

UP Board Class 12 Chemistry Code 347 CB 2023 Question Paper with Solutions

Time Allowed :3 Hours	Maximum Marks :70	Total questions :35
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General Instructions

Instruction:

- i) All questions are compulsory. Marks allotted to each question are given in the margin.
- ii) In numerical questions, give all the steps of calculation.
- iii) Give relevant answers to the questions.
- iv) Give chemical equations, wherever necessary.

1. (a) Structure of the crystal of sodium chloride is:

- (i) body centred cubic (bcc)
- (ii) face centred cubic (fcc)
- (iii) orthorhombic
- (iv) tetragonal

Correct Answer: (ii) face centred cubic (fcc)

Solution:

Step 1: Understanding NaCl crystal structure.

The crystal structure of sodium chloride (NaCl) is based on the arrangement of Na^+ and Cl^- ions. Each Na^+ ion is surrounded by 6 Cl^- ions and each Cl^- ion is surrounded by 6 Na^+ ions. This gives it a coordination number of 6:6.

Step 2: Identifying lattice type.

This arrangement corresponds to a face centred cubic (fcc) lattice, also known as the rock-salt structure.

Step 3: Conclusion.

Thus, the correct answer is (ii) face centred cubic (fcc).

Quick Tip

NaCl crystal is an example of a rock-salt structure with fcc arrangement, where each ion is octahedrally surrounded by opposite ions.

1 (b). The charge on colloidal particles of $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ is:

- (i) Negative
- (ii) Positive
- (iii) No charge
- (iv) None of these

Correct Answer: (ii) Positive

Solution:**Step 1: Nature of ferric oxide sol.**

Ferric oxide sol ($\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$) is a positively charged colloid when dispersed in water. This is because Fe^{3+} ions from hydrolysis impart a positive charge to the dispersed particles.

Step 2: Verification of options.

- (i) Negative: Incorrect, ferric oxide sol is not negatively charged.
- (ii) Positive: Correct, because it acquires Fe^{3+} ions.
- (iii) No charge: Incorrect, as colloidal particles always carry some charge.
- (iv) None of these: Incorrect, as positive charge is correct.

Step 3: Conclusion.

Hence, the charge on colloidal particles of $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ is positive.

Quick Tip

Metal oxides in colloidal form generally acquire charge depending on the medium; Fe_2O_3 sol is positively charged in water.

1 (c). Molecular formula of sulphur at ordinary temperature is:

- (i) S_2
- (ii) S_4
- (iii) S_6
- (iv) S_8

Correct Answer: (iv) S_8

Solution:**Step 1: Physical state of sulphur.**

At ordinary temperature, sulphur exists in the solid state. Its most stable form is rhombic sulphur.

Step 2: Molecular structure.

In rhombic sulphur, each molecule consists of 8 sulphur atoms forming a puckered ring (crown shape). Hence, its molecular formula is S_8 .

Step 3: Conclusion.

Therefore, the correct molecular formula of sulphur at ordinary temperature is (iv) S_8 .

Quick Tip

Sulphur commonly exists as S_8 molecules at room temperature, forming a crown-shaped cyclic structure.

1 (d). Gas present in food packet of substances is:

- (i) H_2
- (ii) O_2
- (iii) N_2
- (iv) F_2

Correct Answer: (iii) N_2

Solution:**Step 1: Purpose of gas in food packets.**

To prevent spoilage and oxidation, an inert atmosphere is required inside sealed food packets.

Step 2: Gas used.

Nitrogen gas (N_2) is used because it is inert, does not react with food, and displaces oxygen which causes oxidation and spoilage.

Step 3: Conclusion.

Thus, the gas present in food packets is (iii) N_2 .

Quick Tip

Nitrogen gas prevents oxidation and rancidity, keeping packed food fresh for longer.

1 (e). Unit of specific conductance is:

- (i) $\text{ohm}^{-1} \text{cm}^2 \text{mol}^{-1}$

(ii) $\text{ohm}^{-1} \text{ cm}^{-2} \text{ mol}^{-1}$

(iii) $\text{ohm}^{-1} \text{ cm}^2 \text{ mol}^2$

(iv) $\text{ohm cm}^2 \text{ mol}^{-1}$

Correct Answer: (i) $\text{ohm}^{-1} \text{ cm}^{-1}$ (or S cm^{-1})

Solution:

Step 1: Definition.

Specific conductance (or conductivity, κ) is the conductance of 1 cm^3 of a solution placed between two electrodes 1 cm apart.

Step 2: Unit.

Since conductance unit is ohm^{-1} (or siemens, S), and length factor introduces cm^{-1} , the unit is $\text{ohm}^{-1} \text{ cm}^{-1}$.

Step 3: Conclusion.

Therefore, the unit of specific conductance is $\text{ohm}^{-1} \text{ cm}^{-1}$.

Quick Tip

Specific conductance is often expressed in S cm^{-1} , where $\text{S} = \text{siemens} = \text{ohm}^{-1}$.

