JEE Main 2025 April 7 Shift 1 Chemistry Question Paper with Solutions

Time Allowed :3 Hours	Maximum Marks :300	Total Questions :75

General Instructions

Read the following instructions very carefully and strictly follow them:

1. Multiple choice questions (MCQs)
2. Questions with numerical values as answers.
3. There are three sections: **Mathematics, Physics, Chemistry**.
4. **Mathematics:** 25 (20+5) 10 Questions with answers as a numerical value. Out of 10 questions, 5 questions are compulsory.
5. **Physics:** 25 (20+5) 10 Questions with answers as a numerical value. Out of 10 questions, 5 questions are compulsory..
6. **Chemistry:** 25 (20+5) 10 Questions with answers as a numerical value. Out of 10 questions, 5 questions are compulsory.
7. Total: 75 Questions (25 questions each).
8. 300 Marks (100 marks for each section).
9. **MCQs:** Four marks will be awarded for each correct answer and there will be a negative marking of one mark on each wrong answer.
10. **Questions with numerical value answers:** Candidates will be given four marks for each correct answer and there will be a negative marking of 1 mark for each wrong answer.

CHEMISTRY

Section - A

51. Given below are two statements:
Statement I: Ozonolysis followed by treatment with Zn, H_2O of cis-2-butene gives ethanal.
Statement II: The product obtained by ozonolysis followed by treatment with Zn, H_2O of 3, 6-dimethyloct-4-ene has no chiral carbon atom.
In the light of the above statements, choose the correct answer from the options given below.
(1) Both Statement I and Statement II are true
(2) Statement I is false but Statement II is true
(3) Statement I is true but Statement II is false
(4) Both Statement I and Statement II are false

Correct Answer: (3) Statement I is true but Statement II is false

Solution:
Step 1: Analyze Statement I
Ozonolysis is a reaction where an alkene undergoes cleavage in the presence of ozone (O_3), forming an ozonide intermediate. This ozonide is then reduced by zinc (Zn) and water (H_2O) to give two carbonyl compounds.
For cis-2-butene, the reaction proceeds as follows:

$$\text{cis-2-butene} \xrightarrow{O_3} \text{ozonide intermediate} \xrightarrow{Zn, H_2O} \text{ethanal (acetaldehyde)}.$$

When cis-2-butene undergoes ozonolysis, the double bond is cleaved symmetrically, producing two molecules of ethanal (acetaldehyde), which is a simple aldehyde. Therefore, **Statement I is true**.

Step 2: Analyze Statement II
For *3, 6-dimethyloct-4-ene*, when ozonolysis occurs followed by treatment with Zn and H_2O, the reaction will lead to cleavage of the double bond, forming two products. The key point here is the symmetry of the molecule.
3, 6-dimethyloct-4-ene is a symmetric compound, and the cleavage of the double bond leads to the formation of two carbonyl groups. The product is symmetrical, and therefore, it will not have any chiral centers because both products are non-chiral and identical.
In other words, the two products obtained are symmetrical and lack any chiral centers, making **Statement II false**.

Quick Tip

For ozonolysis, always check the symmetry of the reactant molecule. Symmetrical cleavage products will not have chiral centers, while asymmetrical products will have chiral centers.

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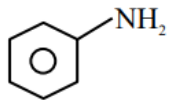
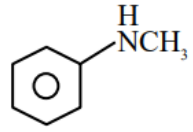
52. Which of the following amine(s) show(s) positive carbamylamine test?

A. 

B. $(CH_3)_2NH$

C. CH_3NH_2

D. $(CH_3)_3N$

E. 

(1) A and E Only
(2) C Only
(3) A and C Only
(4) B, C and D Only

Correct Answer: (3) A and C Only

Solution: The carbamylamine test is used to detect primary amines. It results in the formation of an isocyanide (carbamylamine).
Option A NH_2 (Phenylamine) is a primary amine and will give a positive result.
Option B $(CH_3)_2NH$ (Dimethylamine) is a secondary amine and does not give a positive result.
Option C CH_3NH_2 (Methylamine) is a primary amine and will give a positive result.
Option D $(CH_3)_3N$ (Trimethylamine) is a tertiary amine and does not give a positive result.
Option E $HNCH_3$ (Methylamine attached to a benzene ring) is a primary amine and will give a positive result.
Thus, the correct options are A and C.

Quick Tip

Only primary amines show a positive result in the carbamylamine test, forming isocyanides (carbamylamine).

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53. Reaction A(g) $\rightarrow$ 2B(g) + C(g) is a first-order reaction. It was started with pure A.

The following table shows the pressure of the system at different times:

t(min)	Pressure of system at time t(mm Hg)
10	160
∞	240

Which of the following options is incorrect?
(1) Initial pressure of A is 80 mm Hg
(2) The reaction never goes to completion
(3) Rate constant of the reaction is 1.693 min^{-1}
(4) Partial pressure of A after 10 minutes is 40 mm Hg

Correct Answer: (3) Rate constant of the reaction is 1.693 min^{-1}

Solution:
Step 1: Analyze Statement (1)
The total pressure at $t = \infty$ is 240 mm Hg, which is the pressure due to the products of the reaction (2B + C). The initial pressure of A was 80 mm Hg, and since 2 moles of B and 1 mole of C are produced per mole of A, the increase in total pressure from the initial 80 mm Hg to the final 240 mm Hg indicates that 160 mm Hg pressure is due to the products.
So, the initial pressure of A is indeed 80 mm Hg. Therefore, statement (1) is correct.
Step 2: Analyze Statement (2)
For a first-order reaction, the reaction does not go to completion. It asymptotically approaches a state where the concentration of the reactant is very low but not zero. As time progresses, the

pressure will increase, but it will not go to 240 mm Hg immediately. The reaction approaches this value asymptotically. Therefore, Statement (2) is correct.
Step 3: Analyze Statement (3) - Rate Constant Calculation For a first-order reaction, the integrated rate law is given by:

$$\ln\left(\frac{[A]_0}{[A]}\right) = kt$$

Where:
$[A]_0$ is the initial pressure of A (80 mm Hg),
$[A]$ is the pressure of A after 10 minutes (the difference between the initial and the total pressure),
k is the rate constant,
t is the time in minutes.

At $t = 10$ minutes, the total pressure is 160 mm Hg, and the pressure of A is:

$$P_A = 80 - (160 - 240) = 40 \text{ mm Hg}$$

Now, applying the rate law:

$$\ln\left(\frac{80}{40}\right) = k \times 10$$

$$\ln(2) = k \times 10$$

$$k = \frac{\ln(2)}{10} = \frac{0.693}{10} = 0.0693\,\text{min}^{-1}$$

The rate constant is approximately $0.0693\,\text{min}^{-1}$, not 1.693 min^{-1}. Thus, Statement (3) is incorrect.
Step 4: Analyze Statement (4) The partial pressure of A after 10 minutes is given as 40 mm Hg, which we calculated earlier. Therefore, Statement (4) is correct.

