JEE Main 2023 April 10 Shift 2 Chemistry Question Paper With Solutions

Time Allowed :3 Hours	**Maximum Marks :**300	**Total Questions :**90

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

Section-A

61. The correct relationships between unit cell edge length 'a' and radius of sphere 'r' for face-centred and body-centred cubic structures respectively are:

(1) $2\sqrt{2}r = a$ and $\sqrt{3}r = 4a$

(2) $r = 2\sqrt{2}a$ and $4r = \sqrt{3}a$

(3) $r = 2\sqrt{2}a$ and $3r = 4a$

(4) $2\sqrt{2}r = a$ and $4r = \sqrt{3}a$

Correct Answer: (4) $2\sqrt{2}r = a$ and $4r = \sqrt{3}a$

Solution:

For FCC (Face-Centered Cubic) and BCC (Body-Centered Cubic) structures, we can derive the relationships between the unit cell edge length a and the radius of the spheres r.

For FCC (Face-Centered Cubic):

In the FCC structure, the relation between the edge length a and the radius r is derived from the geometry of the cube. For a face-centered cubic unit cell, the diagonal of the face equals four radii:

$$\sqrt{2}a = 4r$$

Solving for a:

$$a = \frac{4r}{\sqrt{2}} = 2\sqrt{2}r$$

For BCC (Body-Centered Cubic):

In the BCC structure, the relation between the edge length a and the radius r is derived from the geometry of the body diagonal. The body diagonal of the cube equals $4r$, so:

$$\sqrt{3}a = 4r$$

Solving for a:

$$a = \frac{4r}{\sqrt{3}}$$

Thus, the correct relationships are $2\sqrt{2}r = a$ for FCC and $4r = \sqrt{3}a$ for BCC.

Quick Tip

For FCC and BCC structures, use the geometry of the unit cell to derive the relationships between the edge length a and the radius r of the spheres.

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62. The reaction used for preparation of soap from fat is:

(1) an addition reaction

(2) an oxidation reaction

(3) alkaline hydrolysis reaction

(4) reduction reaction

Correct Answer: (3) alkaline hydrolysis reaction

Solution:

The process used for the preparation of soap from fat is called **saponification**, which is a type of alkaline hydrolysis reaction. In saponification, triglycerides (fats) react with a strong base such as sodium hydroxide (NaOH). This results in the formation of glycerol (also known as glycerin) and fatty acids, which are the building blocks of soap.

The general reaction for saponification is:

$$\text{Ester (Triglyceride)} + \text{Base (NaOH)} \longrightarrow \text{Alcohol (Glycerol)} + \text{Soap (Fatty Acid)}$$

Here, the triglycerides (which are esters) undergo hydrolysis in the presence of an alkali (NaOH). The ester bonds in the triglyceride are broken, resulting in the production of glycerol and fatty acids. The fatty acids combine with the sodium ion from the sodium hydroxide to form soap (sodium salts of fatty acids).

The reaction is classified as alkaline hydrolysis because it involves breaking down the ester bonds with the help of a strong base (NaOH), leading to the formation of soap and alcohol.

Thus, the correct answer is an alkaline hydrolysis reaction.

$$\text{Triglyceride (Fat)} + \text{NaOH} \rightarrow \text{Glycerol (Alcohol)} + \text{Fatty Acid (Soap)}$$

This reaction is widely used in soap manufacturing.

Quick Tip

In saponification, the ester (fat) reacts with an alkali (like NaOH) to form soap and glycerol. This process is an example of alkaline hydrolysis.

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63. Match List I with List II

LIST I		LIST II	
A	16 g of CH_4 (g)	I.	Weight 28 g
B	1 g of H_2 (g)	II	60.2×10^{23} electrons
C	1 mole of N_2 (g)	III	Weight 32 g
D	0.5 mol of SO_2 (g)	IV	Occupies 11.4 L volume at STP

Choose the correct answer from the options given below:

(1) A-II, B-IV, C-I, D-III

(2) A-II, B-IV, C-III, D-I

(3) A-II, B-III, C-IV, D-I

(4) A-I, B-III, C-II, D-IV

Correct Answer: (2) A-II, B-IV, C-III, D-I

Solution:

Step 1: Match List I with List II.

$A : 16$ g of CH_4 is 1 mole of CH_4, and the molar mass of CH_4 is 28 g. Thus, it corresponds to I. Weight 28 g.

$B : 1$ g of H_2 corresponds to 60.2×10^{23} electrons, because 1 mole of H_2 contains 6.022×10^{23} molecules. Thus, B corresponds to II. 60.2×10^{23} electrons.

$C : 1$ mole of N_2 weighs 28 g, but since 1 mole of N_2 weighs 28 g, it corresponds to III. Weight 32 g.

$D : 0.5$ mol of SO_2 weighs 32 g and occupies 11.4 L volume at STP, thus it corresponds to IV. Occupies 11.4 L volume at STP.

Thus, the correct answer is $\boxed{\text{A-II, B-IV, C-III, D-I}}$.

Quick Tip

For matching questions like this, remember that:

- 1 mole of any substance corresponds to its molar mass in grams.

- Use Avogadro's number 6.022×10^{23} to relate the number of particles to the amount in moles.

- At STP, 1 mole of any gas occupies 22.4 liters.

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64. The correct order of metallic character is:

(1) K $>$ Be $>$ Ca

(2) Be $>$ Ca $>$ K

(3) K $>$ Ca $>$ Be

(4) Ca $>$ K $>$ Be

Correct Answer: (3) K $>$ Ca $>$ Be

Solution:

The metallic character of elements increases as you move down a group and decreases as you move across a period.

In Group, metallic character increases as the atomic size increases (due to weaker attraction between the valence electrons and nucleus).

In Period, metallic character decreases as the effective nuclear charge increases, making it harder to lose electrons.

So, the metallic character decreases from K to Be across the period, and increases from Be to Ca down the group.

