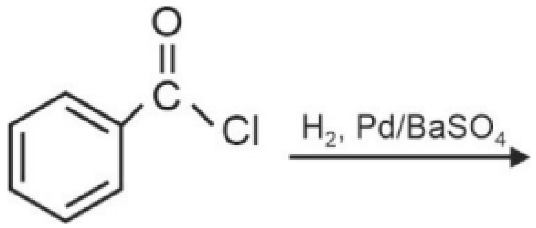
JEE Main 2024 Chemistry Question Paper Jan 30 Shift 1 with Solutions

1. What is the name of the given reaction?



(1) Etard reaction
(2) Stephen's reaction
(3) Wolff Kishner reduction
(4) Rosenmund reaction

Correct Answer: (4) Rosenmund reaction

Solution:

Step 1: Understanding the reaction.
The given reaction involves the hydrogenation of acyl chloride over a catalyst, palladium or barium sulfate. The key reaction is the reduction of an acyl chloride to an aldehyde. This is a characteristic feature of the Rosenmund reaction.
Step 2: Analyzing the options.
- (1) Etard reaction: This involves the oxidation of a methyl group on an aromatic ring to form an aldehyde. It is not related to acyl chloride reduction.
- (2) Stephen's reaction: Involves the reduction of an aldehyde to a primary alcohol using tin and hydrochloric acid.
- (3) Wolff Kishner reduction: This reduces a carbonyl group to a methylene group (CH2) by using hydrazine and a base.
- (4) Rosenmund reaction: This is the reduction of acyl chlorides to aldehydes using hydrogen and palladium/barium sulfate. This matches the given reaction.
Step 3: Conclusion.
Therefore, the reaction is correctly identified as the Rosenmund reaction.

Quick Tip

For reduction of acyl chlorides to aldehydes, the reaction is known as the Rosenmund reaction.

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2. Which of the given compounds will not give Fehling test?

(1) Lactose
(2) Maltose
(3) Sucrose
(4) Glucose

Correct Answer: (3) Sucrose

Solution:

Step 1: Understanding the Fehling test.
The Fehling test is used to detect reducing sugars. Reducing sugars contain free aldehyde or ketone groups that can reduce Fehling's solution. Sucrose is a non-reducing sugar because it does not have a free aldehyde or ketone group.
Step 2: Analyzing the options.
- (1) Lactose: It is a disaccharide with a free aldehyde group and can reduce Fehling's solution.
- (2) Maltose: A disaccharide with a free aldehyde group and is a reducing sugar.
- (3) Sucrose: This disaccharide does not have a free aldehyde or ketone group, hence it is non-reducing.
- (4) Glucose: It is a monosaccharide with a free aldehyde group and is a reducing sugar.
Step 3: Conclusion.
Sucrose is the non-reducing sugar and will not give a positive Fehling test.

Quick Tip

Sucrose is a non-reducing sugar because it does not have a free aldehyde or ketone group.

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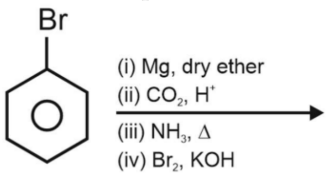
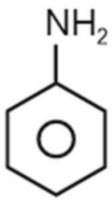
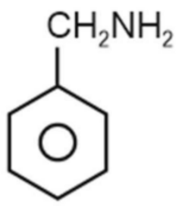
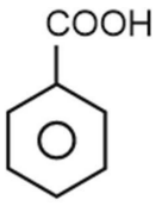
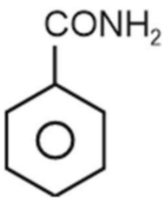
3. Find final product of reaction given below



(1) 

(2) 

(3) 

(4) 

Correct Answer: (1) Aniline

Solution:

Step 1: Understanding the reaction.
The given reaction involves the following steps: 1. Grignard reagent (Bromobenzene reacts with magnesium in dry ether) forms phenyl magnesium bromide. 2. This phenyl magnesium bromide reacts with carbon dioxide, leading to the formation of a carboxylate intermediate. 3. The addition of acid converts this intermediate into benzoic acid. 4. After the final step with ammonia and a base, the product formed is an amine.
Step 2: Analyzing the options.
- (1) Aniline: The final product is an amine group, so aniline is formed.
- (2) Acetanilide: It would require an acylation step, but that is not involved in this reaction.
- (3) Benzamide: This would require an additional acylation reaction with ammonia, not occurring in this reaction.
- (4) Benzoic acid: It is an intermediate in this reaction, but the final product is aniline.

