

JEE Main 2024 Chemistry Question Paper April 5 Shift 2 with Solutions

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| Time Allowed :3 Hours | Maximum Marks :300 | Total Questions :90 |
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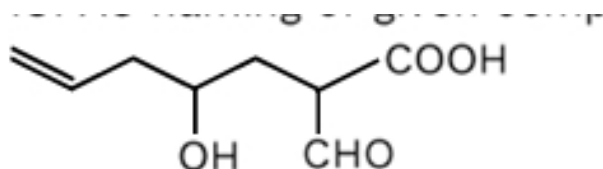
General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours duration.
2. The question paper consists of 90 questions, out of which 75 are to attempted. The maximum marks are 300.
3. There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 30 questions in each part of equal weightage.
4. Each part (subject) has two sections.
 - (i) Section-A: This section contains 20 multiple choice questions which have only one correct answer. Each question carries 4 marks for correct answer and -1 mark for wrong answer.
 - (ii) Section-B: This section contains 10 questions. In Section-B, attempt any five questions out of 10. The answer to each of the questions is a numerical value. Each question carries 4 marks for correct answer and -1 mark for wrong answer. For Section-B, the answer should be rounded off to the nearest integer

Chemistry

1. IUPAC naming of given compound



- (1) 2-formyl-4-hydroxy hept-6-enoic acid
- (2) 6-formyl-4-hydroxy hept-1-enoic acid
- (3) 4-hydroxy-6-formyl-hept-1-enoic acid
- (4) 4-hydroxy-2-formyl-hept-6-enoic acid

Correct Answer: (1) 2-formyl-4-hydroxy hept-6-enoic acid

Solution:

Step 1: Identifying functional groups.

The compound contains a formyl group (-CHO) and a hydroxyl group (-OH) attached to a

heptene backbone. The formyl group is at position 2, and the hydroxyl group is at position 4. The correct IUPAC name is based on this arrangement.

Step 2: Conclusion.

The IUPAC name of the compound is **2-formyl-4-hydroxy hept-6-enoic acid**, which corresponds to option (1).

Quick Tip

When naming compounds, always identify and prioritize functional groups such as formyl and hydroxyl, and follow the numbering based on the longest carbon chain.

2. Coagulation of egg is due to

- (1) Denaturation of protein
- (2) 2° structure does not change
- (3) 1° structure does not change
- (4) 3° structure does not change

Correct Answer: (1) Denaturation of protein

Solution:

Step 1: Understanding coagulation.

Coagulation of egg is a process where proteins undergo denaturation due to heat. This leads to the unfolding and aggregation of protein molecules, causing the egg to solidify.

Step 2: Analyzing the options.

- (1) Denaturation of protein:** Correct — Denaturation causes the proteins in the egg to unfold and coagulate.
- (2) 2° structure does not change:** Incorrect — The secondary structure of proteins is altered during denaturation.
- (3) 1° structure does not change:** Incorrect — The primary structure of proteins is not affected in denaturation, but this does not directly lead to coagulation.
- (4) 3° structure does not change:** Incorrect — The tertiary structure is affected during denaturation.

Step 3: Conclusion.

The correct answer is **(1) Denaturation of protein** because the process of coagulation is directly related to protein denaturation.

Quick Tip

Coagulation is a result of protein denaturation, which is caused by factors like heat, leading to structural changes and solidification of the egg.

3. Square planar complex $Mabcd$ will have how many isomers

- (1) 2
- (2) 3
- (3) 4
- (4) 5

Correct Answer: (2) 3

Solution:

Step 1: Understanding square planar complexes.

A square planar complex typically has cis-trans isomerism, meaning it can have two different configurations — one where two similar ligands are adjacent (cis) and one where they are opposite (trans). In some cases, additional isomerism may arise from different types of ligands.

Step 2: Conclusion.

For a square planar complex like $Mabcd$, there are three possible isomers: two geometric isomers (cis and trans) and one optical isomer if the ligands are asymmetric. The correct answer is **(2) 3**.