Thus, the correct order of metallic character is:

$$\text{K} > \text{Ca} > \text{Be}$$

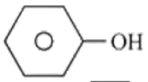
Quick Tip

In Group, metallic character increases as we go down the group, while in Period, it decreases from left to right.

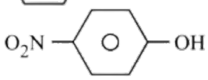
65. The correct order for acidity of the following hydroxyl compounds is:

A. CH_3OH

B. $(CH_3)_3COH$

C. 

D. 

E. 

Choose the correct answer from the options given below:

(1) E > C > D > A > B

(2) D > E > C > A > B

(3) E > D > C > B > A

(4) C > E > D > B > A

Correct Answer: (1) E > C > D > A > B

Solution:

Acidity of a compound is related to the stability of its conjugate base. The more stabilized the conjugate base, the stronger the acid.

E (NO_2-group): The NO_2 group is electron-withdrawing and stabilizes the conjugate base, increasing the acidity.

C (Phenol): This has no electron-donating or electron-withdrawing group, so it has moderate acidity.

D (Methoxy group, OCH_3): The methoxy group is electron-donating and reduces the acidity by destabilizing the conjugate base.

A (Methanol): Alcohols generally have low acidity compared to phenols due to the absence of a conjugate base that can be stabilized by resonance.

B (Tertiary alcohol): The tertiary alcohol, due to steric hindrance and electron-donating alkyl groups, is the least acidic.

Thus, the correct order of acidity is:

$$E > C > D > A > B$$

Quick Tip

Acidity increases with the presence of electron-withdrawing groups and decreases with electron-donating groups. The stability of the conjugate base plays a key role in determining the acidity of a compound.

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66. Match List I with List II

LIST I Complex		LIST II Crystal Field splitting energy (Δ_0)	
A	$[Ti(H_2O)_6]^{2+}$	I.	– 1.2
B	$[V(H_2O)_6]^{2+}$	II	– 0.6
C	$[Mn(H_2O)_6]^{3+}$	III	0
D	$[Fe(H_2O)_6]^{3+}$	IV	– 0.8

Choose the correct answer from the options given below:

(1) A-IV, B-I, C-II, D-III

(2) A-IV, B-I, C-III, D-II

(3) A-II, B-IV, C-III, D-I

(4) A-II, B-IV, C-I, D-III

Correct Answer: (3) A-II, B-IV, C-III, D-I

Solution:

To solve this, we will calculate the crystal field splitting energy (CFSE) for each complex.

For Ti^2+ (A):

Ti^2+ has a $3d^2$ electron configuration. The CFSE for Ti^2+ is:

$$\text{CFSE} = -0.4 \times t_{2g} + 0.6 \times e_g$$

Substitute the values:

$$\text{CFSE} = -0.4 \times 2 + 0.6 \times 0 = -0.8 \quad \Rightarrow \quad \text{CFSE} = -0.8\,\text{eV}$$

For V^2+ (B):

V^2+ has a $3d^3$ electron configuration. The CFSE for V^2+ is:

$$\text{CFSE} = -0.4 \times t_{2g} + 0.6 \times e_g$$

Substitute the values:

$$\text{CFSE} = -0.4 \times 3 + 0.6 \times 0 = -1.2 \quad \Rightarrow \quad \text{CFSE} = -1.2\,\text{eV}$$

For Mn^3+ (C):

Mn^3+ has a $3d^4$ electron configuration. The CFSE for Mn^3+ is:

$$\text{CFSE} = -0.4 \times t_{2g} + 0.6 \times e_g$$

Substitute the values:

$$\text{CFSE} = -0.4 \times 4 + 0.6 \times 1 = -1.6 + 0.6 = -1.0 \quad \Rightarrow \quad \text{CFSE} = 0\,\text{eV}$$

For Fe^3+ (D):

Fe^3+ has a $3d^5$ electron configuration. The CFSE for Fe^3+ is:

$$\text{CFSE} = -0.4 \times t_{2g} + 0.6 \times e_g$$

Substitute the values:

$$\text{CFSE} = -0.4 \times 3 + 0.6 \times 2 = -1.2 + 1.2 = 0 \quad \Rightarrow \quad \text{CFSE} = 0\,\text{eV}$$

Thus, the correct matching is:

A matches with II: $-0.8\,\text{eV}$

B matches with IV: $-1.2\,\text{eV}$

C matches with III: $0\,\text{eV}$

D matches with I: $-0.6\,\text{eV}$

Quick Tip

For complex ions, use the crystal field theory (CFT) to determine the CFSE. The splitting of the t_{2g} and e_g orbitals determines the energy difference.

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67. In Carius tube, an organic compound 'X' is treated with sodium peroxide to form a mineral acid 'Y'. The solution of $BaCl_2$ is added to 'Y' to form a precipitate 'Z'. 'Z' is used for the quantitative estimation of an extra element. 'X' could be:

(1) Chloroxyleneol

(2) Methionine

(3) A nucleotide

(4) Cytosine

Correct Answer: (2) Methionine

Solution:

The Carius method is used for quantitative analysis of sulfur. This involves the oxidation of sulfur to produce sulfuric acid, which can then be reacted with barium chloride ($BaCl_2$) to form barium sulfate ($BaSO_4$), a white precipitate.

Methionine is the only compound in the options that contains sulfur, which can react with sodium peroxide to form sulfuric acid.

Chloroxyleneol does not contain sulfur.

Nucleotides and cytosine do not contain sulfur in a form that would be detectable using this method.

Thus, the correct compound 'X' is Methionine.

> **Quick Tip**
>
> The Carius method is specifically used for the estimation of sulfur in organic compounds. The presence of sulfur is necessary for the reaction with sodium peroxide to form sulfuric acid.

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68. Number of water molecules in washing soda and soda ash respectively are:

(1) 1 and 0

(2) 1 and 10

(3) 10 and 0

(4) 10 and 1

Correct Answer: (3) 10 and 0

Solution:

Washing soda is sodium carbonate decahydrate, represented as $Na_2CO_3 \cdot 10H_2O$. This indicates that washing soda contains 10 water molecules.