1 (f). Non-electrolyte is:

(i) Sodium chloride

(ii) Urea

(iii) Ammonium nitrate

(iv) Nitric acid

Correct Answer: (ii) Urea

Solution:

Step 1: Understanding electrolytes.

Electrolytes are substances that dissociate into ions in aqueous solution and conduct electricity. Non-electrolytes do not dissociate and hence do not conduct electricity.

Step 2: Analysis of options.

- Sodium chloride: Electrolyte, produces Na^+ and Cl^- ions.
- Urea: Non-electrolyte, dissolves in water but does not produce ions.
- Ammonium nitrate: Electrolyte, dissociates into NH_4^+ and NO_3^- .
- Nitric acid: Strong electrolyte, ionizes completely.

Step 3: Conclusion.

Thus, the non-electrolyte among the options is (ii) Urea.

Quick Tip

Non-electrolytes dissolve in water but do not form ions, hence they do not conduct electricity (e.g., urea, glucose).

2 (a). Write the names of two lyophilic and two lyophobic colloids.

Correct Answer: - Lyophilic colloids: Starch sol, Gum sol.

- Lyophobic colloids: Ferric hydroxide sol, Gold sol.

Solution:**Step 1: Understanding lyophilic colloids.**

Lyophilic colloids are "liquid-loving" colloids that form readily when mixed with the dispersion medium. They are stable and reversible in nature. Examples: starch sol, gum sol.

Step 2: Understanding lyophobic colloids.

Lyophobic colloids are "liquid-hating" colloids that do not form readily and require special methods for preparation. They are less stable and irreversible. Examples: ferric hydroxide sol, gold sol.

Step 3: Conclusion.

Thus, starch sol and gum sol are lyophilic colloids, while ferric hydroxide sol and gold sol are lyophobic colloids.

Quick Tip

Lyophilic = stable and reversible, Lyophobic = unstable and irreversible.

2 (b). State Hardy–Schulze law.

Correct Answer: The Hardy–Schulze law states that: “*The coagulating power of an ion increases with the valency of the ion which is oppositely charged to the colloidal particles.*”

Solution:

Step 1: Nature of colloidal particles.

Colloidal particles carry either a positive or negative charge. Their stability depends on the repulsion between similarly charged particles.

Step 2: Role of oppositely charged ions.

When oppositely charged ions are added, they neutralize the charge on the colloidal particles and cause coagulation.

Step 3: Order of coagulating power.

For negatively charged sols: Al^{3+} $\succ$ Ba^{2+} $\succ$ Na^+ . For positively charged sols: $[\text{Fe}(\text{CN})_6]^{4-}$ $\succ$ PO_4^{3-} $\succ$ SO_4^{2-} $\succ$ Cl^- .

Step 4: Conclusion.

Thus, the higher the valency of the oppositely charged ion, the greater its coagulating power.

Quick Tip

Valency matters! Multivalent ions coagulate colloids much faster than monovalent ions.

2 (c). State anti-osmosis with example.

Correct Answer: Anti-osmosis is the process of flow of solvent molecules from a concentrated solution to a dilute solution through a semipermeable membrane under the influence of an applied pressure greater than osmotic pressure. Example: Desalination of seawater using reverse osmosis.

Solution:

Step 1: Recall osmosis.

In osmosis, solvent flows naturally from dilute to concentrated solution across a semipermeable membrane.

Step 2: Applying pressure.

If pressure greater than osmotic pressure is applied on the concentrated side, the natural flow is reversed. Solvent moves from concentrated solution to dilute solution. This is called anti-osmosis or reverse osmosis.

Step 3: Example.

Reverse osmosis is used in water purification, such as desalination of seawater where pure water passes through the membrane leaving salts behind.

Step 4: Conclusion.

Thus, anti-osmosis is reverse osmosis caused by applying external pressure greater than osmotic pressure.

Quick Tip

Anti-osmosis is the principle behind RO water purifiers used in homes.

2 (d-i). State the name and formula of electrophile used in the nitration of benzaldehyde.

Correct Answer: Electrophile = nitronium ion, NO_2^+ .

Solution:

Step 1: Recall nitration mechanism.

Nitration is an electrophilic substitution reaction where an electrophile attacks the benzene ring.

Step 2: Electrophile formation.

In nitration, concentrated HNO_3 reacts with concentrated H_2SO_4 to form the nitronium ion (NO_2^+).



Step 3: Role of electrophile.

This nitronium ion attacks the benzene ring of benzaldehyde to carry out nitration.

Step 4: Conclusion.

Thus, the electrophile is NO_2^+ (nitronium ion).

Quick Tip

Nitration always involves the nitronium ion (NO_2^+) as the electrophile.

2 (d-ii). Name one disaccharide and write its molecular formula.

Correct Answer: Sucrose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$.

Solution:

Step 1: Definition of disaccharide.

A disaccharide is a carbohydrate formed when two monosaccharides are joined by a glycosidic bond.