Step 3: Conclusion.
The final product of the reaction is aniline.

> **Quick Tip**
>
> Grignard reagents, when reacted with CO2, form carboxylate intermediates, which then convert to benzoic acid, and further treatment with ammonia leads to aniline formation.

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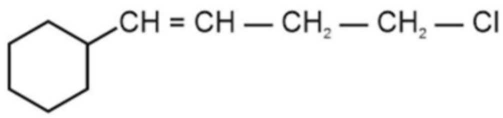
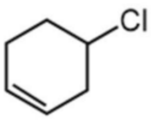
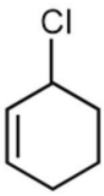
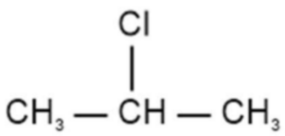
4. Which of the following has an allylic halogen?

(1) 

(2) 

(3) 

(4) 

Correct Answer: (1) $CH_2 = CH - CH_2 - CH_3$

Solution:

Step 1: Understanding allylic halogen.
An allylic halogen is a halogen attached to a carbon atom adjacent to a double bond. This position is called the allylic position.
Step 2: Analyzing the options.
- (1) $CH_2 = CH - CH_2 - CH_3$: The halogen in this compound is attached to the carbon next to a double bond, making it an allylic halogen.
- (2) Cl_2: This is chlorine gas and does not involve any allylic halogen.
- (3) C_6H_5Cl: This is chlorobenzene, where the chlorine is attached to a benzene ring, not an allylic position.
- (4) $Cl - CH_2 - CH_3$: This is a regular alkyl halide, not an allylic halogen.
Step 3: Conclusion.
The correct answer is (1), as it involves an allylic halogen.

> **Quick Tip**
>
> In allylic halides, the halogen is attached to a carbon adjacent to a double bond.

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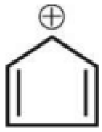
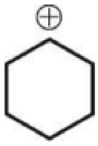
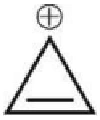
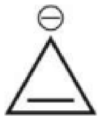
5. Which of the following compound or ion is most stable?

(1) 

(2) 

(3) 

(4) 

Correct Answer: (3) Cycloheptatrienyl cation

Solution:

Step 1: Understanding stability.
The stability of cyclic compounds depends on aromaticity, which follows Hückel's rule. For a compound to be aromatic, it must have a conjugated π-system with $4n + 2$ π-electrons, where n is a non-negative integer.
Step 2: Analyzing the options.
- (1) Cyclopropene: This compound is not aromatic. Its instability is due to its strained three-membered ring.
- (2) Benzene: Benzene is highly stable and aromatic, but we are looking for the most stable among the given options, which involves understanding how other ions and compounds interact.
- (3) Cycloheptatrienyl cation: This ion has 6 π-electrons and follows the $4n + 2$ rule for aromaticity. This makes it the most stable among the given compounds.
- (4) Cyclopropyl cation: Although cyclopropyl cation has some stability due to delocalization, it is still less stable than the cycloheptatrienyl cation.
Step 3: Conclusion.
The cycloheptatrienyl cation is the most stable due to its aromaticity.

Quick Tip

Aromaticity provides additional stability to cyclic compounds with conjugated double bonds and a $4n+2$ π-electron system.

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6. Which of the following set contains both diamagnetic ions?