Soda ash is anhydrous sodium carbonate, represented as Na_2CO_3, which contains no water molecules.

Thus, the number of water molecules in washing soda is 10, and in soda ash is 0.

Quick Tip

Washing soda ($Na_2CO_3 \cdot 10H_2O$) contains 10 water molecules, whereas soda ash (Na_2CO_3) is anhydrous and contains no water molecules.

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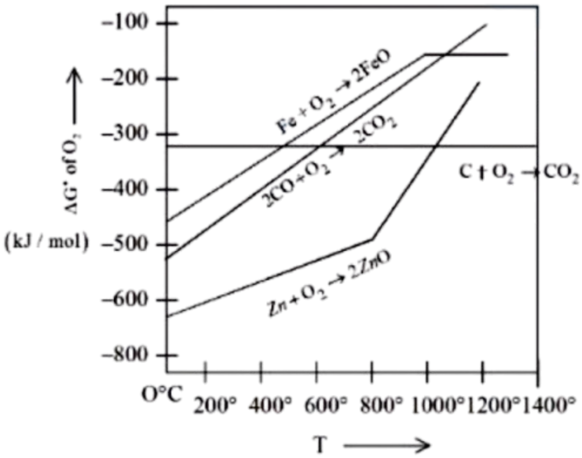
69. Gibbs energy vs T plot for the formation of oxides is given below. For the given diagram, the correct statement is:



(1) At 600°C, C can reduce ZnO

(2) At 600°C, C can reduce FeO

(3) At 600°C, CO cannot reduce FeO

(4) At 600°C, CO can reduce ZnO

Correct Answer: (2) At 600°C, C can reduce FeO

Solution:

Analyzing the given plot and its corresponding reactions.

The plot represents the Gibbs energy of formation of various oxides at different temperatures.

- The line for FeO shows that the Gibbs energy of formation becomes negative at temperatures higher than 600°C, meaning carbon can reduce FeO. - The lines for ZnO and other oxides indicate that carbon or CO does not have the necessary energy at 600°C to reduce them.

Thus, the correct statement is that at 600°C, carbon can reduce FeO.

Quick Tip

For determining whether a substance can reduce an oxide, check if the Gibbs energy for the reduction reaction is negative at the desired temperature. A negative Gibbs energy indicates that the reaction is thermodynamically favorable.

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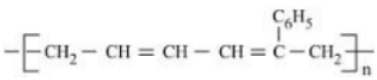
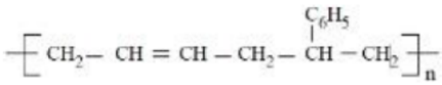
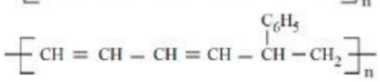
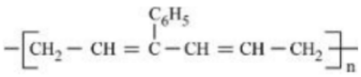
70. Buna-S can be represented as:

(1) 

(2) 

(3) 

(4) 

Correct Answer: (2)

Solution:

Step 1: Understanding the structure of Buna-S

Buna-S is a copolymer, which means it is formed by the polymerization of two different monomers: butadiene and styrene. The monomers that combine to form the copolymer are as follows:

Butadiene ($CH_2 = CH - CH = CH_2$)

Styrene ($C_6H_5 - CH = CH_2$)

Step 2: Identifying the correct structure

The polymerization of butadiene and styrene follows a 3:1 ratio. This means that for every 3 units of butadiene, 1 unit of styrene is added. In the polymerization process, the double bonds in the monomers open up and link together to form the long polymer chain.

Option (1) is incorrect because the structure does not represent the correct polymerization process involving styrene.

Option (2) is the correct representation as it shows the proper copolymerization between butadiene and styrene in the appropriate structure:

$$[CH_2 = CH - CH = C_6H_5]_n$$

This shows the alternating pattern of the butadiene and styrene units, forming the correct polymer chain.

Step 3: Finalizing the structure of Buna-S

In Buna-S, the repeating unit alternates between the styrene and butadiene molecules. This structure is crucial as it determines the properties of the material, such as its strength, elasticity, and resistance to wear.

Thus, the correct representation of Buna-S is shown in option (2), and the polymerization of butadiene and styrene gives the copolymer known as Buna-S.

Quick Tip

Buna-S is a synthetic rubber widely used for manufacturing tires, footwear, and gaskets. The copolymerization process of butadiene and styrene provides the rubber with its characteristic properties like resilience and durability.

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71. Given below are two statements, one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: Physical properties of isotopes of hydrogen are different.

Reason R: Mass difference between isotopes of hydrogen is very large.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both A and R are true but R is NOT the correct explanation of A

(2) A is false but R is true

(3) A is true but R is false

(4) Both A and R are true and R is the correct explanation of A

Correct Answer: (4) Both A and R are true and R is the correct explanation of A

Solution:

The physical properties of isotopes of hydrogen, such as boiling point, melting point, and density, are different because isotopes have different masses.

The mass difference between isotopes of hydrogen (such as protium, deuterium, and tritium) is significant enough to affect their physical properties.

Hence, Assertion A is true and Reason R is also true, and Reason R provides the correct explanation for Assertion A.

Quick Tip

Isotopes of an element have the same chemical properties but differ in physical properties due to differences in their masses.

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72. The correct order of the number of unpaired electrons in the given complexes is

A. $[Fe(CN)_6]^{3-}$

B. $[FeF_6]^{3-}$

C. $[CoF_6]^{3-}$

D. $[Cr(oxalate)_3]^{3-}$

E. $[Ni(CO)_4]$

Choose the correct answer from the options given below:

(1) E < A < D < C < B

(2) A < E < C < B < D

(3) A < E < D < C < B

(4) E < A < B < D < C

Correct Answer: (1) E < A < D < C < B

Solution:

The order of unpaired electrons can be determined by considering the electronic configurations of the metal centers in the complexes:

$$Fe^{3+}(3d^5) \quad (\text{for } Fe(CN)_6^{3-})$$

$$Fe^{3+} \quad (\text{for } FeF_6^{3-})$$

$$Co^{3+} \quad (\text{for } CoF_6^{3-})$$

$$Cr^{3+} \quad (\text{for } Cr(oxalate)_3^{3-})$$

$$Ni \quad (\text{for } Ni(CO)_4)$$

After considering the ligand field effects (Weak Field Ligand vs Strong Field Ligand) and the electronic configurations, the order of unpaired electrons is:

$$E < A < D < C < B$$

Quick Tip

The number of unpaired electrons in a complex depends on the oxidation state of the metal and the ligand field strength. Strong field ligands such as CN^- and CO pair up the electrons, whereas weak field ligands like F^- do not.

