.34 volts

(ii) -0.76 volts

(iii) 0.2 volts

(iv) 0.0 volts

Correct Answer: (iv) 0.0 volts

Solution: The standard hydrogen electrode (SHE) is assigned a potential of 0.0 volts by convention. It acts as a reference electrode in electrochemistry.

Quick Tip

The standard hydrogen electrode is the primary reference for measuring electrode potentials.

(e) The true statement for the formula $K = Ae^{-E_a/RT}$ is:

(i) K is equilibrium constant

(ii) R is Rydberg constant

(iii) A is adsorption coefficient

(iv) E_a is activation energy

Correct Answer: (iv) E_a is activation energy

Solution: The formula $K = Ae^{-E_a/RT}$ is the Arrhenius equation, where:

- K: Rate constant,

- A: Pre-exponential factor,

- E_a: Activation energy,

- R: Gas constant,

- T: Temperature.

Quick Tip

The Arrhenius equation explains how temperature and activation energy affect reaction rates.

(f) For the reaction $\frac{1}{2}A \rightarrow 2B$, rate of dissociation of A and rate of formation of B is related as follows:

(i) $-\frac{d[A]}{dt} = \frac{1}{2}\frac{d[B]}{dt}$

(ii) $-\frac{d[A]}{dt} = \frac{1}{4}\frac{d[B]}{dt}$

(iii) $-\frac{d[A]}{dt} = \frac{d[B]}{dt}$

(iv) $-\frac{d[A]}{dt} = 4\frac{d[B]}{dt}$

Correct Answer: (i) $-\frac{d[A]}{dt} = \frac{1}{2}\frac{d[B]}{dt}$

Solution: For the reaction $\frac{1}{2}A \rightarrow 2B$, the rate of reaction can be expressed in terms of the

rate of disappearance of A and the rate of formation of B:

$$-\frac{1}{2}\frac{d[A]}{dt} = \frac{1}{2}\frac{d[B]}{dt}.$$

Rearranging, we get:

$$-\frac{d[A]}{dt} = \frac{1}{2}\frac{d[B]}{dt}.$$

This relation shows that the rate of dissociation of A is half the rate of formation of B.

Quick Tip

In stoichiometry, the rates of reactants and products are inversely proportional to their respective coefficients in the balanced equation.

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2. (a) Write different resonating structures of aniline.

Solution: The resonating structures of aniline ($C_6H_5NH_2$) are as follows:

Structure 1: Delocalization of lone pair of electrons from the nitrogen into the benzene ring.

Structure 2, 3, etc.: Draw the other resonance structures here.

Quick Tip

Aniline's resonance structures show delocalization of lone pairs on nitrogen, making it less basic than aliphatic amines.

(b) Explain the effect of temperature and concentration on the velocity of a reaction.

Solution: - **Temperature:**

Increasing the temperature increases the reaction rate by providing reactants with more kinetic energy to overcome the activation energy barrier.

- **Concentration:**

Higher reactant concentration leads to more frequent collisions, increasing the reaction rate according to the rate law.

Quick Tip

Use the Arrhenius equation to analyze how temperature affects the reaction rate, and apply the rate law for concentration effects.

(c) Write ions produced in an aqueous solution of $K_4[Fe(CN)_6]$. What is the oxidation number of Fe in this compound?

Solution: - In aqueous solution, $K_4[Fe(CN)_6]$ dissociates as:

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

- Oxidation number of Fe in $[Fe(CN)_6]^{4-}$ is $+2$:

$$x + (-1 \times 6) = -4 \quad \Rightarrow \quad x = +2.$$

Quick Tip

The oxidation state of the central metal ion is calculated by balancing the charge of the complex ion.

(d) Write the difference between Galvanic cell and Electrolytic cell.

Solution: - **Galvanic Cell:**

Converts chemical energy into electrical energy. It has a spontaneous reaction.

- **Electrolytic Cell:**

Converts electrical energy into chemical energy. It has a non-spontaneous reaction.

Quick Tip

Galvanic cells work spontaneously (e.g., batteries), while electrolytic cells require external energy (e.g., electrolysis).

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3. (a) 46 g ethanol is dissolved in 54 g water. Calculate mole fraction of ethanol and water.