Quick Tip

For first-order reactions, use the integrated rate law to calculate the rate constant. The reaction does not go to completion but asymptotically approaches the equilibrium state.

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54. Total enthalpy change for freezing of 1 mol water at 10°C to ice at -10°C is _____ (Given: $\Delta_{\text{fus}}H = x\,\text{kJ/mol}$, $C_p[\text{H}_2\text{O}(l)] = y\,\text{J mol}^{-1}\text{K}^{-1}$, and $C_p[\text{H}_2\text{O}(s)] = z\,\text{J mol}^{-1}\text{K}^{-1}$)
(1) $-x - 10y - 10z$
(2) $-10(100x + y + z)$
(3) $10(100x + y + z)$
(4) $x - 10y - 10z$

Correct Answer: (2) $-10(100x + y + z)$

Solution: To find the total enthalpy change, we need to consider both the freezing process and the cooling of the substance:

1. Freezing process: The enthalpy change for freezing is $\Delta_{\text{fus}}H = -x$, since freezing is an exothermic process.
2. Cooling of liquid water: The enthalpy change for cooling the water from 10°C to 0°C is calculated using the specific heat capacity of liquid water:

$$\Delta H_1 = -10y$$

3. Cooling of ice: The enthalpy change for cooling the ice from 0°C to -10°C is calculated using the specific heat capacity of ice:

$$\Delta H_2 = -10z$$

Thus, the total enthalpy change can be expressed as:

$$\Delta H = -x - 10y - 10z$$

The term x is given in kJ/mol and should be multiplied by 100 to convert it to J/mol to match the units of y and z (which are in J/mol·K). Thus the correct expression for the total enthalpy change is:

$$\Delta H = -10(100x + y + z)$$

Quick Tip

Always ensure that the units are consistent when combining enthalpy changes due to different processes. Convert values as necessary.

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55. An aqueous solution of HCl with pH 1.0 is diluted by adding equal volume of water (ignoring dissociation of water). The pH of HCl solution would be:

(Given log 2 = 0.30)

(1) reduce to 0.5
(2) increase to 1.3
(3) remain same
(4) increase to 2

Correct Answer: (2) increase to 1.3

Solution:
Step 1: Understanding pH and dilution
The pH of a solution is related to the concentration of hydrogen ions ($[H^+]$) in the solution by the equation:

$$\text{pH} = -\log[H^+]$$

For an aqueous HCl solution with pH 1.0, the concentration of hydrogen ions $[H^+]$ is:

$$\text{pH} = 1.0 \quad \Rightarrow \quad [H^+] = 10^{-1} = 0.1\,\text{M}$$

Step 2: Diluting the solution
When an equal volume of water is added to the solution, the concentration of hydrogen ions is halved (since the volume doubles). Therefore, the new concentration of $[H^+]$ will be:

$$[H^+]_{\text{new}} = \frac{0.1}{2} = 0.05\,\text{M}$$

Step 3: Calculating the new pH
The pH of the diluted solution is given by:

$$\text{pH}_{\text{new}} = -\log(0.05)$$

Using the logarithm property $\log 0.05 = \log(5 \times 10^{-2}) = \log 5 + \log 10^{-2}$, we get:

$$\log 0.05 = \log 5 - 2 = 0.69897 - 2 = -1.30103$$

Thus:

$$\text{pH}_{\text{new}} = -(-1.30103) = 1.30103 \approx 1.3$$

Therefore, the pH increases to 1.3 after dilution. Thus, the correct answer is option (2).

Quick Tip

When diluting an acidic solution, the concentration of hydrogen ions is halved, leading to an increase in pH. Always use the logarithmic formula to calculate the change in pH.

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56. Given below are two statements: Statement I: Dimethyl ether is completely soluble in water. However, diethyl ether is soluble in water to a very small extent.
Statement II: Sodium metal can be used to dry diethyl ether and not ethyl alcohol.
In the light of the given statements, choose the correct answer from the options given below:
(1) Statement I is false but Statement II is true
(2) Both Statement I and Statement II are false
(3) Statement I is true but Statement II is false
(4) Both Statement I and Statement II are true

Correct Answer: (4) Both Statement I and Statement II are true

Solution:
Step 1: Analyze Statement I
Dimethyl ether (CH_3OCH_3) is moderately soluble in water, but not completely. It does exhibit hydrogen bonding but due to the small size of the molecule, its solubility in water is limited.
Diethyl ether ($C_2H_5OC_2H_5$) is only slightly soluble in water due to its larger hydrophobic ethyl groups. This statement is partially correct as diethyl ether is indeed soluble in water, but to a very small extent.
Thus, Statement I is true because it correctly describes the solubility of both ethers, although dimethyl ether's solubility is greater than diethyl ether.

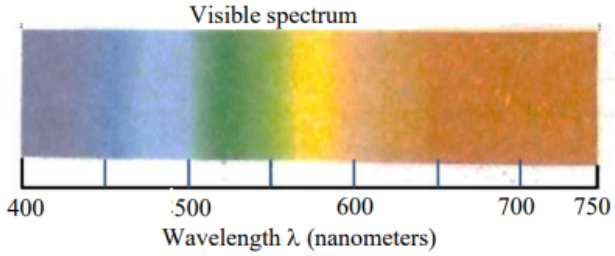
Step 2: Analyze Statement II
Sodium metal is used to dry diethyl ether because it reacts with any water present, forming

sodium hydroxide and hydrogen gas.
Ethyl alcohol (ethanol), however, reacts with sodium metal, forming sodium ethoxide and hydrogen, and thus cannot be dried by sodium.
Thus, Statement II is true because sodium can dry diethyl ether but cannot be used for drying ethyl alcohol.

Quick Tip

When using sodium metal to dry ethers, ensure that the solution is free of water. Sodium reacts with water to form sodium hydroxide and hydrogen gas.

57.



Which of the following statements are correct, if the threshold frequency of caesium is 5.16×10^{14} Hz?
(A) When Cs is placed inside a vacuum chamber with an ammeter connected to it and yellow light is focused on Cs, the ammeter shows the presence of current.
(B) When the brightness of the yellow light is dimmed, the value of the current in the ammeter is reduced.
(C) When a red light is used instead of the yellow light, the current produced is higher with respect to the yellow light.
(D) When a blue light is used, the ammeter shows the formation of current.
(E) When a white light is used, the ammeter shows formation of current.