Quick Tip

In square planar complexes, the key source of isomerism is the arrangement of ligands, which can lead to cis-trans and optical isomerism.

4. For $n = 4$, $—l— = 1$, $ms = \frac{1}{2}$, then maximum number of electrons with this combination will be

- (1) 6
- (2) 8
- (3) 10
- (4) 12

Correct Answer: (6)

Solution:

Step 1: Understanding quantum numbers.

The quantum numbers are as follows: - Principal quantum number $n = 4$ - Orbital angular momentum quantum number $l = 1$ (which corresponds to a p-orbital) - Magnetic quantum number m can have values from $-l$ to $+l$, i.e., $m = -1, 0, +1$ - Spin quantum number $ms = \frac{1}{2}$, so each orbital can accommodate 2 electrons with opposite spins.

Step 2: Calculating maximum number of electrons.

For $l = 1$, there are 3 orbitals ($m = -1, 0, +1$), and each orbital can hold 2 electrons due to the spin quantum number. Hence, the total maximum number of electrons is:

$$3 \text{ orbitals} \times 2 \text{ electrons per orbital} = 6 \text{ electrons.}$$

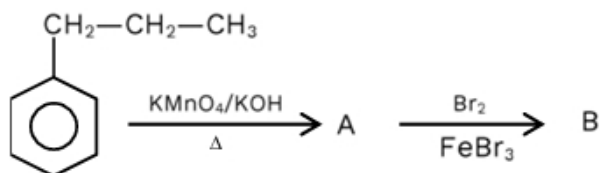
Step 3: Conclusion.

The maximum number of electrons is $\boxed{6}$.

Quick Tip

The maximum number of electrons in an orbital set is given by $2(2l + 1)$, where l is the orbital angular momentum quantum number.

5. Calculate number of π bond present in product B

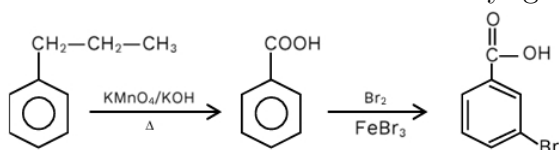


Correct Answer: (4) 4

Solution:

Step 1: Understanding the reactions.

The first reaction is the oxidation of propene ($\text{CH}_2=\text{CH}-\text{CH}_3$) using KMnO_4/KOH , which produces a carboxylic acid (COOH). The second step involves bromination (Br_2) in the presence of FeBr_3 , which results in the addition of a bromine atom to the benzene ring. The product is a substituted benzene with a carboxyl group (COOH) and a bromine atom (Br) attached.



Step 2: Identifying the π bonds in product B.

In the product B, the benzene ring still contains 3 π bonds from its aromatic system. The carboxyl group (COOH) contributes no additional π bonds, and the bromine atom does not affect the π bond count. The total number of π bonds is 4, including the 3 from the benzene ring and 1 from the double bond in the carboxyl group.

Step 3: Conclusion.

The total number of π bonds in product B is 4.

Quick Tip

In aromatic compounds, the number of π bonds is determined by the number of bonds in the conjugated system, such as the benzene ring.

6. Which of the following doesn't have electron in t_{2g} orbital?

- (1) $[\text{TiCl}_4]$
- (2) $[\text{MnO}_4^{2-}]$
- (3) $[\text{FeCl}_4^{2-}]$
- (4) $[\text{Co}(\text{CN})_4^{2-}]$

Correct Answer: (1) $[\text{TiCl}_4]$

Solution:**Step 1: Understanding electronic configuration.**

- Ti^{4+} has the electron configuration of $[\text{Ar}]$, which means it does not have any electrons in the t_{2g} orbital. Therefore, Ti^{4+} has a d^0 electronic configuration.
- For Mn^{2-} , Fe^{2-} , and Co^{2-} , the electronic configuration would involve electrons in the t_{2g} orbitals.