Step 2: Example.

The most common disaccharide is sucrose, formed from glucose + fructose.

Step 3: Molecular formula.

The molecular formula of sucrose is $\text{C}_{12}\text{H}_{22}\text{O}_{11}$.

Step 4: Conclusion.

Thus, one disaccharide example is sucrose with formula $\text{C}_{12}\text{H}_{22}\text{O}_{11}$.

Quick Tip

Other disaccharides include maltose and lactose (same molecular formula: $\text{C}_{12}\text{H}_{22}\text{O}_{11}$).

3 (a). Differentiate between coordination compound and double salt.

Correct Answer:

Coordination Compound	Double Salt
Stable in solution; retain their identity as complex ions.	Dissociate completely into constituent ions in solution.
Show properties different from their constituents.	Show properties similar to their constituent salts.
Example: $K_4[Fe(CN)_6]$	Example: Mohr's salt $[FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O]$

Solution:

Step 1: Recall definitions.

- A coordination compound consists of a central metal atom/ion bonded to ligands forming a complex ion. - A double salt is formed by crystallization of two salts together.

Step 2: Key distinction.

Coordination compounds retain their identity in solution (complex ion remains intact), while double salts dissociate completely.

Step 3: Conclusion.

Thus, coordination compounds differ from double salts in terms of ion dissociation and stability in solution.

Quick Tip

Coordination compounds keep their complex identity in water, but double salts lose it by dissociation.

3 (b). Explain hybridisation on Ni in $[Ni(CN)_4]^{2-}$.

Correct Answer: dsp^2 hybridisation (square planar geometry).

Solution:

Step 1: Oxidation state of Ni.

In $[Ni(CN)_4]^{2-}$, Ni is in +2 oxidation state. Electronic configuration of Ni atom = $[Ar] 3d^8 4s^2$. For $Ni^{2+} = [Ar] 3d^8$.

Step 2: Effect of strong ligand (CN⁻).

CN⁻ is a strong field ligand (according to spectrochemical series). It causes pairing of 3d electrons. Thus configuration becomes: 3d¹⁰.

Step 3: Hybridisation.

Now Ni²⁺ uses one 3d, one 4s, and two 4p orbitals → dsp² hybridisation. This gives a square planar geometry.

Step 4: Conclusion.

Therefore, Ni in [Ni(CN)₄]²⁻ undergoes dsp² hybridisation with square planar shape.

Quick Tip

Strong field ligands like CN⁻ cause pairing → dsp² (square planar). Weak field ligands → sp³ (tetrahedral).

3 (c). Write the formula of half-life period for first order reaction.**Correct Answer:**

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

Solution:**Step 1: General expression for first order kinetics.**

For a first order reaction, the integrated rate law is:

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

Step 2: Condition for half-life.

At half-life, $[R] = \frac{[R]_0}{2}$.

Step 3: Substitution.

$$k = \frac{2.303}{t_{1/2}} \log \frac{[R]_0}{[R]_0/2} = \frac{2.303}{t_{1/2}} \log 2$$
$$k = \frac{0.693}{t_{1/2}}$$

Step 4: Rearranging.

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

Quick Tip

Half-life for a first order reaction is independent of initial concentration.

3 (d). Find oxidation number and coordination number of Fe in $K_4[Fe(CN)_6]$.

Correct Answer: - Oxidation number of Fe = +2.

- Coordination number of Fe = 6.

Solution:

Step 1: Formula.

The complex is $K_4[Fe(CN)_6]$. Potassium has charge +1. Cyanide ion (CN^-) has charge -1.

Step 2: Calculation of oxidation state.

Let oxidation state of Fe = x .

$$4(+1) + x + 6(-1) = 0$$

$$4 + x - 6 = 0 \implies x - 2 = 0 \implies x = +2$$

Step 3: Coordination number.

The number of ligands directly attached to Fe is 6 (from 6 CN^- ligands). Hence, coordination number = 6.

Step 4: Conclusion.

Oxidation number of Fe = +2, coordination number = 6.

Quick Tip

Oxidation number is found by charge balance; coordination number = number of ligands directly bonded.

4 (a). In a first order reaction the concentration of a substance gets dissociated by 99% of the initial concentration in 100 minutes. Calculate the velocity constant of the reaction.

Correct Answer: $k = 0.0462 \text{ min}^{-1}$

Solution:

Step 1: Recall integrated rate law for first order.

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

Step 2: Apply given values.

99% dissociated $\rightarrow$ remaining concentration = 1% of initial.

$$\frac{[R]_0}{[R]} = \frac{100}{1} = 100$$

$t = 100 \text{ min.}$

Step 3: Substitution.

$$k = \frac{2.303}{100} \log(100)$$
$$k = \frac{2.303}{100} \times 2 = 0.04606 \text{ min}^{-1}$$

Step 4: Conclusion.

The velocity constant = 0.046 min^{-1} .

Quick Tip

In first order kinetics, percentage dissociation is directly related to $\log \frac{[R]_0}{[R]}$.