Correct Answer: (4) B, C, and D Only

Solution: In the photoelectric effect, electrons are ejected from a material when light of a frequency greater than the threshold frequency strikes it.
Option A: When yellow light (which has a frequency greater than the threshold frequency) is focused on caesium, electrons are ejected, and current flows. Therefore, this statement is correct.
Option B: Dimming the brightness of the yellow light reduces the number of photons, which in turn decreases the number of electrons ejected. Hence, the current in the ammeter is reduced. This statement is correct. Option C: Red light has a frequency lower than the threshold frequency of caesium, so it does not have enough energy to eject electrons. Hence, no current will be produced. This statement is incorrect.
Option D: Blue light has a frequency greater than the threshold frequency, so it will eject electrons and form current in the ammeter. This statement is correct.

Option E: White light, which contains frequencies higher than the threshold frequency (including blue light), will also cause the ejection of electrons and formation of current. This statement is correct.
Thus, the correct answer is B, C, and D Only.

Quick Tip

In the photoelectric effect, only light with a frequency greater than the threshold frequency can cause the ejection of electrons. Reducing light intensity reduces the current, but light with insufficient frequency (like red light) will not cause any emission of electrons.

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58. Which of the following is the correct IUPAC name of the given organic compound (X)?
The structure of compound X is as follows:

$$H_3C - CH_3 - CH = CH - H - Br$$

(1) 2-Bromo-2-methylbut-2-ene
(2) 3-Bromo-3-methylprop-2-ene
(3) 1-Bromo-2-methylbut-2-ene
(4) 4-Bromo-3-methylbut-2-ene

Correct Answer: (3) 1-Bromo-2-methylbut-2-ene

Solution:
Step 1: Identify the longest carbon chain.
The longest continuous chain that includes the double bond consists of 4 carbon atoms, so the base name is "butene" (indicating a 4-carbon alkene).
Step 2: Number the chain.
Number the chain such that the double bond gets the lowest possible number. Since the double bond is between carbon 2 and carbon 3, we assign numbers to the carbon chain as follows:

$$H_3C - CH_3 - CH = CH - H - Br$$

The double bond is between carbons 2 and 3, so the compound is "but-2-ene."
Step 3: Identify the substituents.
There is a methyl group (CH) attached to carbon 2.
There is a bromo group (Br) attached to carbon 1.

Step 4: Assign positions to the substituents. The methyl group is on carbon 2, and the bromo group is on carbon 1. The substituents should be numbered to give the lowest possible numbers, so the correct positions are:
Methyl group on carbon 2
Bromo group on carbon 1

Step 5: Construct the IUPAC name.
The name of the compound is 1-Bromo-2-methylbut-2-ene, where:
"But" indicates the 4-carbon chain (butene).
"2-ene" indicates the double bond between carbons 2 and 3.
"2-methyl" refers to the methyl group on carbon 2.
"1-bromo" refers to the bromo group on carbon 1.

Thus, the correct name is 1-Bromo-2-methylbut-2-ene.

Quick Tip

When naming organic compounds, always prioritize giving the lowest possible number to the position of the double bond and substituents. If there are multiple substituents, assign the lowest possible sum of numbers.

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59. At the sea level, the dry air mass percentage composition is given as nitrogen gas : 70.0, oxygen gas : 27.0, and argon gas : 3.0. If the total pressure is 1.15 atm, then calculate the ratio of the following respectively:

(i) **Partial pressure of nitrogen gas to partial pressure of oxygen gas**
(ii) **Partial pressure of oxygen gas to partial pressure of argon gas**

(Given: Molar mass of N, O, and Ar are 14, 16, and 40 g mol^{-1} respectively)
(1) 4.26, 19.3
(2) 2.59, 11.85
(3) 5.46, 17.8
(4) 2.96, 11.2

Correct Answer: (4) 2.96, 11.2

Solution:
Step 1: Understanding Dalton's Law of Partial Pressures
Dalton's Law states that the partial pressure of a gas is proportional to its mole fraction in the mixture. The partial pressure is given by:

$$P_{\text{gas}} = X_{\text{gas}} \times P_{\text{total}}$$

Where:
P_{gas} is the partial pressure of the gas,
X_{gas} is the mole fraction of the gas,
P_{total} is the total pressure.

Step 2: Calculate the mole fraction of each gas
We are given the mass percentages of the gases and their molar masses:
Mass percentage of nitrogen (N_2) = 70.0%

Mass percentage of oxygen $(O_2) = 27.0\%$
Mass percentage of argon $(Ar) = 3.0\%$

The moles of each gas are calculated by dividing the mass by the molar mass of each gas:

$$\text{Moles of } N_2 = \frac{70}{14} = 5 \text{ moles}$$

$$\text{Moles of } O_2 = \frac{27}{16} = 1.6875 \text{ moles}$$

$$\text{Moles of } Ar = \frac{3}{40} = 0.075 \text{ moles}$$

Now, the total moles of gases:

$$\text{Total moles} = 5 + 1.6875 + 0.075 = 6.7625 \text{ moles}$$

Step 3: Calculate the partial pressures The mole fraction of each gas is given by:

$$X_{N_2} = \frac{5}{6.7625} = 0.7396, \quad X_{O_2} = \frac{1.6875}{6.7625} = 0.2499, \quad X_{Ar} = \frac{0.075}{6.7625} = 0.0111$$

Now, calculate the partial pressures:

$$P_{N_2} = X_{N_2} \times P_{\text{total}} = 0.7396 \times 1.15 = 0.8516 \text{ atm}$$

$$P_{O_2} = X_{O_2} \times P_{\text{total}} = 0.2499 \times 1.15 = 0.2879 \text{ atm}$$

$$P_{Ar} = X_{Ar} \times P_{\text{total}} = 0.0111 \times 1.15 = 0.0128 \text{ atm}$$

Step 4: Calculate the ratios (i) The ratio of the partial pressures of nitrogen to oxygen is:

$$\frac{P_{N_2}}{P_{O_2}} = \frac{0.8516}{0.2879} = 2.96$$

(ii) The ratio of the partial pressures of oxygen to argon is:

$$\frac{P_{O_2}}{P_{Ar}} = \frac{0.2879}{0.0128} = 11.2$$

Thus, the correct answer is (4) 2.96, 11.2.

Quick Tip

Dalton's Law of partial pressures allows you to find the partial pressures of gases from their mole fractions. Ensure to use mass percentages and molar masses to first calculate the moles of each gas.

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60. Given below are two statements:
Statement I: Mohr's salt is composed of only three types of ions—ferrous, ammonium, and sulphate.
Statement II: If the molar conductance at infinite dilution of ferrous, ammonium, and sulphate ions are x_1, x_2, and x_3 S cm^2 mol^{-1}, respectively, then the molar conductance for Mohr's salt solution at infinite dilution would be given by $x_1 + x_2 + 2x_3$.