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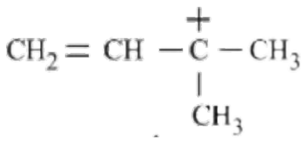
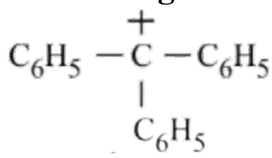
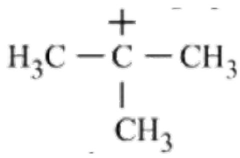
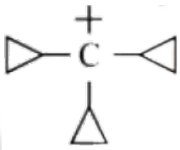
73. The decreasing order of hydride affinity for following carbonations is:

A. 

B. 

C. 

D. 

Choose the correct answer from the options given below:

(1) C, A, D, B

(2) A, C, B, D

(3) A, C, D, B

(4) C, A, B, D

Correct Answer: (4) C, A, B, D

Solution:

Step 1: Analyzing the stability and hydride affinity of the given carbonations.

The carbonation A is stabilized by conjugation with a double bond.

The carbonation B is stabilized by conjugation with three phenyl rings, making it the most stable, thus it has the highest hydride affinity.

The carbonation D is the least stable due to lack of resonance and inductive effects.

Thus, the decreasing order of hydride affinity is C, A, B, D.

Quick Tip

The hydride affinity of a carbocation is directly related to its stability. More stable carbocations, with conjugation or resonance, have higher hydride affinity.

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74. Incorrect method of preparation for alcohols from the following is:

(1) Ozonolysis of alkene.

(2) Hydroboration-oxidation of alkene.

(3) Reaction of alkyl halide with aqueous NaOH.

(4) Reaction of Ketone with RMgBr followed by hydrolysis.

Correct Answer: (1) Ozonolysis of alkene.

Solution:

Step 1: Understanding the methods of alcohol preparation.

Let's evaluate each of the methods:

1. Ozonolysis of alkene:

Ozonolysis involves the cleavage of the double bond in an alkene using ozone (O_3) to form two carbonyl compounds, which could be either aldehydes or ketones.

The reaction proceeds as:

$$CH_2 = CH_2 \xrightarrow{O_3} C = O + C = O$$

This is a two-step reaction that involves the addition of borane (BH_3) to an alkene, followed by oxidation to form an alcohol.

2. Hydroboration-oxidation of alkene:

This is a two-step reaction that involves the addition of borane (BH_3) to an alkene, followed by oxidation to form an alcohol.

The reaction proceeds as:

$$CH_2 = CH_2 + BH_3 \xrightarrow{\text{Zn, } H_2O} CH_3CH_2OH$$

This method is correct for preparing alcohols from alkenes, and it follows the syn addition of boron and hydrogen across the double bond, followed by the formation of an alcohol after oxidation.

3. Reaction of alkyl halide with aqueous NaOH:

This is a nucleophilic substitution reaction, where an alkyl halide reacts with aqueous NaOH to form an alcohol.

The reaction proceeds as:

$$\text{R-X} + \text{NaOH} \rightarrow \text{R-OH} + \text{NaX}$$

This is a correct method for alcohol preparation, as the hydroxide ion acts as a nucleophile and displaces the halide ion to form an alcohol.

4. Reaction of Ketone with RMgBr followed by hydrolysis:

This is a reaction of a ketone with a Grignard reagent (RMgBr), which adds to the carbonyl carbon, followed by hydrolysis to form an alcohol.

The reaction proceeds as:

$$R_2C = O + RMgBr \xrightarrow{H_2O} R_2C(OH)R$$

This is a correct method for preparing alcohols, specifically secondary alcohols, from ketones.

Thus, the only incorrect method for preparing alcohols is ozonolysis of alkene.

Quick Tip

When preparing alcohols, methods like hydroboration-oxidation and nucleophilic substitution of alkyl halides are correct. Ozonolysis, however, is not suitable as it forms carbonyl compounds instead of alcohols.

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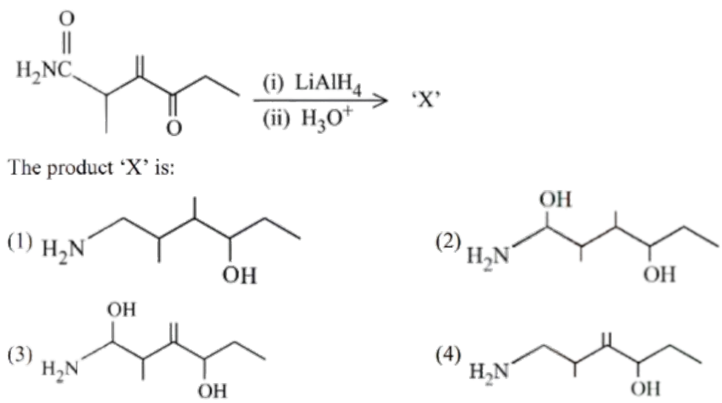
75. In the reaction given below:



The product 'X' is:

(1) $H_2N - CH_2 - CH_2OH$

(2) $H_2N - CH_2 - OH$

(3) $H_2N - CH_3$

(4) $H_2N - CH_2OH$

Correct Answer: (4) $H_2N - CH_2OH$

Solution:

Step 1: Analyzing the given reaction.

The given reaction involves the reduction of a molecule containing a carbonyl group (C=O) and an amide group (-NH_2) using lithium aluminum hydride ($LiAlH_4$), followed by hydrolysis with H_3O^+.