4 (b). Explain the following: (i) Conductance, (ii) Cell constant.

Correct Answer:

(i) **Conductance:** Reciprocal of resistance, denoted by G . Unit: ohm^{-1} or siemens (S). (ii)

Cell constant: Ratio of distance between electrodes to the area of cross-section of electrodes, $\frac{l}{A}$.

Solution:

Step 1: Conductance.

Resistance (R) opposes current; conductance is ease of current flow.

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

Step 2: Cell constant.

In a conductivity cell:

$$\text{Cell constant} = \frac{l}{A}$$

where l = distance between electrodes, A = electrode area.

Step 3: Importance.

Cell constant helps to convert measured conductance into specific conductance.

Quick Tip

Conductance = $1/R$. Cell constant = l/A , crucial for conductivity experiments.

4 (c). Silver forms ccp lattice. Edge length of its unit cell is 408.6 pm. Calculate the density of silver. (Atomic weight of Ag = 108)

Correct Answer: $\rho = 10.5 \text{ g cm}^{-3}$

Solution:

Step 1: Recall formula for density.

$$\rho = \frac{Z \times M}{N_A \times a^3}$$

where $Z = 4$ (ccp), $M = 108 \text{ g mol}^{-1}$, $a = 408.6 \text{ pm}$, $N_A = 6.022 \times 10^{23}$.

Step 2: Convert edge length.

$$a = 408.6 \times 10^{-10} \text{ cm} = 4.086 \times 10^{-8} \text{ cm}$$

Step 3: Substitution.

$$\rho = \frac{4 \times 108}{6.022 \times 10^{23} \times (4.086 \times 10^{-8})^3}$$

$$\rho \approx 10.5 \text{ g cm}^{-3}$$

Step 4: Conclusion.

Density of silver = 10.5 g cm^{-3} .

Quick Tip

For ccp/fcc structures, always take $Z = 4$.

4 (d). Calculate the osmotic pressure of 5% aqueous urea solution (w/v) at 27°C.

Molecular weight of urea = 60. ($R = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$)

Correct Answer: $\pi = 20.5 \text{ atm}$

Solution:

Step 1: Recall formula.

$$\pi = CRT$$

where C = molarity, $R = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$, $T = 27 + 273 = 300 \text{ K}$.

Step 2: Calculate molarity.

5 Moles of urea = $\frac{50}{60} = 0.833 \text{ mol}$. Molarity = 0.833 M.

Step 3: Substitution.

$$\pi = 0.833 \times 0.0821 \times 300$$

$$\pi \approx 20.5 \text{ atm}$$

Step 4: Conclusion.

Osmotic pressure = 20.5 atm .

Quick Tip

Osmotic pressure depends directly on molarity and temperature ($\pi \propto C \times T$).

5 (a). State any four properties of d-block elements.

Correct Answer: 1. Exhibit variable oxidation states.
2. Form coloured compounds.
3. Show catalytic properties.
4. Form complexes due to presence of vacant d-orbitals.

Solution:

Step 1: Recall position.

d-block elements are transition metals, lying in groups 3–12. Their valence electrons enter the $(n-1)d$ orbitals.

Step 2: Properties.

- Variable oxidation states due to similar energies of $(n-1)d$ and ns orbitals. - Coloured compounds due to d–d electronic transitions. - Catalytic properties as they provide active sites and variable oxidation states. - Complex formation due to vacant d-orbitals and high charge density.

Step 3: Conclusion.

Thus, d-block elements have distinct properties like variable oxidation states, colour, catalysis, and complex formation.

Quick Tip

Transition metals are best known for colour, variable oxidation states, and catalytic activity.

5 (b). Phenol shows acidic character but ethanol remains approximately neutral. Why?

Correct Answer: Phenol is acidic due to resonance stabilization of phenoxide ion, while ethanol cannot stabilize ethoxide ion effectively.

Solution:

Step 1: Compare acidity.

Both phenol and ethanol can release a proton (H^+).

Step 2: Stability of conjugate base.

- Phenoxide ion is resonance stabilized over the aromatic ring. - Ethoxide ion has no resonance stabilization, only negative charge localized on oxygen.

Step 3: Conclusion.

Thus, phenol is acidic whereas ethanol is neutral because resonance stabilization makes phenol more likely to lose H^+ .

Quick Tip

Acidity depends on stability of conjugate base; resonance increases acidity.

5 (c-i). Write I.U.P.A.C. name of $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_2\text{CH}_3$.

Correct Answer: Ethoxypropane (specifically 1-ethoxypropane).

Solution:

Step 1: Identify parent chain.

Longest chain = propane (3 carbons).

Step 2: Identify substituent.

$-\text{OCH}_2\text{CH}_3$ group is an ethoxy group.

Step 3: Numbering.

The ethoxy group is attached to C-1 of propane.

Step 4: Conclusion.

IUPAC name = 1-ethoxypropane.