(1) Both statements I and Statement II are false
(2) Statement I is false but Statement II is true
(3) Statement I is true but Statement II is false
(4) Both statements I and Statement II are true

Correct Answer: (3) Statement I is true but Statement II is false

Solution:
Step 1: Analyzing Statement I
Mohr's salt is composed of three ions: ferrous Fe^{2+}, ammonium NH_4^+, and sulphate SO_4^{2-}. This statement is true because Mohr's salt (also known as ammonium ferrous sulphate) contains only these three types of ions. Thus, Statement I is correct.
Step 2: Analyzing Statement II
The molar conductance of a salt at infinite dilution is the sum of the molar conductances of the ions it dissociates into. For Mohr's salt, the ions involved are:
Ferrous ion Fe^{2+}, with a molar conductance of x_1,
Ammonium ion NH_4^+, with a molar conductance of x_2,
Sulphate ion SO_4^{2-}, with a molar conductance of x_3.
At infinite dilution, the total molar conductance λ_∞ of Mohr's salt should be the sum of the conductances of these ions. However, Statement II suggests the wrong coefficient for the sulphate ion. The sulphate ion SO_4^{2-} is a monoatomic ion and should contribute x_3 to the total conductance, not $2x_3$. Thus, the correct expression for the molar conductance should be:

$$\lambda_\infty = x_1 + x_2 + x_3$$

Therefore, Statement II is incorrect because it incorrectly doubles the contribution of the sulphate ion.

Quick Tip

When calculating molar conductance at infinite dilution for ionic compounds, remember that each ion contributes to the total conductance according to its molar conductance, without any extra multiplication unless the ion is polyatomic and contributes differently.

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61. The number of valence electrons present in the metal among Cr, Co, Fe, and Ni which has the lowest enthalpy of atomisation is
(1) 8
(2) 9
(3) 6
(4) 10

Correct Answer: (3) 6

Solution:
Step 1: Atomic Configuration and Valence Electrons

- **Chromium (Cr):** Atomic number = 24. Its electron configuration is $[Ar]3d^5 4s^1$, giving it **6 valence electrons**.
- **Cobalt (Co):** Atomic number = 27. Its electron configuration is $[Ar]3d^7 4s^2$, giving it **9 valence electrons**.
- **Iron (Fe):** Atomic number = 26. Its electron configuration is $[Ar]3d^6 4s^2$, giving it **8 valence electrons**.
- **Nickel (Ni):** Atomic number = 28. Its electron configuration is $[Ar]3d^8 4s^2$, giving it **10 valence electrons**.

Step 2: Relation to Enthalpy of Atomisation
Enthalpy of atomisation generally decreases as the number of valence electrons increases, because more electrons lead to stronger metallic bonding and thus require more energy to break the bonds. Therefore, the element with fewer valence electrons will have the lowest enthalpy of atomisation.
Since Cr has 6 valence electrons, it will have the lowest enthalpy of atomisation compared to Co, Fe, and Ni.
Thus, the correct answer is 6 valence electrons.

Quick Tip

In general, for transition metals, a lower number of valence electrons leads to weaker metallic bonding, hence a lower enthalpy of atomisation.

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62. When a salt is treated with sodium hydroxide solution, it gives gas X. On passing gas X through reagent Y, a brown coloured precipitate is formed. X and Y respectively, are:
(1) X = NH and Y = HgO
(2) X = NH and Y = KHgI + KOH
(3) X = NHCl and Y = KOH
(4) X = HCl and Y = NHCl

Correct Answer: (2) X = NH and Y = KHgI + KOH

Solution:
Step 1: Understand the reaction with sodium hydroxide When a salt, such as ammonium chloride (NH_4Cl), reacts with sodium hydroxide (NaOH), ammonia gas (NH_3) is evolved:

$$NH_4Cl + NaOH \rightarrow NH_3 + NaCl + H_2O$$

Thus, gas X is ammonia (NH_3).
Step 2: Analyze the reagent Y When ammonia gas is passed through potassium tetraiodomercurate(II) (K_2HgI_4) in the presence of potassium hydroxide (KOH), a brown precipitate of mercury(I) iodide (Hg_2I_2) is formed:

$$NH_3 + K_2HgI_4 + KOH \rightarrow Hg_2I_2 + KCl + H_2O$$

The brown precipitate is mercury(I) iodide (Hg_2I_2).
Thus, reagent Y is $K_2HgI_4 + KOH$.

Quick Tip

Ammonia (NH_3) reacts with potassium tetraiodomercurate(II) and potassium hydroxide to form a brown precipitate of mercury(I) iodide (Hg_2I_2).

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63. The group 14 elements A and B have the first ionisation enthalpy values of 708 and 715 kJ mol^{-1} respectively. The above values are lowest among their group members. The nature of their ions A^{2+} and B^{4+} respectively is:
(1) both reducing
(2) both oxidising
(3) reducing and oxidising
(4) oxidising and reducing

Correct Answer: (3) reducing and oxidising

Solution:
Step 1: Understanding Ionization Enthalpy
Ionization enthalpy refers to the energy required to remove an electron from a neutral atom in its gaseous state. Lower ionization enthalpy indicates that the element can lose electrons more easily.
The elements A and B have the lowest ionization enthalpy values in their group. This suggests that they are relatively easier to ionize compared to other members of their group.

Step 2: Analyzing the Nature of Their Ions Element A: Since A has a low ionization enthalpy, it will lose electrons easily and thus, the A^{2+} ion will readily accept electrons (reduced). Hence, element A behaves as a **reducing agent**.

Element B: On the other hand, element B has a slightly higher ionization enthalpy compared to A. The B^{4+} ion tends to attract electrons, which makes it a strong **oxidizing agent**.

Thus, the nature of their ions is reducing (for A^{2+}) and oxidizing (for B^{4+}).

Quick Tip

In general, elements with low ionization enthalpies are reducing agents because they can easily lose electrons, while elements with high ionization enthalpies tend to attract electrons and thus act as oxidizing agents.

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64. The first transition series metal 'M' has the highest enthalpy of atomisation in its series. One of its aquated ion (M^{n+}) exists in green colour. The nature of the oxide formed by the above M^{n-} ion is:

(1) neutral
(2) acidic
(3) basic
(4) amphoteric

Correct Answer: (3) basic

Solution:
Step 1: Identifying the Metal 'M'
The first transition series metal with the highest enthalpy of atomisation is iron (Fe). Iron has a relatively high enthalpy of atomisation compared to other metals in the first transition series.
Step 2: Analyzing the Aquated Ion
The green colour of the aquated ion M^{n+} indicates that it is likely to be a transition metal ion, as many transition metal ions exhibit characteristic colours due to d-d transitions. For iron, the Fe^{2+} ion is known to be green in colour when aquated in water. Therefore, the metal M is iron.
Step 3: Nature of the Oxide Formed
Iron forms oxides in both the +2 and +3 oxidation states. The oxide formed in the +2 oxidation state is iron(II) oxide (FeO), which is basic in nature. Basic oxides tend to react with acids to form salts and water.
Therefore, the oxide formed by the Fe^{2+} ion (a metal in the +2 oxidation state) is basic.