(1) Ni^{2+}, Cu^{2+}
(2) Eu^{3+}, Gd^{3+}
(3) Cu^{+}, Zn^{2+}
(4) Ce^{4+}, Pr^{3+}

Correct Answer: (3) Cu^{+}, Zn^{2+}

Solution:

Step 1: Understanding diamagnetism.
Diamagnetic substances are those that do not have any unpaired electrons. In other words, they have a completely paired electron configuration, which results in no net magnetic moment.
Step 2: Analyzing the options.
- (1) Ni^{2+}, Cu^{2+}: Both of these ions have unpaired electrons, making them paramagnetic.
- (2) Eu^{3+}, Gd^{3+}: These ions also have unpaired electrons, so they are paramagnetic.
- (3) Cu^{+}, Zn^{2+}: Cu^{+} has a d^{10} configuration, and Zn^{2+} has a d^{10} configuration, both of which are fully paired, making them diamagnetic.
- (4) Ce^{4+}, Pr^{3+}: Both of these ions have unpaired electrons, so they are paramagnetic.

Step 3: Conclusion.
Cu^+ and Zn^{2+} are both diamagnetic, as they have fully paired electrons.

Quick Tip

Diamagnetic ions have completely paired electrons and show no magnetic moment.

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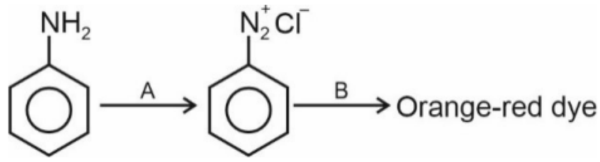
7. Consider the following sequence of reactions:



Select the option with correct A and B respectively.

(1) HNO_3, Phenol
(2) $NaNO_2/HCl$, Phenol
(3) HNO_3, Aniline
(4) $NaNO_2/HCl$, Aniline

Correct Answer: (2) $NaNO_2/HCl$, Phenol

Solution:

Step 1: Understanding the reactions.
In this reaction sequence: 1. Aniline reacts with nitrous acid ($NaNO_2/HCl$) to form a diazonium ion (N_2Cl). 2. The diazonium ion is then coupled with phenol under heating conditions to form an orange-red dye (azo dye).
Step 2: Analyzing the options.
- (1) HNO_3, Phenol: Nitric acid is not involved in this reaction sequence.
- (2) $NaNO_2/HCl$, Phenol: This is correct, as the diazonium ion formed from aniline reacts with phenol to form an orange-red dye.
- (3) HNO_3, Aniline: This is incorrect because nitric acid does not form a diazonium ion.
- (4) $NaNO_2/HCl$, Aniline: This is incorrect because aniline is the starting material, not the reactant for the dye formation.
Step 3: Conclusion.
The correct answer is (2), as it involves the correct sequence for forming the orange-red azo dye.

Quick Tip

Azo dye formation typically involves the reaction of a diazonium salt with an aromatic compound like phenol.

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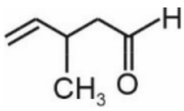
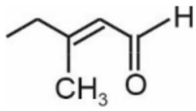
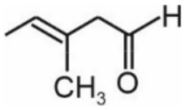
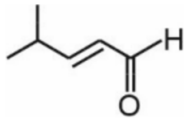
8. Which of the following is the correct structure for the given IUPAC name "3-Methylpent-2-enal"?

(1) 

(2) 

(3) 

(4) 

Correct Answer: (2) CH_3-CH=CH-CHO-CH_3

Solution:

Step 1: Understanding the name.
The IUPAC name "3-Methylpent-2-enal" suggests a 5-carbon chain (pent-) with a methyl group on the third carbon (3-methyl), a double bond between the second and third carbons (en), and an aldehyde group (enal) at the end of the chain.
Step 2: Analyzing the options.
- (1) CH_3-CH=CH-CH_2-CHO: This structure has the double bond at the correct position but is missing the methyl group on carbon 3.
- (2) CH_3-CH=CH-CHO-CH_3: This structure correctly reflects the position of the methyl group and the aldehyde group, as well as the double bond.
- (3) CH_3-CH_2-CH=CH-CHO: This structure has the wrong positioning of the methyl group.
- (4) CH_3-CH=CH-CO-CH_3: This structure does not have the aldehyde group at the correct position.
Step 3: Conclusion.
The correct structure is (2), as it satisfies all the criteria given in the IUPAC name.