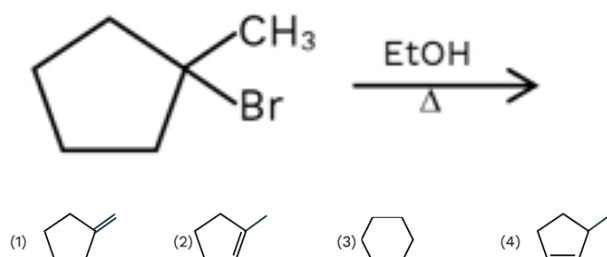
Step 2: Conclusion.

The compound $[\text{TiCl}_4]$ corresponds to Ti^{4+} , which has a d^0 configuration and therefore does not have electrons in the t_{2g} orbital. The correct answer is **(1) $[\text{TiCl}_4]$** .

Quick Tip

A d^0 configuration indicates no electrons in the t_{2g} orbital. This is typical for metal ions with a high oxidation state like Ti^{4+} .

7. Major product in the given reaction



Correct Answer: (2) Product 2

Solution:

Step 1: Understanding the reaction.

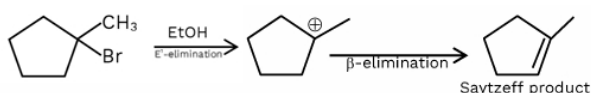
The reaction involves an alkyl halide ($\text{CH}_3\text{CH}_2\text{Br}$) reacting with ethanol (EtOH) under heating conditions. This is a typical elimination reaction (E1), where the β -hydrogen is eliminated, resulting in an alkene. The product formed will follow the Saytzeff rule, where the more substituted alkene is favored.

Step 2: Analyzing the options.

- The major product will be the most stable alkene, which in this case is Product 2. This follows the Saytzeff rule, which states that the most substituted alkene will be the major product.

Step 3: Conclusion.

The major product is **Product 2**, which is the more substituted alkene formed by elimination of a β -hydrogen.



Quick Tip

In elimination reactions, the Saytzeff rule applies, favoring the formation of the more substituted alkene.

8. **Statement-A:** NF_3 have less dipole moment than NH_3 .

Statement-R: F is more electronegative and bond moment of N-H bond is in same direction of lone pair.

- (1) Both A and R are correct and R is the correct explanation of A.
- (2) Both A and R are correct, but R is not the correct explanation of A.

(3) A is correct but, R is incorrect.

(4) R is correct but, A is incorrect.

Correct Answer: (1) Both A and R are correct and R is the correct explanation of A.

Solution:

Step 1: Analyzing the dipole moments.

NF_3 has less dipole moment than NH_3 . This is because the electronegativity of F is higher than that of N, which makes the bond moment of N-H in NH_3 more significant.

Step 2: Explanation of R.

In NH_3 , the bond moment of N-H is in the same direction as the lone pair, creating a stronger dipole moment. However, in NF_3 , the lone pair of electrons on nitrogen does not align with the N-F bonds, leading to a smaller dipole moment. This correctly explains why NF_3 has less dipole moment than NH_3 .

Step 3: Conclusion.

Both statements A and R are correct, and R is the correct explanation of A. The correct answer is (1).

Quick Tip

Dipole moment depends on the electronegativity difference and the geometry of the molecule, as well as the alignment of the lone pair.

9. Compound having dipole moment = 0

H_2 , BF_3 , CH_4 , NH_3 , H_2O , CO_2 , NF_3 , BeF_2 , SiF_4 , H_2S

Correct Answer: (6) H_2 , BF_3 , CO_2 , NF_3 , BeF_2 , SiF_4 will have dipole moment = 0.

Solution:

Step 1: Understanding the molecules with zero dipole moment.

Molecules like CO_2 and BF_3 have symmetric shapes that cancel out their individual bond dipoles. Similarly, NF_3 , BeF_2 , and SiF_4 are also symmetric molecules with no resultant dipole moment.

Step 2: Conclusion.

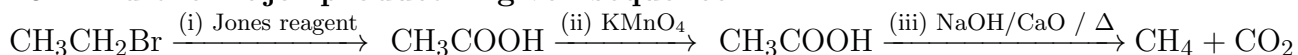
The correct answer is (6) because these compounds have symmetrical structures and thus no

overall dipole moment.