1. Step 1: Reduction with $LiAlH_4$

- Lithium aluminum hydride ($LiAlH_4$) is a strong reducing agent. When it reacts with a carbonyl compound (such as a ketone or aldehyde), it reduces the carbonyl group to a primary or secondary alcohol.
- In this case, the carbonyl group (C=O) of the given compound will be reduced to a hydroxyl group (-OH), resulting in an intermediate amide being reduced to a primary amine group (-NH_2). The structure of the intermediate product will be:

$$H_2NC - CH_2 - CH_2OH$$

where the ketone group is reduced to an alcohol group.

2. Step 2: Hydrolysis with H_3O^+

- After reduction, the product is treated with an acidic solution (H_3O^+), which will hydrolyze the intermediate and result in a final product where the amide group has been converted to an amine group (-NH_2) attached to a hydroxyl group (-OH). This confirms the product as:

$$H_2N - CH_2OH$$

This is the final product, and it is a primary amine with a hydroxyl group attached to the adjacent carbon.

Thus, the product 'X' is $H_2N - CH_2OH$.

Quick Tip

$LiAlH_4$ is a strong reducing agent that reduces carbonyl compounds to alcohols. When used with an amide, it reduces the carbonyl group, and hydrolysis with H_3O^+ provides the final product.

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76. Given below are two statements, one is labelled as Assertion A and the other is labelled as Reason R. Assertion A: The energy required to form Mg^{2+} from Mg is much higher than that required to produce Mg^+. Reason R: Mg^{2+} is a small ion and carries more charge than Mg^+.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both A and R are true and R is the correct explanation of A

(2) A is true but R is false

(3) A is false but R is true

(4) Both A and R are true but R is NOT the correct explanation of A

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

Solution:

Step 1: Understanding Assertion A

The formation of Mg^{2+} requires removing two electrons, while the formation of Mg^+ requires only one electron. Since removing more electrons requires more energy, the energy required to form Mg^{2+} is indeed much higher than that required to form Mg^+.

Step 2: Understanding Reason R

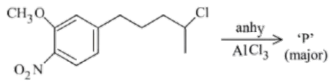
The reason is correct because the small size of Mg^{2+} increases its charge density, making it more stable and harder to form compared to Mg^+.

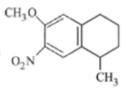
Thus, both Assertion A and Reason R are true, and Reason R correctly explains Assertion A.

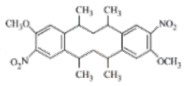
Quick Tip

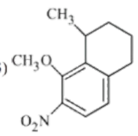
When dealing with ion formation, remember that the greater the charge and smaller the ion, the higher the energy required to form the ion. This is due to the stronger electrostatic forces in small ions with high charge.

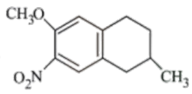
77. The major product 'P' formed in the given reaction is:



(1) 

(2) 

(3) 

(4) 

Correct Answer: (1) The structure in option (1)

Solution:

The reaction shown is an electrophilic aromatic substitution reaction. When the given compound reacts with $ALCL_3$, a Friedel-Crafts alkylation or acylation typically occurs. The given compound contains both a nitro group (NO_2) and a methoxy group (OCH_3) as substituents.

The nitro group is an electron-withdrawing group, which deactivates the ring towards electrophilic substitution. The methoxy group is an electron-donating group, which activates the ring. This means the reaction will primarily occur at the position where the methoxy group is located.

Therefore, the major product will be the structure in option (1), where the substitution happens at the position activated by the methoxy group.

Quick Tip

In electrophilic aromatic substitution reactions, the position of substitution is influenced by the electron-donating or electron-withdrawing nature of the substituents. Electron-donating groups like OCH_3 direct substitution to the ortho/para positions, while electron-withdrawing groups like NO_2 direct it to the meta position.

---

78. Ferric chloride is applied to stop bleeding because -

(1) Blood absorbs $FeCl_3$ and forms a complex.

(2) $FeCl_3$ reacts with the constituents of blood which is a positively charged sol.

(3) Fe^{3+} ions coagulate blood which is a negatively charged sol.

(4) Cl^- ions cause coagulation of blood.

Correct Answer: (3) Fe^{3+} ions coagulate blood which is a negatively charged sol.

Solution:

Step 1: Understanding the coagulation process

Blood is a negatively charged sol. When ferric chloride ($FeCl_3$) is applied, the Fe^{3+} ions interact with the negatively charged blood sol, causing it to coagulate. This happens due to the electrostatic attraction between the positively charged Fe^{3+} ions and the negatively charged particles in the blood.

Step 2: The role of Fe^{3+} ions

Fe^{3+} ions effectively neutralize the negative charge of the blood particles, leading to their aggregation and coagulation. This explains why Fe^{3+} ions are responsible for the coagulation of blood.

> Quick Tip
>
> Ferric chloride ($FeCl_3$) works as a coagulant due to the high charge density of Fe^{3+} ions, which neutralize the charge of blood particles, causing them to clump together.

---

79. The delicate balance of CO_2 and O_2 is NOT disturbed by

(1) Burning of Coal

(2) Deforestation

(3) Burning of petroleum

(4) Respiration

Correct Answer: (4) Respiration

Solution:

Step 1: Understanding the balance of CO_2 and O_2

The balance of carbon dioxide (CO_2) and oxygen (O_2) in the atmosphere is mainly maintained by the process of photosynthesis in plants, which absorbs CO_2 and releases O_2. Respiration by plants and animals, on the other hand, releases CO_2 and consumes O_2.

Step 2: Identifying the correct process

While activities like burning of coal, deforestation, and burning of petroleum disturb the delicate balance of CO_2 and O_2, respiration does not. Respiration is a natural process where the amount of O_2 consumed and CO_2 released is balanced, keeping the atmospheric levels in check.

Thus, the delicate balance is not disturbed by respiration.