Quick Tip

For transition metals in the lower oxidation states (such as +2), the oxide formed is usually basic. These oxides react with acids to form salts.

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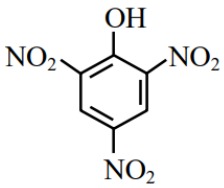
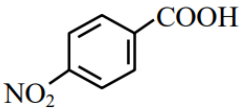
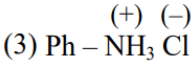
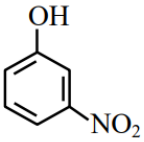
65. Which of the following compounds is least likely to give effervescence of CO_2 in presence of aq. $NaHCO_3$?

(1) 

(2) 

(3) 

(4) 

Correct Answer: (4) NO_2

Solution: In this question, we are determining which compound is least likely to produce effervescence of CO_2 when reacted with aqueous $NaHCO_3$. Effervescence occurs when an acid

reacts with $NaHCO_3$, producing CO_2.

Compound (1) contains a hydroxyl group (-OH) and nitro groups ($-NO_2$) which will likely result in an acidic environment and cause effervescence with $NaHCO_3$.
Compound (2) contains a carboxyl group (-COOH), a strong acid, which will react with $NaHCO_3$ and release CO_2.
Compound (3) contains an amine group ($-NH_3$), which is basic and does not typically react with $NaHCO_3$ to produce CO_2.
Compound (4) contains a nitro group ($-NO_2$) but lacks a strongly acidic functional group that would promote CO_2 production. Thus, it is the least likely to produce CO_2 effervescence in the presence of $NaHCO_3$.

Therefore, the compound least likely to give effervescence of CO_2 is compound (4).

Quick Tip

In reactions with $NaHCO_3$, look for acidic functional groups (like -COOH or -OH) that readily react to release CO_2. Nitrogenous compounds without strong acidic groups generally do not react.

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66. Match the LIST-I with LIST-II.

LIST-I Molecule/ion		**LIST-II Bond pair : lone pair (on the central atom)**	
A.	ICl_2^-	I.	4 : 2
B.	H_2O	II.	4 : 1
C.	SO_2	III.	2 : 3
D.	XeF_4	IV.	2 : 2

Choose the correct answer from the options given below :
(1) A-IV, B-III, C-II, D-I
(2) A-III, B-IV, C-II, D-I
(3) A-III, B-IV, C-I, D-II
(4) A-II, B-I, C-IV, D-III

Correct Answer: (2) A-III, B-IV, C-II, D-I
Solution: Let's analyze the molecular structures:
ICl^-: This ion has a central iodine atom with 2 bonding pairs and 3 lone pairs, resulting in a 2 : 3 ratio (option III).
H_2O: The oxygen atom has 2 lone pairs and 2 bonding pairs, which gives the ratio 2 : 2 (option

IV).
SO_2: The sulfur atom has 2 bonding pairs and 1 lone pair, leading to a 4 : 1 ratio (option II).
XeF_4: The xenon atom has 4 bonding pairs and 2 lone pairs, giving the ratio 4 : 2 (option I).

Therefore, the correct matching is: A-III, B-IV, C-II, D-I.

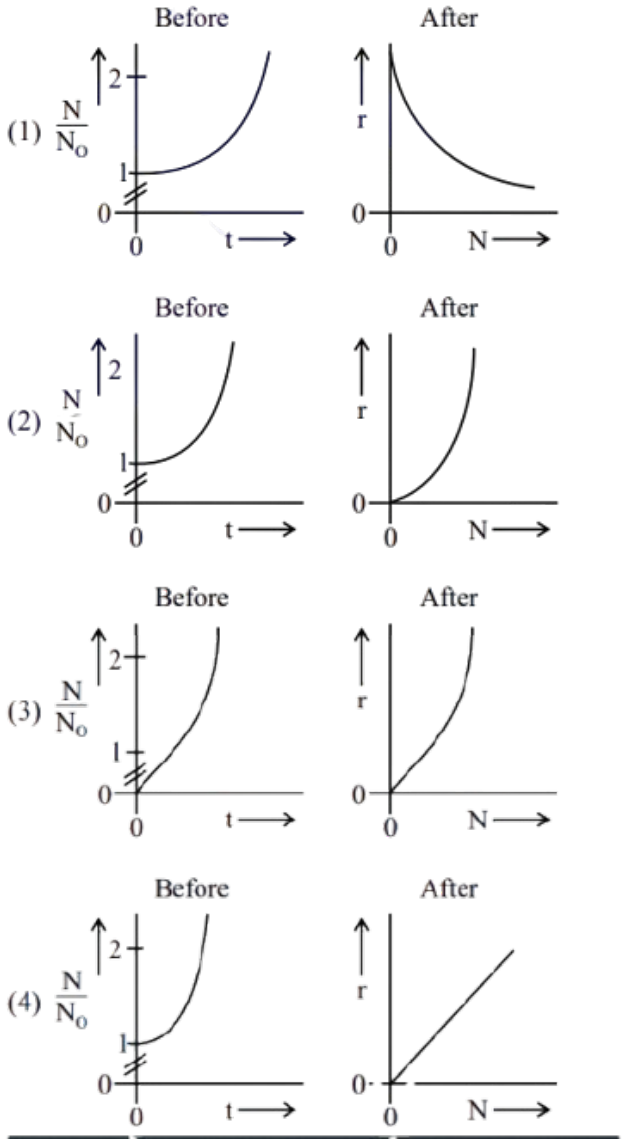
Quick Tip

In molecular structures, use the VSEPR theory to determine the number of bonding and lone pairs on the central atom, which helps in predicting the molecular geometry and bond pair to lone pair ratios.

---

67. A person's wound was exposed to some bacteria and then bacteria growth started to happen at the same place. The wound was later treated with some antibacterial medicine and the rate of bacterial decay (r) was found to be proportional with the square of the existing number of bacteria at any instance. Which of the following set of graphs correctly represents the 'before' and 'after' situation of the application of the medicine?

[Given: N = No. of bacteria, t = time, bacterial growth follows 1st order kinetics.]



Correct Answer: (2)

Solution:

Step 1: Understanding Bacterial Growth Before Treatment

The initial growth of the bacteria follows 1st order kinetics. This means that the rate of bacterial growth is proportional to the current number of bacteria present.

In first-order kinetics, the graph of the number of bacteria N over time t (shown as $\frac{N}{N_0}$) would exhibit an exponential increase. This is characterized by a rapidly rising curve as bacteria reproduce over time.