Solution: Moles of ethanol:

$$\text{Moles of ethanol} = \frac{\text{Mass}}{\text{Molar mass}} = \frac{46}{46} = 1\,\text{mol}.$$

Moles of water:

$$\text{Moles of water} = \frac{54}{18} = 3\,\text{mol}.$$

Mole fraction of ethanol:

$$\text{Mole fraction of ethanol} = \frac{\text{Moles of ethanol}}{\text{Total moles}} = \frac{1}{1+3} = 0.25.$$

Mole fraction of water:

$$\text{Mole fraction of water} = 1 - 0.25 = 0.75.$$

Quick Tip

Mole fractions always add up to 1, and they are dimensionless quantities.

(b) Calculate the normality of a solution prepared by dissolving 1.325 g of anhydrous sodium carbonate (Na_2CO_3) in 250 mL of water. Equivalent weight of Na_2CO_3 is 53.

Solution: Moles of Na_2CO_3:

$$\text{Moles} = \frac{\text{Mass}}{\text{Equivalent weight}} = \frac{1.325}{53} = 0.025\,\text{mol}.$$

Normality:

$$\text{Normality} = \frac{\text{Moles}}{\text{Volume (in L)}} = \frac{0.025}{0.25} = 0.1\,\text{N}.$$

Quick Tip

Normality is the number of gram-equivalents of solute per liter of solution.

(c) State important applications of phenol.

Solution: 1. Used as an antiseptic in low concentrations.

2. Used in the production of plastics like Bakelite.

3. Intermediate in the synthesis of dyes and drugs.

Quick Tip

Phenol's versatility makes it crucial in industries ranging from medicine to materials science.

(d) State the role of hormones in our body.

Solution: 1. Regulate growth and development.

2. Control metabolic processes.

3. Maintain homeostasis in the body.

Quick Tip

Hormones act as chemical messengers, coordinating various physiological processes.

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4. (a) Write a short note on Rosenmund reduction. Write only the chemical equation of the reaction of ethyne with water in presence of H_2SO_4 and $HgSO_4$.

Solution:

Rosenmund Reduction:

In Rosenmund reduction, acid chlorides are reduced to aldehydes using hydrogen gas and palladium catalyst poisoned with barium sulfate:

$$RCOCl + H_2 \xrightarrow{Pd/BaSO_4} RCHO.$$

Reaction of ethyne with water:

Ethyne reacts with water in the presence of H_2SO_4 and $HgSO_4$ to form acetaldehyde:

$$HC \equiv CH + H_2O \xrightarrow{H_2SO_4, HgSO_4} CH_3CHO.$$

Quick Tip

Rosenmund reduction is useful for selectively reducing acid chlorides to aldehydes, while ethyne hydration gives aldehydes via Markovnikov's addition.

(b) State the difference between molecularity of a reaction and order of a reaction.

Write the velocity equation for the reaction $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$, which is a zero-order reaction.

Solution:

- **Molecularity:**

The number of reacting species involved in an elementary reaction. It is always a whole number.

- **Order:**

The sum of the powers of the concentration terms in the rate law. It can be fractional or zero.

Velocity equation for zero-order reaction:

$$\text{Rate} = k \quad \text{(independent of reactant concentrations)}.$$

For the reaction $H_2 + Cl_2 \rightarrow 2HCl$, the rate equation is:

$$\text{Rate} = k.$$

Quick Tip

Molecularity applies to elementary reactions only, while order is determined experimentally for any reaction.

(c) Define specific resistance and conductance of a cell.

Solution:

- **Specific resistance (ρ):** The resistance offered by a unit length and unit cross-sectional area of a material. It is given by:

$$\rho = R \cdot \frac{A}{l},$$

where R is resistance, A is cross-sectional area, and l is the length.

- **Conductance (G):** The reciprocal of resistance. It is given by:

$$G = \frac{1}{R}.$$

Quick Tip

Specific resistance depends on material properties, while conductance measures the ease of electric flow.

(d) Why is bromine atom of bromoethane more reactive than that of bromobenzene? Write only chemical equation of the reaction of bromoethane with Na in presence of dry ether.

Solution:

- **Reactivity:** The bromine atom in bromoethane is more reactive because it is bonded to an sp^3-hybridized carbon, making the $C-Br$ bond weaker and more prone to cleavage. In bromobenzene, the bromine is bonded to an sp^2-hybridized carbon in the benzene ring, stabilizing the bond due to resonance.