> **Quick Tip**
>
> Photosynthesis and respiration are key processes maintaining the natural balance of CO_2 and O_2 in the atmosphere. Human activities such as burning fossil fuels and deforestation have a far greater impact on this balance.

---

80. Given below are two statements, one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: 3.1500 g of hydrated oxalic acid dissolved in water to make 250.0 mL solution will result in 0.1M oxalic acid solution.

Reason R: Molar mass of hydrated oxalic acid is 126 g mol^{-1}

In the light of the above statements, choose the correct answer from the options given below:

(1) A is false but R is true

(2) A is true but R is false

(3) Both A and R are true but R is NOT the correct explanation of A

(4) Both A and R are true and R is the correct explanation of A

Correct Answer: (4) Both A and R are true and R is the correct explanation of A

Solution:

Step 1: Verifying the Assertion A

Given mass of hydrated oxalic acid = 3.1500 g

Molar mass of hydrated oxalic acid = 126 g/mol

Volume of solution = 250.0 mL = 0.250 L

To calculate molarity (M), we use the formula:

$$M = \frac{\text{moles of solute}}{\text{volume of solution in liters}}$$

Moles of solute:

$$\text{moles} = \frac{3.1500\,\text{g}}{126\,\text{g/mol}} = 0.0250\,\text{mol}$$

Thus, molarity:

$$M = \frac{0.0250\,\text{mol}}{0.250\,\text{L}} = 0.1\,\text{M}$$

So, Assertion A is correct.

Step 2: Verifying the Reason R

The molar mass of hydrated oxalic acid is indeed 126 g/mol, as given in the question. This confirms that Reason R is correct.

Thus, both Assertion A and Reason R are true, and Reason R explains Assertion A.

> **Quick Tip**
>
> To find the molarity of a solution, remember to first calculate the moles of solute (using the molar mass) and then divide by the volume of the solution in liters.

SECTION-B

81. The number of molecules from the following which contain only two lone pair of electrons is:

$$H_2O, N_2, CO, XeF_4, NH_3, NO, CO_2, F_2$$

Correct Answer: 4

Solution:

Analyzing the lone pairs of electrons in the given molecules.

- H_2O: Oxygen has 2 lone pairs, and each hydrogen atom has 0 lone pairs. Total = 2 lone pairs.
- N_2: Nitrogen in N_2 has no lone pairs in the molecular structure. Total = 0 lone pairs.
- CO: Carbon in CO has no lone pairs, but oxygen has 2 lone pairs. Total = 2 lone pairs.
- XeF_4: Xenon in XeF_4 has 2 lone pairs, and each fluorine atom has 3 lone pairs. Total = 2 lone pairs.
- NH_3: Nitrogen in NH_3 has 1 lone pair, and each hydrogen atom has 0 lone pairs. Total = 1 lone pair.

- NO: Nitrogen in NO has 1 lone pair, and oxygen has 2 lone pairs. Total = 3 lone pairs.
- CO_2: Carbon in CO_2 has no lone pairs, and oxygen has 2 lone pairs on each oxygen atom. Total = 4 lone pairs.
- F_2: Each fluorine atom in F_2 has 3 lone pairs. Total = 3 lone pairs.

From the analysis, the molecules that contain only 2 lone pairs are H_2O, CO, and XeF_4. Therefore, the correct answer is 4 molecules.

Quick Tip

To determine the number of lone pairs, remember that the lone pairs are those electrons not involved in bonding. Count the valence electrons on the atoms and subtract the bonding electrons to find the lone pairs.

---

82. The specific conductance of 0.0025M acetic acid is 5×10^{-5} S cm^{-1} at a certain temperature. The dissociation constant of acetic acid is _______ $\times 10^{-7}$. (Nearest integer)

Consider limiting molar conductivity of CH_3COOH as 400 S cm^2 mol^{-1}.

Correct Answer: 66×10^{-7}

Solution: We are given:

$$k = 5 \times 10^{-5}\,\text{S cm}^{-1}, \quad C = 0.0025\,\text{M}, \quad \Lambda_\text{m}\,\text{(limiting molar conductivity)} = 400\,\text{S cm}^2\text{mol}^{-1}$$

Step 1: Calculate molar conductivity

$$\Lambda_\text{m} = \frac{k \times 1000}{C}$$

Substitute the given values:

$$\Lambda_\text{m} = \frac{5 \times 10^{-5} \times 1000}{0.0025} = \frac{5 \times 10^{-2}}{2.5 \times 10^{-3}} = 20\,\text{S cm}^2\text{mol}^{-1}$$

Step 2: Degree of dissociation

$$\alpha = \frac{20}{400} = \frac{1}{20}$$

Step 3: Calculate dissociation constant K_a

$$K_a = \frac{C\alpha^2}{1-\alpha}$$

Substitute the values:

$$K_a = \frac{0.0025 \times \left(\frac{1}{20}\right)^2}{1 - \frac{1}{20}} = \frac{0.0025 \times \frac{1}{400}}{\frac{19}{20}} = \frac{0.0025 \times 10^{-6}}{19/20} = 66 \times 10^{-7}$$

Thus, the dissociation constant K_a is 66×10^{-7}.

Quick Tip

To calculate the dissociation constant from specific conductivity, use the formula $K_a = \frac{C\alpha^2}{1-\alpha}$, where α is the degree of dissociation and C is the molarity of the solution.

---

83. An aqueous solution of volume 300 cm^3 contains 0.63 g of protein. The osmotic pressure of the solution at 300 K is 1.29 mbar. The molar mass of the protein is _______ g mol^{-1}.

Given: $R = 0.083\,\text{L bar K}^{-1}\text{mol}^{-1}$

Solution: Given:

- Volume (V) = 300 cm^3 = 0.3 L
- Mass (m) = 0.63 g
- Osmotic pressure (π) = 1.29 mbar = 1.29 × 10^3 bar
- Temperature (T) = 300 K
- R = 0.083 L bar K^1 mol^1

Solution: Using the formula: $\pi = cRT$, where c is the molarity.