Quick Tip

In ethers, name smaller alkyl group as alkoxy substituent on main chain.

5 (c-ii). What are tetrahedral voids?

Correct Answer: A tetrahedral void is a space in a crystal lattice formed when four atoms are arranged tetrahedrally, leaving a small void in between.

Solution:

Step 1: Recall concept of voids.

Voids are empty spaces in close packing of spheres.

Step 2: Tetrahedral void formation.

When three spheres form a triangle in one layer and a sphere from the next layer is placed above it, the resulting void is tetrahedral in shape.

Step 3: Ratio.

Number of tetrahedral voids = $2 \times$ number of spheres.

Step 4: Conclusion.

Thus, tetrahedral voids are small empty spaces formed in close packing with tetrahedral geometry.

Quick Tip

Every atom in close packing is associated with 2 tetrahedral voids.

5 (c-iii). Which of 0.1 M urea and 0.1 M NaCl will have more osmotic pressure?

Explain with reason.

Correct Answer: 0.1 M NaCl has more osmotic pressure than 0.1 M urea.

Solution:

Step 1: Recall osmotic pressure formula.

$$\pi = iCRT$$

where i = van't Hoff factor.

Step 2: For urea.

Urea is non-electrolyte $\rightarrow i = 1$.

Step 3: For NaCl.

NaCl dissociates completely $\rightarrow i = 2$. So effective concentration doubles.

Step 4: Conclusion.

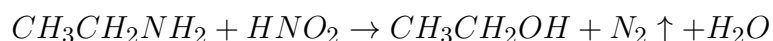
Osmotic pressure of NaCl solution is higher than that of urea.

Quick Tip

Electrolytes give higher colligative properties due to dissociation ($i > 1$).

5 (d-i). Write balanced chemical equation of the reaction of ethanamine with NaNO_2 + dil. HCl.

Correct Answer:



Solution:

Step 1: Nature of reaction.

Aliphatic primary amines react with nitrous acid to form alcohols, releasing nitrogen gas.

Step 2: Reaction.

Ethanamine + nitrous acid $\rightarrow$ Ethanol + N_2 + H_2O .

Step 3: Conclusion.

Hence ethanamine gives ethanol by reaction with NaNO_2/HCl .

Quick Tip

Primary aliphatic amines liberate N_2 gas on reaction with nitrous acid – useful for identification.

5 (d-ii). Write balanced chemical equation of the reaction of ethanamine with Hinsberg reagent.

Correct Answer:



Solution:**Step 1: Recall Hinsberg test.**

Primary amines react with Hinsberg's reagent (benzenesulphonyl chloride) to form sulphonamide, soluble in alkali.

Step 2: Reaction.

Ethanamine + $\text{C}_6\text{H}_5\text{SO}_2\text{Cl} \rightarrow$ Ethanamide sulphonamide (soluble in alkali).

Step 3: Importance.

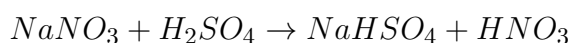
This reaction is used to distinguish primary, secondary, and tertiary amines.

Step 4: Conclusion.

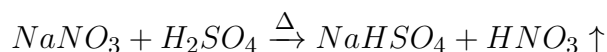
Ethanamine forms a soluble sulphonamide with Hinsberg's reagent.

Quick Tip

Hinsberg's reagent helps in classification of amines: primary = soluble, secondary = insoluble, tertiary = no reaction.

6 (a-i). Reaction of NaNO_3 and H_2SO_4 .**Correct Answer:****Solution:****Step 1: Type of reaction.**

When sodium nitrate is heated with concentrated sulphuric acid, nitric acid vapours are liberated.

Step 2: Balanced reaction.**Step 3: Conclusion.**

This is the laboratory method of preparing nitric acid.

Quick Tip

Conc. H_2SO_4 acts as a strong dehydrating acid to liberate HNO_3 .

6 (a-ii). Reaction of conc. HNO_3 with I_2 .

Correct Answer:



Solution:

Step 1: Oxidising nature.

Conc. HNO_3 acts as a powerful oxidising agent.

Step 2: Reaction with iodine.

Iodine is oxidised to iodic acid (HIO_3) and HNO_3 is reduced to NO_2 .

Step 3: Balanced reaction.



Step 4: Conclusion.

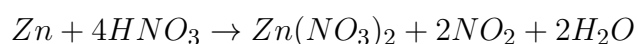
Thus, conc. HNO_3 oxidises iodine to iodic acid.

Quick Tip

Conc. HNO_3 is a strong oxidiser; it readily converts halogens to higher oxo-acids.

6 (a-iii). Reaction of nitric acid and zinc.

Correct Answer:



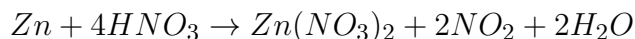
Solution:

Step 1: Nature of reaction.

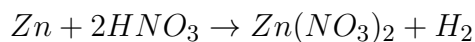
Nitric acid oxidises zinc to zinc nitrate, liberating nitrogen oxides.