Chemical Equation: The reaction of bromoethane with sodium in dry ether is the Wurtz reaction, forming ethane:

$$2C_2H_5Br + 2Na \xrightarrow{\text{dry ether}} C_2H_6 + 2NaBr.$$

Quick Tip

In bromoalkanes, the $C-Br$ bond is weaker than in bromobenzenes, making them more reactive. The Wurtz reaction is used for alkane synthesis.

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5. (a) (i) What are amines? Write one differentiating test for primary, secondary, and tertiary amines.

Solution:

- **Amines:** Amines are organic compounds derived from ammonia (NH_3) by replacing one or more hydrogen atoms with alkyl or aryl groups.

Differentiating test: Hinsberg test: - Primary amines form a soluble sulfonamide. - Secondary amines form an insoluble sulfonamide. - Tertiary amines do not react.

Quick Tip

Amines are classified as primary, secondary, or tertiary based on the number of alkyl or aryl groups attached to nitrogen.

(ii) Write chemical equations for the reaction of (x) ethanamine with HCl and (y)

aniline with $NaNO_2$ and dilute HCl at $0^\circ C$.

Solution:

(x) Reaction of ethanamine with HCl:

$$CH_3CH_2NH_2 + HCl \rightarrow CH_3CH_2NH_3^+Cl^-.$$

(y) Reaction of aniline with $NaNO_2$ and dilute HCl:

$$C_6H_5NH_2 + NaNO_2 + 2HCl \xrightarrow{0^\circ C} C_6H_5N_2^+Cl^- + 2H_2O.$$

Quick Tip

Primary aromatic amines undergo diazotization to form diazonium salts, while aliphatic amines form ammonium salts with acids.

(b) (i) What are d-block and f-block elements?

Solution:

- **d-block elements:** Elements in which the last electron enters the d-orbital. Examples: Transition metals like Fe, Cu. - **f-block elements:** Elements in which the last electron enters the f-orbital. Examples: Lanthanides and Actinides.

Quick Tip

d-block elements show variable oxidation states, while f-block elements are known for their magnetic and spectral properties.

(ii) Write general electronic configuration of d-block and f-block elements.

Solution:

- **d-block elements:** $(n-1)d^{1-10}ns^{0-2}$. - **f-block elements:** $(n-2)f^{1-14}(n-1)d^{0-1}ns^2$.

Quick Tip

d-block elements are also called transition elements, while f-block elements include inner transition metals.

(c) What happens when (write only chemical equations):

Solution:

(i) Ethanol is heated with sodium bromide and conc. H_2SO_4:

$$C_2H_5OH + NaBr + H_2SO_4 \rightarrow C_2H_5Br + NaHSO_4 + H_2O.$$

Quick Tip

Heating alcohols with sodium halides and acids forms alkyl halides.

(ii) Toluene reacts with Cl_2 gas in the presence of Fe powder in the dark:

$$C_6H_5CH_3 + Cl_2 \xrightarrow{Fe} C_6H_4ClCH_3 + HCl.$$

Quick Tip

In the dark, halogenation of aromatic hydrocarbons occurs at the benzene ring.

(iii) Benzene diazonium chloride reacts with water:

$$C_6H_5N_2^+Cl^- + H_2O \xrightarrow{\Delta} C_6H_5OH + N_2 + HCl.$$

Quick Tip

Diazonium salts decompose in water to form phenols.

(iv) 2-Bromopentane is heated with alcoholic KOH:

$$CH_3CH(Br)CH_2CH_2CH_3 \xrightarrow{alc.\,KOH} CH_3CH = CHCH_2CH_3 + HBr.$$

Quick Tip

Alcoholic KOH causes dehydrohalogenation, forming alkenes.

(d) State Raoult's law related to lowering of vapour pressure. Calculate the vapour pressure of pure water at 293 K temperature when 25 g of glucose is dissolved in 450 g of water. Vapour pressure of pure water at 293 K temperature is 17.535 mmHg.

Solution:

Raoult's Law: The relative lowering of vapour pressure is equal to the mole fraction of the solute:

$$P_1 = P_1^0 \cdot (1 - x_2),$$

where P_1^0 is the vapour pressure of pure solvent, P_1 is the vapour pressure of solution, and x_2 is the mole fraction of solute.