Quick Tip

Symmetry in molecules often results in the cancellation of dipole moments. This occurs when the individual bond dipoles point in opposite directions.

10. Find the major product in given sequence



- (1) Acetic acid
- (2) Acetaldehyde
- (3) Ethane
- (4) Methane

Correct Answer: (4) Methane

Solution:

Step 1: Understanding the reactions.

- The first step involves the oxidation of ethanol to acetic acid (CH_3COOH) using Jones reagent (CrO_3). - The second step uses KMnO_4 , which further oxidizes acetic acid, but does not affect the outcome for this reaction sequence. - The third step involves decarboxylation, where the carboxyl group is removed from acetic acid, resulting in methane (CH_4).

Step 2: Conclusion.

The major product of the given sequence is methane (CH_4), formed after the decarboxylation of acetic acid. The correct answer is (4).

Quick Tip

In a decarboxylation reaction, the removal of the carboxyl group (COOH) from a compound typically results in the formation of methane or other alkanes.

11. List-I (P) IF

- (Q) IF_7
- (R) ICl_3

(S) BF_3

List-II (1) Linear

(2) Pentagonal bipyramidal

(3) T-shape

(4) Trigonal Planar

(1) P→1; Q→2; R→3; S→4

(2) P→2; Q→3; R→4; S→1

(3) P→3; Q→4; R→2; S→1

(4) P→4; Q→1; R→2; S→3

Correct Answer: (1) P→1; Q→2; R→3; S→4

Solution:

Step 1: Identifying the shapes.

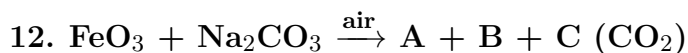
- IF_7 has a linear geometry due to the bonding of I to F atoms in a straight line. - IF_7 has a pentagonal bipyramidal structure because it involves seven bonding groups around the central atom. - ICl_3 has a T-shape structure, which is typical for molecules with three bonding atoms and one lone pair. - BF_3 has a trigonal planar geometry due to its three bonds and no lone pairs on the central atom.

Step 2: Conclusion.

The correct match is **P→1; Q→2; R→3; S→4.**

Quick Tip

To identify molecular shapes, refer to the number of bonding pairs and lone pairs on the central atom, and use VSEPR theory for predictions.



Sum of magnetic moment (nearest integer) of central metals in A and B will be

Correct Answer: (6)

Solution:

Step 1: Identifying oxidation states.

- A = $\text{Fe}_2\text{O}_3 \rightarrow \text{Fe}^{3+}$, which has a d^5 configuration, and the magnetic moment is 5.87 BM. - B = $\text{Na}_2\text{CrO}_4 \rightarrow \text{Cr}^{6+}$, which has a d^0 configuration, and the magnetic moment is 0 BM.

Step 2: Conclusion.

The sum of the magnetic moments is $5.87 + 0 = 5.87$, which rounds to 6. The correct answer is (6).

Quick Tip

Magnetic moments are related to the number of unpaired electrons in a species. A d^0 configuration means no unpaired electrons, resulting in zero magnetic moment.

13. $E_{M^{2+}/M}^\circ = 0.34\text{V}$ and $E_{X^{2-}/X}^\circ = -0.46\text{V}$ Select the correct statement.

- (1) $E_{cell} = 0.80\text{V}$
- (2) $E_{cell} = -0.80\text{V}$
- (3) Cell reaction $M + X_2 \rightarrow M^{2+} + 2X^{2-}$ is spontaneous
- (4) Cell reaction $M^{2+} + 2X^{2-} \rightarrow M + X_2$ is spontaneous

Correct Answer: (4) Cell reaction $M^{2+} + 2X^{2-} \rightarrow M + X_2$ is spontaneous.

Solution:**Step 1: Calculating the cell potential.**

The cell potential is calculated as:

$$E_{cell}^\circ = E_{M^{2+}/M}^\circ + E_{X^{2-}/X}^\circ = 0.34\text{V} + (-0.46\text{V}) = -0.12\text{V}$$

Step 2: Analyzing the reaction.