Since the rate of decay r is proportional to the square of the number of bacteria at any instant, $r \propto N^2$. Hence, the rate r increases as N increases.

Step 2: Introducing the Medicine

Once the medicine is introduced, its effect is to slow down the bacterial growth by increasing the decay rate. The rate of bacterial decay is now proportional to the square of the number of bacteria, i.e., $r \propto N^2$.

As the medicine works, the number of bacteria no longer follows the exponential increase.

Instead, it starts to flatten, and the growth rate slows down because of the increased bacterial decay rate.
Thus, the growth of bacteria is hindered, and the graph showing bacterial growth should start to flatten out after a certain time.
Step 3: Interpreting the Graphs
Before treatment: The graph of $\frac{N}{N_0}$ versus t should show an upward exponential curve (exponential growth), as described earlier for first-order kinetics.
After treatment: Once the medicine is applied, the bacterial growth curve flattens. The graph of rate of decay r versus the number of bacteria N should show a sharp decline, as the bacteria are no longer able to grow rapidly.
Step 4: Evaluating the Graphs
Option (1): The graphs do not correctly show the flattening of bacterial growth after the application of the medicine.
Option (2): This option correctly represents the situation, where:
The "before" graph shows an exponential increase of $\frac{N}{N_0}$ over time.
The "after" graph shows a declining rate of decay r, reflecting the effect of the antibacterial treatment.
Option (3): The "after" graph incorrectly shows an increasing rate of decay, which is not correct after the medicine is applied.
Option (4): This graph shows a linear relationship for the "after" scenario, which is not consistent with bacterial decay behavior under first-order kinetics.

Therefore, Option (2) is the correct set of graphs that represents the situation before and after the application of the medicine.

Quick Tip

In first-order kinetics, the growth curve exhibits exponential increase. When an antibacterial treatment is applied, the growth rate slows down, resulting in a flattening of the growth curve.

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68. Given below are two statements:
Statement I: D-(+)-glucose + D-(+)-fructose $\xrightarrow{H_2O}$ sucrose
sucrose $\xrightarrow{\text{Hydrolysis}}$ D-(+)-glucose + D-(+)-fructose
Statement II: Invert sugar is formed during sucrose hydrolysis.
In the light of the above statements, choose the correct answer from the options given below -
(1) Both Statement I and Statement II are true.
(2) Statement I is false but Statement II is true.
(3) Statement I is true but Statement II is false.
(4) Both Statement I and Statement II are false.

Correct Answer: (2) Statement I is false but Statement II is true.

Solution:

Step 1: Understanding Statement I
Statement I is incorrect. The reaction described in Statement I is wrong because it says that D-(+)-glucose and D-(+)-fructose combine to form sucrose, which is incorrect. The correct reaction should be the formation of sucrose from glucose and fructose, not the other way around. Therefore, Statement I is false because it incorrectly describes the formation of sucrose.

Step 2: Understanding Statement II
Statement II is correct. Invert sugar is indeed formed during the hydrolysis of sucrose. When sucrose undergoes hydrolysis (by the action of water), it breaks down into glucose and fructose. This mixture of glucose and fructose is called invert sugar.
Therefore, Statement II is true because invert sugar is indeed formed during sucrose hydrolysis.

Step 3: Conclusion
Statement I is false because it incorrectly describes the synthesis of sucrose.
Statement II is true because it correctly describes the formation of invert sugar during sucrose hydrolysis.

Quick Tip

In biochemical processes, the hydrolysis of sucrose results in the formation of invert sugar (a mixture of glucose and fructose), but the synthesis of sucrose is the reverse reaction of this process.

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69. An octahedral complex having molecular composition $Co.5NH_3.Cl.SO_4$ has two isomers A and B. The solution of A gives a white precipitate with $AgNO_3$ solution and the solution of B gives a white precipitate with $BaCl_2$ solution. The type of isomerism exhibited by the complex is,
(1) Co-ordinate isomerism
(2) Linkage isomerism
(3) Ionisation isomerism
(4) Geometrical isomerism

Correct Answer: (3) Ionisation isomerism
Solution: Step 1: Understanding the molecular composition:
The complex is given as $Co.5NH_3.Cl.SO_4$. It consists of a central Co^3+ ion surrounded by 5 ammonia molecules (NH_3) and one chloride (Cl) ion as well as a sulfate (SO_4^{2-}) ion.

Step 2: Identifying the isomers:
Isomer A: The solution of A gives a white precipitate with $AgNO_3$ solution. This indicates the presence of chloride ions (Cl^-) in the solution because $AgNO_3$ reacts with chloride ions to form a white precipitate of AgCl.
Isomer B: The solution of B gives a white precipitate with $BaCl_2$ solution. This indicates the presence of sulfate ions (SO_4^{2-}) in the solution because $BaCl_2$ reacts with sulfate ions to form a white precipitate of $BaSO_4$.

Step 3: Analyzing the isomerism:

The two isomers A and B are ionisation isomers.
In ionisation isomerism, two or more compounds have the same molecular formula but release different ions in solution.
In this case, the only difference between the two isomers is that in A, chloride (Cl^-) is the counter-ion, while in B, sulfate (SO_4^{2-}) is the counter-ion. These two isomers give different ions in solution, which is the defining characteristic of ionisation isomerism.

Step 4: Conclusion: Since the two isomers differ in the ions that are released into the solution (chloride in A and sulfate in B), this is a classic example of ionisation isomerism.

Quick Tip

In ionisation isomerism, even though the molecular formula is the same, the arrangement of ligands around the metal ion and the counter-ions can differ, leading to different ions being released in solution.

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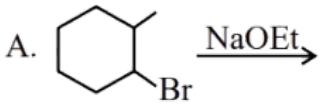
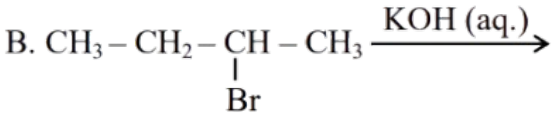
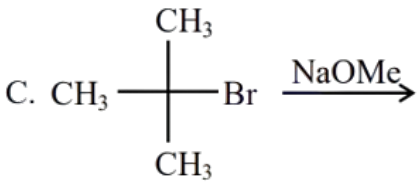
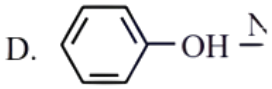
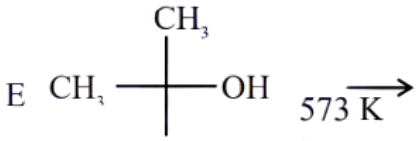
70. The reactions which cannot be applied to prepare an alkene by elimination, are

A. 

B. 

C. 