Calculation: - Moles of glucose:

$$\text{Moles of glucose} = \frac{25}{180} = 0.1389\,\text{mol}.$$

- Moles of water:

$$\text{Moles of water} = \frac{450}{18} = 25\,\text{mol}.$$

- Mole fraction of glucose:

$$x_2 = \frac{\text{Moles of glucose}}{\text{Total moles}} = \frac{0.1389}{25 + 0.1389} = 0.00554.$$

- Vapour pressure of solution:

$$P_1 = 17.535 \cdot (1 - 0.00554) = 17.435\,\text{mmHg}.$$

Quick Tip

Raoult's law applies to ideal solutions and relates vapour pressure lowering to solute concentration.

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6. (a) Write Valence Bond Theory (VBT) of coordination compounds. Also state the demerits of this theory.

Solution:

Valence Bond Theory (VBT):

- VBT explains the bonding in coordination compounds by considering the hybridization of orbitals on the central metal atom or ion.

- The metal ion provides vacant orbitals to accommodate the lone pairs of electrons donated by ligands, forming coordinate covalent bonds.

- The geometry of the complex depends on the type of hybridization:

- sp^3: Tetrahedral

- dsp^2: Square planar

- d^2sp^3: Octahedral

Demerits of VBT:

1. Fails to explain the color of coordination compounds.

2. Cannot account for the magnetic properties of some complexes.

3. Does not provide a quantitative measure of bond strength or stability.

Quick Tip

VBT is useful for explaining the geometry of complexes but is limited in predicting their optical and magnetic properties.

OR Explain the importance of coordination compounds.

Solution:

1. **Medicinal applications:** Cisplatin is used as an anti-cancer drug.

2. **Biological importance:** Hemoglobin (iron complex) and chlorophyll (magnesium complex) are vital for life processes.

3. **Industrial applications:** Coordination compounds like $[Ag(NH_3)_2]^+$ are used in photography.

4. **Analytical chemistry:** Complexometric titrations use EDTA as a ligand.

Quick Tip

Coordination compounds play key roles in medicine, biology, industry, and analytical chemistry.

(b) Write a short note on amino acids and nucleic acids.

Solution:

Amino Acids:

- Building blocks of proteins, containing an amino group ($-NH_2$) and a carboxyl group ($-COOH$).

- Essential amino acids must be obtained from the diet.

- Functions: Protein synthesis, enzyme activity, and metabolism regulation.

Nucleic Acids:

- DNA and RNA are polymers of nucleotides, composed of a sugar, phosphate group, and nitrogenous base.

- DNA stores genetic information, while RNA is involved in protein synthesis.

Quick Tip

Amino acids are essential for protein structure, while nucleic acids are carriers of genetic information.

OR State the source and the diseases caused by the deficiency of the following vitamins:

(i) Vitamin A

(ii) Vitamin C

(iii) Vitamin D

(iv) Vitamin E

(v) Vitamin K

Solution:

(i) Vitamin A: - Source: Carrots, sweet potatoes, spinach. - Deficiency Disease: Night blindness.

(ii) Vitamin C: - Source: Citrus fruits, tomatoes, strawberries. - Deficiency Disease: Scurvy (bleeding gums, weakened immunity).

(iii) Vitamin D: - Source: Sunlight, fish liver oil, fortified milk. - Deficiency Disease: Rickets (in children) and osteomalacia (in adults).

(iv) Vitamin E: - Source: Nuts, seeds, green leafy vegetables. - Deficiency Disease: Neurological problems and muscle weakness.

(v) Vitamin K: - Source: Green leafy vegetables, broccoli, soybean oil. - Deficiency Disease: Delayed blood clotting and excessive bleeding.

Quick Tip

Vitamins are essential nutrients required in small amounts to prevent deficiency diseases and maintain health.

7. (a) When an organic compound of molecular formula $C_4H_8O_2$ undergoes hydrolysis with dilute H_2SO_4, a carboxylic acid A and an alcohol B are obtained. On oxidising B with chromic acid, carboxylic acid A is obtained. On heating A with P_2O_5, acid anhydride C of this acid is obtained. On hydrolysing this anhydride, acid A is obtained again. Identify A, B, and C and also write chemical equations related to them.