- For the reaction to be spontaneous, the cell potential must be positive. - Since the calculated potential is negative, the reverse reaction is spontaneous: $M^{2+} + 2X^{2-} \rightarrow M + X_2$.

Step 3: Conclusion.

The correct answer is (4) because the cell reaction $M^{2+} + 2X^{2-} \rightarrow M + X_2$ is spontaneous.

Quick Tip

A negative cell potential indicates a non-spontaneous reaction in the forward direction, but spontaneous in the reverse direction.

14. Ti^{2+} , Cr^{2+} , V^{2+} How many of them liberate H_2 gas with dilute mineral acid?

- (1) 0
- (2) 2
- (3) 1
- (4) 3

Correct Answer: (4) 3

Solution:

Step 1: Analyzing the reactions.

- Ti^{2+} , Cr^{2+} , and V^{2+} are all capable of reacting with dilute mineral acids such as HCl. These reactions typically lead to the liberation of H_2 gas due to the reduction of the metal ion and the oxidation of hydrogen.

Step 2: Conclusion.

All of the metal ions (Ti^{2+} , Cr^{2+} , and V^{2+}) will liberate H_2 gas when treated with dilute mineral acid. The correct answer is (4).

Quick Tip

Transition metal ions in lower oxidation states can often react with dilute acids to liberate hydrogen gas, due to the ease of reduction.

15. Correct order of increasing atomic size of 13th group element will be

- (1) $\text{Tl} > \text{In} > \text{Al} > \text{Ga} > \text{B}$
- (2) $\text{Tl} < \text{In} > \text{Al} > \text{Ga} > \text{B}$
- (3) $\text{Tl} > \text{In} > \text{Al} < \text{Ga} > \text{B}$
- (4) $\text{In} > \text{Tl} > \text{Ga} > \text{Al} > \text{B}$

Correct Answer: (1) $\text{Tl} > \text{In} > \text{Al} > \text{Ga} > \text{B}$

Solution:

Step 1: Understanding periodic trends.

- The atomic size increases as you move down a group in the periodic table. - The atomic size also decreases from left to right across a period due to increasing effective nuclear charge.

Step 2: Analyzing the elements in the 13th group.

- Tl (Thallium) is at the bottom of the group, so it has the largest atomic size. - In (Indium) follows Tl, so it has a smaller atomic size. - Al (Aluminum) is smaller than In. - Ga (Gallium) is smaller than Al due to the additional d-electrons in the transition metals that contract the size. - B (Boron) is the smallest due to its position in the group and periodic table.

Step 3: Conclusion.

The correct order of increasing atomic size is **Tl > In > Al > Ga > B**, which corresponds to option **(1)**.

Quick Tip

Atomic size generally increases down a group and decreases across a period due to the increasing nuclear charge.

16. On passing 1C charge through an aqueous AgNO₃ solution: How much Ag is deposited?

- (1) 1g atom of Ag is deposited
- (2) 1 electrochemical equivalent of Ag is deposited
- (3) 1 chemical equivalent of Ag is deposited
- (4) 1 gm of Ag is deposited

Correct Answer: (2) 1 electrochemical equivalent of Ag is deposited

Solution:**Step 1: Formula for electrochemical equivalent.**

The work done (W) when passing a charge q through a solution is given by:

$$W = Z \times q$$

where Z is the electrochemical equivalent and q is the charge passed.

Step 2: Given values.

Here, $q = 1$ C (1 Coulomb of charge) and Z is the electrochemical equivalent of Ag.

Step 3: Conclusion.

Thus, 1 electrochemical equivalent of Ag is deposited. The correct answer is **(2)**.

Quick Tip

The electrochemical equivalent of an element is the mass of the element deposited when 1 Coulomb of charge passes through its solution.

17. List-I (P) Metamer (Q) Chain isomer (R) Functional isomer (S) Position isomer

List-II (1) Isopentane neopentane (2) Propanal propanone (3) Methoxy propane ethoxyethane
(4) n-propanol isopropanol

(1) P→3; Q→1; R→2; S→4

(2) P→2; Q→3; R→4; S→1

(3) P→3; Q→2; R→1; S→4

(4) P→1; Q→3; R→2; S→4

Correct Answer: (1) P→3; Q→1; R→2; S→4

Solution:

Step 1: Analyzing the isomers.