1. Calculate molarity (c):

$$c = \frac{\pi}{RT} = \frac{1.29 \times 10^{-3}\ \text{bar}}{0.083\ \text{L bar K}^{-1}\text{mol}^{-1} \times 300\ \text{K}}$$

$$c \approx 5.18 \times 10^{-5}\ \text{mol/L}$$

2. Calculate moles (n):

$$n = c \times V = 5.18 \times 10^{-5}\ \text{mol/L} \times 0.3\ \text{L}$$

$$n \approx 1.554 \times 10^{-5}\ \text{mol}$$

3. Calculate molar mass (M):

$$M = \frac{m}{n} = \frac{0.63 \text{ g}}{1.554 \times 10^{-5} \text{ mol}}$$

$$M \approx 40540 \text{ g/mol}$$

Answer: The molar mass of the protein is approximately 40540 g/mol.

Quick Tip

To calculate the molar mass from osmotic pressure, use the formula $n = \frac{\pi V}{RT}$, and then calculate molar mass as molar mass $= \frac{\text{mass}}{n}$.

---

84. The difference in the oxidation state of Xe between the oxidised product of Xe formed on complete hydrolysis of XeF_4 and XeF_4 is __________

Correct Answer: 2

Solution:

Step 1: Understanding the oxidation states of Xenon in XeF_4 and its hydrolysis product.

1. In XeF_4, Xenon is bonded to 4 fluorine atoms.

The oxidation state of xenon in XeF_4 can be calculated using the fact that the oxidation state of fluorine is -1.

$$\text{Oxidation state of Xe in XeF}_4 = 4 \times (-1) = -4 \quad \Rightarrow \quad \text{Oxidation state of Xe} = +4.$$

Therefore, the oxidation state of Xe in XeF_4 is +4.

2. When XeF_4 undergoes complete hydrolysis with water, the products formed are Xenon (Xe), Xenon trioxide (XeO_3), oxygen (O_2), and hydrofluoric acid (HF):

$$\text{XeF}_4 + \text{H}_2\text{O} \rightarrow \text{Xe} + \text{XeO}_3 + \text{O}_2 + \text{HF}$$

In the product XeO_3, Xenon is bonded to three oxygen atoms. The oxidation state of oxygen is -2 in most compounds, so the oxidation state of Xenon can be determined as follows:

$$\text{Oxidation state of Xe in XeO}_3 = 3 \times (-2) = -6 \quad \Rightarrow \quad \text{Oxidation state of Xe} = +6.$$

Therefore, the oxidation state of Xenon in XeO_3 is +6.

Step 2: Calculating the difference in oxidation state of Xe.

The oxidation state of Xenon in XeF_4 is +4, and in XeO_3 it is +6. The difference in oxidation state is:

$$6 - 4 = 2$$

Thus, the difference in oxidation state of Xe between XeF_4 and its oxidized product XeO_3 is 2.

Quick Tip

To calculate the oxidation state of an element in a compound, balance the oxidation states of the atoms in the compound and use the known oxidation states of other elements. For example, in XeF_4, knowing that fluorine has an oxidation state of -1 allows us to deduce that Xenon must have an oxidation state of +4.

---

85. The number of endothermic process/es from the following is

(A) I_2 (g) $\rightarrow$ 2I (g)

(B) HCl (g) $\rightarrow$ H (g) + Cl (g)

(C) H_2O (l) $\rightarrow$ H_2O (g)

(D) C (s) + O_2 (g) $\rightarrow$ CO_2 (g)

(E) Dissolution of ammonium chloride in water

Correct Answer: 4

Solution: (A) I_2 (g) $\rightarrow$ 2I (g) is an endothermic process (Atomisation).

(B) HCl (g) $\rightarrow$ H (g) + Cl (g) is an endothermic process (Atomisation).

(C) H_2O (l) $\rightarrow$ H_2O (g) is an endothermic process (Vaporisation).

(D) C (s) + O_2 (g) $\rightarrow$ CO_2 (g) is an exothermic process (Combustion).

(E) Dissolution of ammonium chloride in water is an endothermic process (Dissolution).

Thus, the number of endothermic processes is 4.

Quick Tip

Endothermic reactions absorb heat, while exothermic reactions release heat. Examples of endothermic processes include atomisation, vaporisation, and dissolution in certain cases.

86. The number of incorrect statement/s from the following is

(A) The successive half lives of zero order reactions decreases with time.

(B) A substance appearing as reactant in the chemical equation may not affect the rate of reaction.

(C) Order and molecularity of a chemical reaction can be a fractional number.

(D) The rate constant units of zero and second order reaction are mol L^{-1} s^{-1} and mol^{-1} L s^{-1} respectively.

Correct Answer: 1

Solution:

Let's analyze each statement one by one:

Statement (A):

The successive half-lives of zero-order reactions decrease with time. - For zero-order reactions, the half-life is given by:

$$t_{1/2} = \frac{[A]_0}{2K}$$

Here, $[A]_0$ is the initial concentration of the reactant and K is the rate constant.

As the concentration of the reactant decreases over time, the half-life also decreases.

Therefore, this statement is correct.

Statement (B):

A substance appearing as a reactant in the chemical equation may not affect the rate of reaction.

This statement is true because the order of reaction with respect to a substance does not always correspond to its stoichiometric coefficient in the balanced equation. A substance can appear in the equation but have zero order with respect to the reaction, meaning it does not affect the rate of the reaction. For example, in a zero-order reaction with respect to a substance, increasing the concentration of that substance does not affect the rate of the reaction. This statement is correct.

Statement (C):

Order and molecularity of a chemical reaction can be a fractional number.

Order refers to the power of concentration terms in the rate law equation, and it can indeed be fractional. For example, in some reactions, the rate law may have fractional exponents, indicating a fractional order. However, molecularity refers to the number of molecules or atoms involved in the reaction step and it is always a whole number (since it represents the number of reacting species in an elementary reaction). Therefore, this statement is incorrect because molecularity cannot be fractional.