D. 

E 

Choose the correct answer from the options given below:
(1) B & E Only
(2) B, C & D Only
(3) A, C & D Only
(4) B & D Only

Correct Answer: (4) B & D Only

Solution:
Step 1: Reviewing Reaction A:
Reaction A involves the NaOEt base, which induces an E2 elimination reaction. This reaction forms an alkene by eliminating the bromine from the cyclohexane ring. Thus, Reaction A is valid for elimination.
Step 2: Reviewing Reaction B:
Reaction B involves the aqueous KOH, which can induce E2 elimination on the alkyl halide to form an alkene. However, Reaction B is invalid because KOH (aqueous) is more likely to induce nucleophilic substitution (SN2) rather than elimination under these conditions.
Reaction B is not valid for elimination because aqueous KOH typically favors nucleophilic substitution over elimination.

Step 3: Reviewing Reaction C:
Reaction C involves sodium methoxide (NaOMe), which can induce an E2 elimination reaction to form an alkene by abstracting a proton from the β-carbon. This reaction is valid for elimination.
Reaction C is valid for elimination.

Step 4: Reviewing Reaction D:
Reaction D involves the oxidation of phenol (C_6H_5OH) with $Na_2Cr_2O_7$ and H_2SO_4, which leads to the formation of a quinone, not an alkene. This is an oxidation reaction, not an elimination reaction.
Reaction D is not valid for elimination.

Step 5: Reviewing Reaction E: Reaction E involves the use of Cu at 573K, which can dehydrogenate the alcohol to form an alkene via E1 elimination. This reaction works and forms an alkene. Reaction E is valid for elimination.
Conclusion:
Reactions B and D are the reactions that cannot be applied to prepare an alkene by elimination. Reaction B favors nucleophilic substitution, and Reaction D involves oxidation rather than elimination.

Quick Tip

In elimination reactions, strong bases such as NaOEt or NaOMe can induce E2 eliminations, while aqueous KOH typically favors SN2 reactions. Additionally, oxidation reactions like in Reaction D do not lead to alkenes via elimination.

SECTION-B

71. An organic compound weighing 500 mg, produced 220 mg of CO_2 on complete combustion. The percentage composition of carbon in the compound is ..... % (nearest integer).

(Given molar mass in g mol^{-} of C: 12, O: 16)

Solution: Step 1: Determine the amount of carbon in CO_2:
When the compound undergoes complete combustion, carbon from the compound reacts with oxygen to produce CO_2. The molar mass of CO_2 is:

$$\text{Molar mass of } CO_2 = 12 + 2 \times 16 = 44 \text{ g/mol}$$

The molar mass of carbon (C) is 12 g/mol. In 44 g of CO_2, 12 g is carbon. Therefore, the mass of carbon in 220 mg of CO_2 can be calculated as:

$$\text{Mass of C} = \left(\frac{12}{44}\right) \times 220 = 60 \text{ mg}$$

Step 2: Calculate the percentage of carbon in the compound:
The mass of carbon in the original organic compound is 60 mg. The total mass of the compound is 500 mg. The percentage of carbon in the compound is given by:

$$\text{Percentage of C} = \left(\frac{60}{500}\right) \times 100 = 12\%$$

Quick Tip

When calculating the percentage composition, use the ratio of the mass of the element to the total mass of the compound, then multiply by 100.

---

72. Thyroxine, the hormone has the given structure.
The percentage of iodine in thyroxine is ..... % (nearest integer). (Given molar mass in g mol^{-} C:12, H:1, O:16, N:14, I:127)
Solution: Step 1: Count atoms from structure

- Carbon (C) = 15 atoms
- Hydrogen (H) = 11 atoms
- Oxygen (O) = 4 atoms
- Nitrogen (N) = 1 atom
- Iodine (I) = 4 atoms

Step 2: Compute mass contribution

$$\begin{aligned}
\text{Mass of C} &= 15 \times 12 = 180\,\text{g/mol} \\
\text{Mass of H} &= 11 \times 1 = 11\,\text{g/mol} \\
\text{Mass of O} &= 4 \times 16 = 64\,\text{g/mol} \\
\text{Mass of N} &= 1 \times 14 = 14\,\text{g/mol} \\
\text{Mass of I} &= 4 \times 127 = 508\,\text{g/mol}
\end{aligned}$$

Step 3: Total molar mass of thyroxine

$$\text{Molar mass} = 180 + 11 + 64 + 14 + 508 = 777\,\text{g/mol}$$

Step 4: Percentage of Iodine

$$\text{Percentage of Iodine} = \frac{508}{777} \times 100 \approx 65.37\%$$

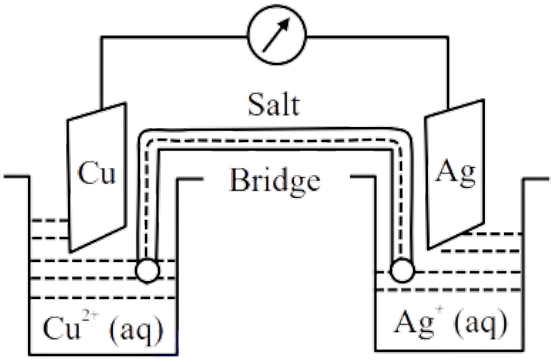
Correct Answer: $\boxed{65\%}$

Quick Tip

To calculate the percentage composition, divide the mass of the element by the molar mass of the compound and multiply by 100.

---

73. 1 Faraday electricity was passed through Cu^{2+} (1.5 M, 1 L)/Cu and 0.1 Faraday was passed through Ag^{+} (0.2 M, 1 L) electrolytic cells. After this, the two cells were connected as shown below to make an electrochemical cell. The emf of the cell thus formed at 298 K is:



Given:

$$E^{\circ}_{Cu^{2+}/Cu} = 0.34\,\text{V}$$
$$E^{\circ}_{Ag^{+}/Ag} = 0.8\,\text{V}$$
$$\frac{2.303RT}{F} = 0.06\,\text{V}$$

Solution:

Step 1: Standard Electrode Potentials

The given standard electrode potentials are:

$$E^{\circ}_{Cu^{2+}/Cu} = 0.34\,\text{V}$$
$$E^{\circ}_{Ag^{+}/Ag} = 0.80\,\text{V}$$

Step 2: Applying the Nernst Equation
The Nernst equation gives the relationship between the emf of the electrochemical cell, the standard electrode potentials, and the concentrations of the ions involved:

$$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.0591}{n} \log Q$$

Where:
E°_{cell} is the standard cell potential,
n is the number of electrons involved,
Q is the reaction quotient.