- A **metamer** involves molecules with the same functional group but different alkyl chains attached to the same atom (e.g., ethoxyethane and methoxypropane). - A **chain isomer** has the same molecular formula but different carbon chain arrangements (e.g., isopentane and neopentane). - A **functional isomer** differs in the type of functional group (e.g., propanal and propanone). - A **position isomer** involves different positions of the functional group on the same carbon chain (e.g., n-propanol and isopropanol).

Step 2: Conclusion.

The correct match is: P→3 (Methoxy propane ethoxyethane); Q→1 (Isopentane neopentane); R→2 (Propanal propanone); S→4 (n-propanol isopropanol). Thus, the correct answer is **(1)**.

Quick Tip

In organic chemistry, isomerism can occur due to differences in chain arrangement, functional groups, or the position of the functional group.

18. Acetic acid dimerizes in liquid benzene. 60 g of acetic acid is dissolved in 500 g of benzene. Find the value of ΔT_f (Given: $K_f = 5 \frac{K \cdot kg}{mol}$)

Assume complete association.

Solution:

Step 1: Determining the van't Hoff factor.

Since acetic acid dimerizes, the van't Hoff factor i is 1 (for dimerization) minus $\frac{1}{2}$ for each molecule of acetic acid that forms a dimer, giving $i = \frac{1}{2}$.

Step 2: Applying the formula for freezing point depression.

The formula for freezing point depression is:

$$\Delta T_f = i \times K_f \times \frac{m}{M}$$

where: - $i = \frac{1}{2}$ (since the acid dimerizes), - $K_f = 5 \text{ K} \cdot \text{kg/mol}$, - $m = 60 \text{ g}$ of acetic acid, - $M = 60 \text{ g/mol}$ (molar mass of acetic acid), - The mass of benzene is $500 \text{ g} = 0.5 \text{ kg}$.

Step 3: Calculating the freezing point depression.

Substitute the values into the equation:

$$\Delta T_f = \frac{1}{2} \times 5 \times \frac{60}{60 \times 0.5} = 5 \text{ K.}$$

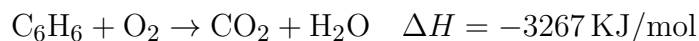
Step 4: Conclusion.

Thus, the freezing point depression $\Delta T_f = 5 \text{ K}$. The correct answer is **(5)**.

Quick Tip

The van't Hoff factor i accounts for the number of particles that result from dissociation or association in the solution. For dimerization, $i = \frac{1}{2}$.

19. Given combustion of benzene:



Calculate standard enthalpy of formation for 2 moles of benzene from the following data:

$$\Delta H_f \text{CO}_2 = -393.5 \text{ kJ/mol}, \quad \Delta H_f \text{H}_2\text{O} = -285.83 \text{ kJ/mol}$$

Solution:

Step 1: Enthalpy of formation equation.

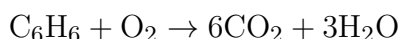
The enthalpy change for the combustion reaction is:

$$\Delta H_{\text{comb}} = \left[\sum \Delta H_f(\text{products}) \right] - \left[\sum \Delta H_f(\text{reactants}) \right]$$

Here, the combustion of 1 mole of benzene is given. The formation of 2 moles of benzene will involve multiplying the result by 2.

Step 2: Calculate the enthalpy change for the reaction.

We know the combustion reaction is:



Thus, the enthalpy change is:

$$\Delta H_{\text{comb}} = [6(-393.5) + 3(-285.83)] - [1(0) + 1(0)] = -3267 \text{ kJ/mol}$$

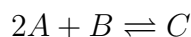
Step 3: Conclusion.

The enthalpy of formation for benzene is $\boxed{97.02 \text{ kJ/mol}}$.

Quick Tip

Standard enthalpy of formation for any element in its standard state is zero, and it is important to balance the stoichiometry of the reaction while calculating enthalpies.