Step 2: Reaction.

With conc. HNO_3 :



With dilute HNO_3 :



Step 3: Conclusion.

Thus, nitric acid reacts with zinc producing zinc nitrate and nitrogen oxides (or H_2 with dilute acid).

Quick Tip

Conc. HNO_3 acts as oxidiser, dilute HNO_3 acts more like a normal acid.

OR

6 (i). Explain the method of preparation of ozone gas by electric discharge method.

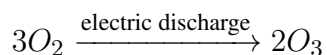
Correct Answer: Ozone is prepared by passing silent electric discharge through pure, dry oxygen.

Solution:

Step 1: Principle.

Electric discharge splits O_2 molecules into oxygen atoms, which combine with O_2 to form O_3 .

Step 2: Reaction.



Step 3: Apparatus.

Silent discharge (ozoniser) is used to prevent decomposition of ozone by spark.

Step 4: Conclusion.

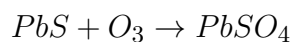
Thus, ozone is prepared by passing silent electric discharge through oxygen.

Quick Tip

Always use silent discharge to avoid decomposition of ozone.

6 (ii). Write the reaction of ozone with lead sulphide.

Correct Answer:



Solution:

Step 1: Nature of reaction.

Ozone is a strong oxidising agent.

Step 2: Reaction.

It oxidises PbS (black) to PbSO₄ (white).

Step 3: Conclusion.

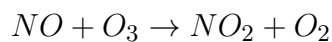
This is used as a test for ozone.

Quick Tip

PbS (black) → PbSO₄ (white): classic ozone test.

6 (iii). Write the reaction between NO (g) and O₃ (g).

Correct Answer:

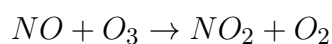


Solution:

Step 1: Reactants.

Nitric oxide (NO) reacts rapidly with ozone.

Step 2: Reaction.



Step 3: Conclusion.

Thus ozone oxidises NO to NO₂.

Quick Tip

Ozone readily oxidises NO to NO₂, an important atmospheric reaction.

6 (b). Write the structural formula and I.U.P.A.C. name of D-glucose. How will you prove the presence of aldehyde group in glucose molecule?

Correct Answer: - Structural formula: D-glucose is an aldohexose with the open chain structure:



- I.U.P.A.C. name: D-(+)-Glucose is systematically named as

(2R,3S,4R,5R)-2,3,4,5,6-pentahydroxyhexanal. - Aldehyde group in glucose is proved by Fehling's and Tollen's tests.

Solution:

Step 1: Structural formula.

The open-chain form of D-glucose:



It has 6 carbons, 5 hydroxyl groups, and 1 aldehyde group.

Step 2: IUPAC name.

As an aldohexose, the correct name is **2,3,4,5,6-pentahydroxyhexanal**. In stereochemical form, it is (2R,3S,4R,5R).

Step 3: Test for aldehyde group.

- **Fehling's Test:** On heating with Fehling's solution, glucose reduces Cu²⁺ to red precipitate of Cu₂O. - **Tollen's Test:** On heating with ammoniacal silver nitrate, glucose reduces Ag⁺ to metallic silver (silver mirror).

Step 4: Conclusion.

Thus, D-glucose contains an aldehyde group confirmed by positive Fehling's and Tollen's tests.

Quick Tip

Glucose is an aldohexose; aldehyde group is confirmed by classical silver mirror and Fehling's tests.

OR

6 (b-i). Denaturation of protein.

Solution:

Step 1: Understanding protein structure.

Proteins have four levels of structure: primary (sequence of amino acids), secondary (-helix, -sheet), tertiary (3D folding), and quaternary (multiple chains).

Step 2: What is denaturation?

Denaturation is the process in which the secondary, tertiary, and quaternary structures of proteins are destroyed, while the primary structure (amino acid sequence) remains unchanged.

Step 3: Causes.

Denaturation occurs due to heat, acids, alkalis, organic solvents, or heavy metals that disrupt hydrogen bonds, ionic bonds, and hydrophobic interactions.

Step 4: Example.

The most common example is the coagulation of egg white (albumin) when boiled – it turns from soluble to insoluble solid.

Step 5: Conclusion.

Hence, denaturation destroys biological activity of proteins by altering their shape.

Quick Tip

Denaturation changes shape of proteins, not their peptide bond sequence.

6 (b-ii). Zwitter ion.

Solution:

Step 1: Nature of amino acids.

Amino acids contain both an acidic group ($-\text{COOH}$) and a basic group ($-\text{NH}_2$).

Step 2: Behaviour in water.

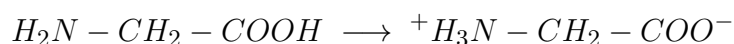
In aqueous solution, $-\text{COOH}$ donates a proton forming $-\text{COO}^-$, while $-\text{NH}_2$ accepts a proton forming $-\text{NH}_3^+$.

Step 3: Dipolar form.