Step 3: Determining the Standard Cell Potential
The standard cell potential is the difference between the two half-cell potentials:

$$E^\circ_{\text{cell}} = E^\circ_{\text{Ag}^+/\text{Ag}} - E^\circ_{\text{Cu}^{2+}/\text{Cu}} = 0.80\,\text{V} - 0.34\,\text{V} = 0.46\,\text{V}$$

Step 4: Reaction Quotient (Q)
The reaction quotient Q is given by the ratio of the concentrations of the products over the reactants. The concentrations of Cu^{2+} and Ag^+ ions change due to the passage of electricity:
After 1 Faraday is passed through the Cu^{2+} cell, the concentration of Cu^{2+} is reduced by a factor based on the number of moles reduced. Since 1 Faraday corresponds to 1 mole of electrons, the concentration of Cu^{2+} decreases.
Similarly, after 0.1 Faraday is passed through the Ag^+ cell, the concentration of Ag^+ decreases.

Now, using the changes in concentration:
Initially, the concentration of Cu^{2+} is 1.5 M, and after 1 Faraday, the concentration of Cu^{2+} decreases as per the stoichiometry.
Initially, the concentration of Ag^+ is 0.2 M, and after 0.1 Faraday, the concentration of Ag^+ decreases accordingly.

$$Q = \frac{[\text{Cu}^{2+}]}{[\text{Ag}^+]}$$

Step 5: Substituting Values into the Nernst Equation
Substitute the concentrations and other known values into the Nernst equation:

$$E_{\text{cell}} = 0.46\,\text{V} - \frac{0.0591}{1} \log\left(\frac{1.5\,\text{M}}{0.2\,\text{M}}\right)$$

Now, calculate the logarithmic term:

$$\log\left(\frac{1.5}{0.2}\right) = \log(7.5) \approx 0.875$$

$$E_{\text{cell}} = 0.46\,\text{V} - 0.0591 \times 0.875$$
$$E_{\text{cell}} = 0.46\,\text{V} - 0.0518\,\text{V}$$
$$E_{\text{cell}} = 0.4082\,\text{V} \approx 0.40\,\text{V}$$

Quick Tip

The Nernst equation helps to adjust the standard electrode potential by accounting for the concentration of the ions involved in the reaction. For each 10-fold change in concentration, the potential changes by approximately 0.0591 V at 298 K.

---

74. The percentage dissociation of a salt (MX_3) solution at a given temperature (van't Hoff factor $i = 2$) is ..... % (Nearest integer)

Solution:
Step 1: Understanding the Dissociation of Salt MX_3
The salt MX_3 dissociates in water as follows:

$$MX_3 \rightarrow M^{3+} + 3X^-$$

For each mole of MX_3, it dissociates to give one mole of M^{3+} and three moles of X^-.
Step 2: van't Hoff Factor (i)
The van't Hoff factor i is given as $i = 2$. The van't Hoff factor represents the total number of particles in solution per formula unit of solute.
In this case, for MX_3, the dissociation would produce 4 particles (1 M^{3+} and 3 X^-) per formula unit of MX_3. However, since $i = 2$, this suggests that the dissociation is not complete, and the actual number of particles formed is only double the initial number of formula units.

Step 3: Using the Formula for Percentage Dissociation
The formula for the percentage dissociation (α) is given by:

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

Where:
i is the van't Hoff factor (2 in this case),
α is the degree of dissociation,
n is the number of ions produced per formula unit of solute (which is 4 for MX_3).

$$2 = 1 + \alpha(4 - 1)$$
$$2 = 1 + 3\alpha$$
$$3\alpha = 1$$
$$\alpha = \frac{1}{3}$$

Step 4: Calculating the Percentage Dissociation
The percentage dissociation is given by:

$$\text{Percentage dissociation} = \alpha \times 100 = \frac{1}{3} \times 100 = 33.33\%$$

To the nearest integer, the percentage dissociation is 33%.

Quick Tip

The van't Hoff factor i is a key parameter in determining the degree of dissociation. When i is less than the theoretical number of particles formed from dissociation, the salt has not fully dissociated.

---

75. The number of paramagnetic complexes among $[FeF_6]^{3-}$, $[Fe(CN)_6]^{3-}$, $[Mn(CN)_6]^{3-}$, $[Co(C_2O$ and $[CoF_6]^{3-}$, which involved d^2sp^3 hybridization is .....

Solution: To determine the number of paramagnetic complexes, we need to check the number of unpaired electrons in each complex. Paramagnetic complexes have at least one unpaired electron, while diamagnetic complexes have all paired electrons.

1. $[FeF_6]^{3-}$:
Iron in Fe^{3+} has the electron configuration $[Ar]3d^5$.
Fluoride (F^-) is a weak field ligand and does not cause electron pairing.
Fe^{3+} undergoes d^2sp^3 hybridization, leaving 5 unpaired electrons in the d-orbitals.
Paramagnetic.

2. $[Fe(CN)_6]^{3-}$:
Iron in Fe^{3+} has the electron configuration $[Ar]3d^5$.
Cyanide (CN^-) is a strong field ligand that causes electron pairing.
Fe^{3+} undergoes d^2sp^3 hybridization, resulting in no unpaired electrons.
Diamagnetic.

3. $[Mn(CN)_6]^{3-}$:
Manganese in Mn^{3+} has the electron configuration $[Ar]3d^4$.
Cyanide (CN^-) is a strong field ligand and causes pairing of electrons.
Mn^{3+} undergoes d^2sp^3 hybridization, resulting in 2 unpaired electrons.
Paramagnetic.

4. $[Co(C_2O_4)_3]^{3-}$:
Cobalt in Co^{3+} has the electron configuration $[Ar]3d^6$.
Oxalate ($C_2O_4^{2-}$) is a weak field ligand.
Co^{3+} undergoes d^2sp^3 hybridization, resulting in 3 unpaired electrons.
Paramagnetic.

5. $[MnCl_6]^{3-}$:
Manganese in Mn^{3+} has the electron configuration $[Ar]3d^4$.
Chloride (Cl^-) is a weak field ligand and does not cause electron pairing.
Mn^{3+} undergoes d^2sp^3 hybridization, leaving 4 unpaired electrons.
Paramagnetic.

6. $[CoF_6]^{3-}$:
Cobalt in Co^{3+} has the electron configuration $[Ar]3d^6$.
Fluoride (F^-) is a weak field ligand and does not cause electron pairing.

Co^{3+} undergoes d^2sp^3 hybridization, leaving 2 unpaired electrons.
Paramagnetic.

Step 2: Conclusion.
The number of paramagnetic complexes is 2. These are:
$[FeF_6]^{3-}$
$[Mn(CN)_6]^{3-}$

Thus, the number of paramagnetic complexes is 2.

Quick Tip

To determine paramagnetism, look for unpaired electrons in the complex. Strong field ligands usually pair up electrons, while weak field ligands leave electrons unpaired.