Solution:

- Compound A: Ethanoic acid (CH_3COOH)

- Compound B: Ethanol (CH_3CH_2OH)

- Compound C: Ethanoic anhydride ($(CH_3CO)_2O$)

Chemical equations:

1. Hydrolysis of $C_4H_8O_2$ (ethyl acetate):

$$CH_3COOC_2H_5 + H_2O \xrightarrow{H_2SO_4} CH_3COOH + C_2H_5OH$$

2. Oxidation of ethanol (B):

$$C_2H_5OH + [O] \xrightarrow{H_2CrO_4} CH_3COOH$$

3. Formation of acid anhydride (C):

$$2CH_3COOH \xrightarrow{P_2O_5} (CH_3CO)_2O + H_2O$$

4. Hydrolysis of acid anhydride (C):

$$(CH_3CO)_2O + H_2O \rightarrow 2CH_3COOH$$

Quick Tip

Carboxylic acids form anhydrides when heated with dehydrating agents like P_2O_5, and the process is reversible via hydrolysis.

OR How will you prepare the following? (Write only chemical equations.)

Solution:

(i) Benzene from benzoic acid:

$$C_6H_5COOH + NaOH \xrightarrow{\Delta} C_6H_6 + Na_2CO_3$$

Quick Tip

Decarboxylation of carboxylic acids with soda lime produces hydrocarbons.

(ii) Phthalimide from phthalic acid:

$$C_6H_4(COOH)_2 \xrightarrow{NH_3,\Delta} C_6H_4(CO)NH$$

Quick Tip

Heating phthalic acid with ammonia produces phthalimide via dehydration.

(iii) m-Nitrobenzaldehyde from benzaldehyde:

$$C_6H_5CHO + HNO_3 \xrightarrow{Conc.H_2SO_4} C_6H_4(NO_2)CHO$$

Quick Tip

Nitration of benzaldehyde selectively produces nitro derivatives at meta positions.

(iv) Benzaldehyde from benzene:

$$C_6H_6 + CO + HCl \xrightarrow{AlCl_3} C_6H_5CHO$$

Quick Tip

The Gattermann-Koch reaction is used to form benzaldehyde from benzene.

(v) Silver mirror from C_6H_5CHO:

$$C_6H_5CHO + 2[Ag(NH_3)_2]^+ + 3OH^- \rightarrow C_6H_5COOH + 2Ag + 4NH_3 + H_2O$$

Quick Tip

The silver mirror test is a qualitative test for aldehydes using Tollens' reagent.

(b) Write the chemical equation for obtaining phenol from cumene. What is the reaction of phenol with the following? (Write only chemical equations.)

Solution:

Phenol from cumene:

$$C_6H_5CH(CH_3)_2 + [O] \rightarrow C_6H_5OH + CH_3COCH_3$$

(i) Reaction of phenol with zinc powder:

$$C_6H_5OH + Zn \xrightarrow{\Delta} C_6H_6 + ZnO$$

Quick Tip

Heating phenol with zinc powder reduces it to benzene.

(ii) Reaction of phenol with conc. HNO_3**:**

$$C_6H_5OH + HNO_3 \xrightarrow{H_2SO_4} C_6H_2(NO_2)_3OH$$

Quick Tip

Phenol undergoes nitration to form picric acid ($2, 4, 6$-trinitrophenol) with concentrated nitric acid.

(iii) Reaction of phenol with bromine water:

$$C_6H_5OH + 3Br_2 \xrightarrow{\text{aq.}} C_6H_2Br_3OH + 3HBr$$

Quick Tip

Phenol reacts with bromine water to form a white precipitate of tribromophenol.

OR Write short notes on the following:

(i) Industrial preparation of methanol from water gas:

$$CO + 2H_2 \xrightarrow{ZnO, Cr_2O_3} CH_3OH$$

Quick Tip

Methanol is industrially prepared by catalytic hydrogenation of carbon monoxide.

(ii) Preparation of ethanol by alcoholic fermentation of sucrose:

$$C_{12}H_{22}O_{11} + H_2O \xrightarrow{\text{Invertase}} 2C_6H_{12}O_6 \xrightarrow{\text{Zymase}} 4C_2H_5OH + 4CO_2$$

Quick Tip

Fermentation of sugars like sucrose produces ethanol and carbon dioxide.

(iii) Applications of ethanol:

1. Used as a solvent in industries.
2. Utilized as a fuel and in fuel blends (e.g., gasohol).
3. Used in the production of alcoholic beverages.

Quick Tip

Ethanol has diverse applications in industrial, medicinal, and fuel sectors.