Thus, the molecule carries both positive and negative charges simultaneously, existing as a zwitterion.

Step 4: Example.

For glycine:



Step 5: Conclusion.

At isoelectric point, the amino acid exists mainly in zwitterionic form with no net charge.

Quick Tip

Zwitter ions are electrically neutral overall, but carry both +ve and -ve charges.

6 (b-iii). Uses of protein.

Solution:

Step 1: Structural role.

Proteins provide support and strength to body structures (collagen in connective tissues, keratin in hair, nails, skin).

Step 2: Catalytic role.

Proteins act as enzymes that catalyse biochemical reactions (e.g., amylase, protease).

Step 3: Transport and storage.

Some proteins carry vital substances – haemoglobin transports oxygen, myoglobin stores oxygen in muscles.

Step 4: Defence mechanism.

Antibodies are protein molecules that protect the body against infections.

Step 5: Hormonal regulation.

Certain hormones like insulin and glucagon are proteins that regulate metabolism.

Step 6: Conclusion.

Proteins are indispensable biomolecules for structural, catalytic, protective, transport, and regulatory functions.

Quick Tip

Proteins = body's building blocks: structure, enzymes, transport, defence, and regulation.

7 (a). Write the structural formula of benzaldehyde. Write chemical equations of the reaction of benzaldehyde with (i) NH_2NH_2 , (ii) Tollen's reagent and (iii) NaOH .

Correct Answer: - Structural formula: $\text{C}_6\text{H}_5\text{CHO}$ (benzene ring attached to $-\text{CHO}$ group).

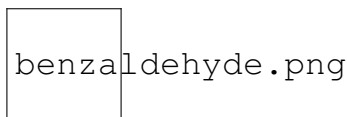
- Reactions: (i) With hydrazine: forms hydrazone.

(ii) With Tollen's reagent: gives silver mirror (oxidation to benzoic acid).

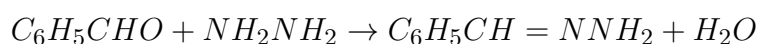
(iii) With NaOH : undergoes Cannizzaro reaction $\rightarrow$ sodium benzoate + benzyl alcohol.

Solution:**Step 1: Structural formula.**

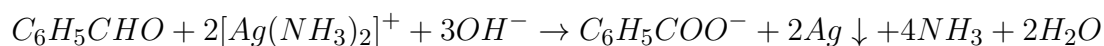
Benzaldehyde has formula $\text{C}_6\text{H}_5\text{CHO}$.

**Step 2: Reaction with NH_2NH_2 .**

Benzaldehyde reacts with hydrazine to form benzaldehyde hydrazone:

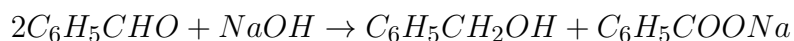
**Step 3: Reaction with Tollen's reagent.**

Tollen's reagent oxidises the $-\text{CHO}$ group to $-\text{COOH}$, producing benzoic acid and metallic silver (silver mirror):



Step 4: Reaction with NaOH (Cannizzaro reaction).

Benzaldehyde (without $-\text{H}$) undergoes disproportionation in presence of conc. NaOH:



Step 5: Conclusion.

Thus, benzaldehyde reacts with hydrazine (condensation), Tollen's reagent (oxidation), and NaOH (Cannizzaro reaction).

Quick Tip

Benzaldehyde lacks $-\text{H}$, hence undergoes Cannizzaro reaction instead of aldol condensation.

OR

7 (a). Write I.U.P.A.C. name of Acetaldehyde. Write chemical equations of its reaction with (i) NaHSO_3 , (ii) NaOH , (iii) NH_2NH_2 , and (iv) HCN .

Correct Answer: - IUPAC name: Ethanal (CH_3CHO). - Reactions: (i) With NaHSO_3 : addition product sodium bisulphite compound.

(ii) With NaOH : aldol condensation.

(iii) With hydrazine: hydrazone formation.

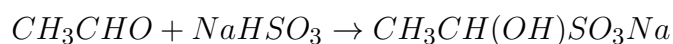
(iv) With HCN : cyanohydrin formation.

Solution:

Step 1: IUPAC name.

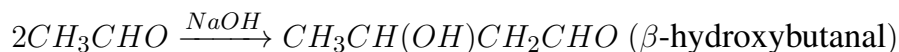
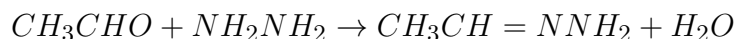
Acetaldehyde = Ethanal (CH_3CHO).

Step 2: Reaction with NaHSO_3 .



Step 3: Reaction with NaOH.

Aldol condensation:

**Step 4: Reaction with NH_2NH_2 .****Step 5: Reaction with HCN.****Step 6: Conclusion.**

Thus, acetaldehyde shows addition and condensation reactions due to its $-\text{CHO}$ group.

Quick Tip

Aldehydes readily undergo nucleophilic addition reactions at the carbonyl carbon.