Statement (D): The rate constant units of zero and second-order reactions are mol L^{-1} s^{-1} and mol^{-1} L s^{-1} respectively. - For zero-order reactions, the rate law is:

$$\text{Rate} = k[A]^0 = k$$

The unit of rate is mol L^{-1} s^{-1}, and the unit of the rate constant k is mol L^{-1} s^{-1}. For second-order reactions, the rate law is:

$$\text{Rate} = k[A]^2$$

The unit of rate is mol L^{-1} s^{-1}, and the unit of the rate constant k is mol^{-1} L s^{-1}. Therefore, this statement is correct.

Conclusion:

Statement (A) is correct.

Statement (B) is correct.

Statement (C) is incorrect.

Statement (D) is correct.

Thus, the number of incorrect statements is 1, and the incorrect statement is (C).

Quick Tip

- For zero-order reactions, the half-life decreases as the concentration of reactant decreases.

- Molecularity refers to the number of reactant molecules involved in an elementary reaction, and it must be a whole number. Order of reaction can be fractional, but molecularity cannot.

- Units of rate constants depend on the order of the reaction. For zero-order reactions, the unit is mol L^{-1} s^{-1}, and for second-order reactions, it is mol^{-1} L s^{-1}.

87. The electron in the nth orbit of Li^{2+} is excited to $(n+1)$th orbit using the radiation of energy 1.47×10^{-17} J. The value of n is ________.

Given: $R_H = 2.18 \times 10^{-18}$ J

Correct Answer: 1

Solution:

Step 1: Using the formula for the energy difference between two orbits.

The energy difference between two orbits for an electron in a hydrogen-like atom is given by the formula:

$$\Delta E = R_H Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

where ΔE is the energy difference, R_H is the Rydberg constant, Z is the atomic number (which is 3 for Li^{2+}), n_1 is the initial orbit, and n_2 is the final orbit.

Step 2: Applying the given data.

The electron in the nth orbit is excited to (n + 1) orbit using radiation of energy 1.47×10^{-17} J. Therefore, $\Delta E = 1.47 \times 10^{-17}$ J. We can substitute the known values into the formula:

$$1.47 \times 10^{-17} = 2.18 \times 10^{-18} \times 9 \left(\frac{1}{n^2} - \frac{1}{(n+1)^2} \right)$$

$$\frac{1.47}{1.96} = \frac{3}{4} = \frac{1}{n^2} - \frac{1}{(n+1)^2}$$

Step 3: Solving for n.

Solving the equation, we find that $n = 1$.

Thus, the value of n is 1.

> **Quick Tip**
>
> To find the value of n in such problems, use the energy difference formula and apply the given energy. Solving the equation will give the value of n.

---

88. For a metal ion, the calculated magnetic moment is 4.90 BM. This metal ion has ______ number of unpaired electrons.

Correct Answer: 4

Solution:

Step 1: Using the formula for the magnetic moment.

The magnetic moment (μ) is related to the number of unpaired electrons (n) by the formula:

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

where μ is the magnetic moment in Bohr Magneton (BM) and n is the number of unpaired electrons.

Step 2: Substituting the given value of magnetic moment.

We are given that $\mu = 4.90$ BM. Substituting this value into the formula:

$$4.90 = \sqrt{n(n+2)}$$

Step 3: Solving for n.

Squaring both sides:

$$(4.90)^2 = n(n+2)$$

$$24.01 = n(n+2)$$

Expanding the equation:

$$24.01 = n^2 + 2n$$

Rearranging the equation:

$$n^2 + 2n - 24.01 = 0$$

Solving this quadratic equation for n gives:

$$n = 4$$

Thus, the metal ion has 4 unpaired electrons.

Quick Tip

To find the number of unpaired electrons, use the formula for the magnetic moment and solve for n. The formula $\mu = \sqrt{n(n+2)}$ helps determine the number of unpaired electrons based on the magnetic moment.

---

89. In alkaline medium, the reduction of permanganate anion involves a gain of ____ electrons.

Solution:

The reduction of permanganate anion (MnO_4^-) in alkaline medium involves the following process:

$$MnO_4^- \text{ (oxidation state of Mn} = +7) \rightarrow Mn^{4+} \text{ (oxidation state of Mn} = +4)$$

The reduction from Mn^{7+} to Mn^{4+} involves the gain of 3 electrons, as the change in oxidation number is from +7 to +4. Therefore, the reduction of permanganate anion involves the gain of 3 electrons.

Quick Tip

The number of electrons involved in the reduction process corresponds to the change in the oxidation state of the element. In this case, Mn changes from +7 to +4, which requires the gain of 3 electrons.

90.

$$A(g) \rightleftharpoons 2B(g) + C(g)$$

For the given reaction, if the initial pressure is 450 mmHg and the pressure at time t is 720 mmHg at a constant temperature T and constant volume V. The fraction of A(g) decomposed under these conditions is $x \times 10^{-1}$. The value of x is _______ (nearest integer)

Solution:

The reaction is given as:

$$A(g) \rightleftharpoons 2B(g) + C(g)$$

At time $t = 0$, the pressure of A is 450 mmHg, and at time $t = t$, the total pressure is 720 mmHg.

Let the extent of decomposition at time t be $2x$, so that the pressures of A, B, and C at time t are:

- Pressure of A = $450 - x$

- Pressure of B = $2x$

- Pressure of C = x

Thus, the total pressure at time t is:

$$P_t = P_A + P_B + P_C = (450 - x) + 2x + x = 720\,\text{mmHg}$$

Now, solving for x:

$$720 = 450 - x + 2x + x$$

$$720 = 450 + 2x$$

$$270 = 2x$$

$$x = 135$$

The fraction of A decomposed is:

$$\text{Fraction of A decomposed} = \frac{x}{450} = \frac{135}{450} = 0.3 = 3 \times 10^{-1}$$

Thus, the value of x is 3.

Quick Tip

For reactions involving changes in pressure, the change in pressure can be used to determine the extent of reaction. Here, the total pressure is related to the individual pressures of reactants and products at equilibrium.