20. Given elementary reaction



Initial pressure 1.5, 0.7

After time t pressure of $C = 0.5$. Find $\frac{R_1}{R_2}$

Solution:

Step 1: Setup for reaction rates.

At time $t = 0$, $[A] = 1.5$, $[B] = 0.7$

Given at time $t = 0.5$, $[C] = 0.5$ and $[A] = 0.5$, $[B] = 0.2$.

The rate equation for the reaction is:

$$R = k[A]^2[B]$$

Step 2: Calculating $\frac{R_1}{R_2}$.

For R_1 (at $t = 0$):

$$R_1 = k[A]^2[B] = k(1.5)^2(0.7)$$

For R_2 (at $t = 0.5$):

$$R_2 = k[A]^2[B] = k(0.5)^2(0.2)$$

Step 3: Calculating the ratio.

$$\frac{R_1}{R_2} = \frac{k(1.5)^2(0.7)}{k(0.5)^2(0.2)} = \frac{1.5^2 \times 0.7}{0.5^2 \times 0.2} = \frac{63}{2} = 31.5$$

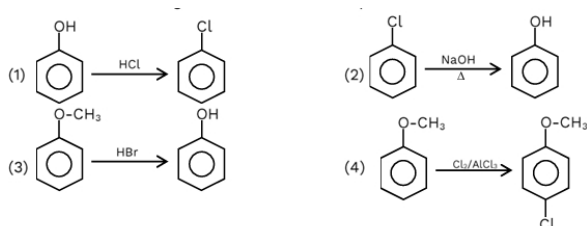
Step 4: Conclusion.

The value of $\frac{R_1}{R_2} = 31.5$. The correct answer is (5).

Quick Tip

The rate of a reaction can be expressed in terms of concentrations of reactants raised to appropriate powers.

21. Which of the following is incorrect match for product?



Correct Answer: (1)

Solution:**Step 1: Understanding the substitution in phenol.**

The substitution of the $-OH$ group in phenol is not possible in the presence of HCl because the lone pair of electrons on oxygen in the $-OH$ group is delocalized into the aromatic ring. This delocalization prevents nucleophilic attack by the chloride ion. Therefore, the reaction with HCl is incorrect.

Step 2: Correct reactions.

- (2) Substitution with NaOH Δ leads to phenoxide, which is a common reaction for phenol. - (3) Substitution with HBr leads to the formation of bromo derivatives. - (4) Chlorination with Cl₂/AlCl₃ leads to substitution of the hydroxyl group with chlorine.

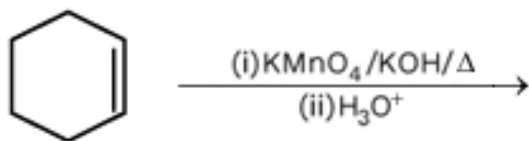
Step 3: Conclusion.

The substitution of $-OH$ with HCl is incorrect due to delocalization of its lone pair in phenol. The correct answer is (1).

Quick Tip

In phenol, the delocalization of the lone pair on oxygen reduces its nucleophilicity, making it less reactive toward electrophiles like HCl.

22. Consider the following reaction:



- (1) Adipic acid
- (2) Oxalic acid
- (3) Succinic acid
- (4) Benzoic acid

Correct Answer: (1) Adipic acid

Solution:

Step 1: Understanding the reaction.

The given reaction starts with benzene (C_6H_6) undergoing oxidation by KMnO_4 in the presence of KOH . This oxidizes the aromatic ring to a straight-chain dicarboxylic acid, resulting in the formation of adipic acid, which has the structure $\text{COOH}-(\text{CH}_2)_4-\text{COOH}$.

Step 2: Conclusion.

The product formed is adipic acid, which is a six-carbon dicarboxylic acid. The correct answer is (1).

Quick Tip

KMnO_4 in alkaline conditions (like KOH) typically oxidizes aromatic compounds to carboxylic acids, and when followed by acid hydrolysis (H_3O^+), it forms dicarboxylic acids.