7 (b). Why is chlorine atom of chlorobenzene less reactive than chlorine atom of chloroethane? Write chemical equations of reactions of chlorobenzene with (i) Cl_2 and (ii) conc. H_2SO_4 .

Correct Answer: - Chlorobenzene is less reactive due to resonance stabilization and partial double bond character in the C–Cl bond. - Reactions: (i) Chlorobenzene + $\text{Cl}_2 \rightarrow$ 1,2-dichlorobenzene / 1,4-dichlorobenzene.

(ii) Chlorobenzene + conc. $\text{H}_2\text{SO}_4 \rightarrow$ chlorobenzene sulphonic acid.

Solution:**Step 1: Reactivity comparison.**

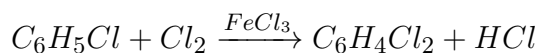
- In chloroethane, the C–Cl bond is a simple polar covalent bond; chlorine can easily undergo nucleophilic substitution. - In chlorobenzene, the lone pair of chlorine interacts with the benzene ring (π -resonance). This delocalisation gives partial double bond character to the C–Cl bond.

Step 2: Effect of resonance.

Due to resonance: 1. Bond length of C–Cl decreases. 2. Bond strength increases. 3. Nucleophilic substitution becomes difficult.

Step 3: Reaction with Cl₂.

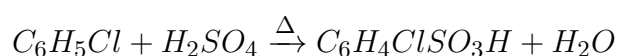
In presence of FeCl₃, chlorobenzene undergoes electrophilic substitution:



Products: 1,2-dichlorobenzene (ortho) and 1,4-dichlorobenzene (para).

Step 4: Reaction with conc. H₂SO₄.

Sulphonation occurs:



Product: p-chlorobenzene sulphonic acid (major).

Step 5: Conclusion.

Thus, chlorobenzene is less reactive than chloroethane due to resonance, and it undergoes electrophilic substitution with Cl₂ and H₂SO₄.

Quick Tip

In aryl halides, resonance stabilisation makes C–Cl bond strong and unreactive toward nucleophiles, but benzene ring favours electrophilic substitution.

OR

7b. Write short notes on the following:

- (i) Electrophilic substitution in halobenzene,**
- (ii) Wurtz–Fittig reaction,**
- (iii) Applications of Grignard's reagent.**

Solution:

(i) Electrophilic substitution in halobenzene

Step 1: Nature of halogen substituent.

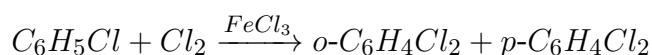
In halobenzene, halogen atoms are deactivating due to the –I effect (electron withdrawing inductive effect). However, they also exhibit +R effect (electron donating by resonance), which increases electron density at ortho and para positions.

Step 2: Directive influence.

Because of this dual effect, halogens are ortho/para directing but overall deactivate the ring towards electrophilic substitution.

Step 3: Example reaction.

Chlorobenzene + Cl₂ (in presence of FeCl₃):



Step 4: Conclusion.

Thus, halobenzene undergoes electrophilic substitution at ortho and para positions, but at a slower rate than benzene.

Quick Tip

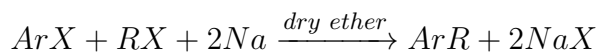
Halogen = ortho/para directing but deactivating.

(ii) Wurtz–Fittig reaction

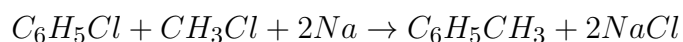
Step 1: Definition.

The Wurtz–Fittig reaction is the coupling reaction of an aryl halide (Ar–X) with an alkyl halide (R–X) using sodium metal in dry ether.

Step 2: General equation.



Step 3: Example.



(Product: toluene).

Step 4: Importance.

This reaction provides a method to prepare alkyl-substituted aromatic hydrocarbons.

Quick Tip

Wurtz = R–R coupling, Fittig = Ar–Ar coupling, Wurtz–Fittig = Ar–R coupling.

(iii) Applications of Grignard's reagent

Step 1: Definition.

Grignard's reagent has the general formula RMgX (where R = alkyl/aryl group, X = halogen). It is a powerful nucleophile.

Step 2: Reaction with aldehydes and ketones.

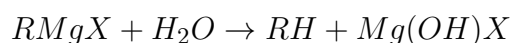
- With formaldehyde $\rightarrow$ primary alcohol. - With aldehydes $\rightarrow$ secondary alcohol. - With ketones $\rightarrow$ tertiary alcohol.

Step 3: Reaction with CO_2 .



Thus, carboxylic acids are prepared.

Step 4: Reaction with water or alcohol.



This gives hydrocarbons.

Step 5: Conclusion.

Grignard's reagent is widely used for synthesis of alcohols, acids, and hydrocarbons, making it a versatile tool in organic chemistry.

Quick Tip

Grignard's reagent reacts with electrophiles ($\text{C}=\text{O}$, CO_2 , H_2O) to form a wide range of products.