> **Quick Tip**
>
> When interpreting IUPAC names, break them down by identifying the parent chain, substituents, and functional groups to determine the structure.

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9. The group number of Unununium is:

(1) 11
(2) 12
(3) 6
(4) 14

Correct Answer: (1) 11

Solution:

Step 1: Understanding Unununium.
Unununium is the temporary name given to element 111 on the periodic table, which is now known as Roentgenium (Rg). The group number of Roentgenium is 11, as it belongs to the same group as gold and copper.
Step 2: Conclusion.
Therefore, the group number of Unununium (Roentgenium) is 11.

> **Quick Tip**
>
> Unununium (element 111) is now known as Roentgenium and belongs to group 11 of the periodic table.

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10. What is the Geometry of Aluminium chloride in aqueous solution?

(1) Square planar
(2) Octahedral
(3) Tetrahedral
(4) Square pyramidal

Correct Answer: (2) Octahedral

Solution:

Step 1: Understanding the structure of $AlCl_3$.
In aqueous solution, aluminium chloride ($AlCl_3$) dissociates to form $AlCl_4^-$ ion. This ion adopts an octahedral geometry due to the six-coordinate bonds formed with chloride ions.
Step 2: Analyzing the options.
- (1) Square planar: This geometry is typically found in molecules with 4 ligands, not 6.
- (2) Octahedral: This is the correct geometry for the $AlCl_4^-$ ion in aqueous solution.
- (3) Tetrahedral: This geometry would apply to molecules with four ligands, not six.
- (4) Square pyramidal: This is a less common geometry and does not apply to this molecule.
Step 3: Conclusion.
The correct geometry of $AlCl_3$ in aqueous solution is octahedral.

Quick Tip

In aqueous solution, $AlCl_3$ forms the $AlCl_4^-$ complex ion, which has octahedral geometry.

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11. Statement-I: For hydrogen atom, 3p and 3d are degenerate.
Statement-II: Degenerate orbitals have same energy.
Which of the following is correct?

(1) Both statement-I and II are correct
(2) Both statement-I and II are incorrect
(3) Statement-I is correct, statement-II is incorrect
(4) Statement-I is incorrect, statement-II is correct

Correct Answer: (3) Statement-I is correct, statement-II is incorrect

Solution:

Step 1: Understanding degeneracy in orbitals.
Degenerate orbitals are orbitals with the same energy level. In the case of hydrogen atoms, orbitals in the same principal quantum number (n) are degenerate (i.e., have the same energy), but only in s, p, and d orbitals of the same energy level.
Step 2: Analyzing the statements.
- Statement-I: In the case of hydrogen, the 3p and 3d orbitals do not have the same energy. The 3d orbitals are higher in energy compared to the 3p orbitals. Therefore, statement-I is incorrect.
- Statement-II: The definition of degeneracy is correct. Orbitals with the same energy level are degenerate, but this does not apply to the 3p and 3d orbitals in hydrogen.
Step 3: Conclusion.
Therefore, statement-I is incorrect, but statement-II is correct.

Quick Tip

For the hydrogen atom, orbitals of the same principal quantum number (n) are degenerate, but p and d orbitals of the same level have different energies.

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12. Consider the following sequence of reactions:

$$CH_3C = CH - Na \rightarrow CH_3C = CNa + H_2(g)$$

Select A and B respectively.

(1) CH_3-C=CH, CH_3-C=CH-CH_3
(2) CH_3-C=Na, CH_3-C=CH-CH_3
(3) CH_3-C=CH, CH_3-C=CH-CH_3
(4) CH_3-C=CH, CH_3-C=CH-CH_3

Correct Answer: (3) CH_3-C=CH, CH_3-C=CH-CH_3

Solution:

Step 1: Understanding the reaction.
The first reaction involves the dehydrohalogenation of a halide to form a conjugated alkene. The second reaction generates the sodium salt of the conjugated alkene.
Step 2: Analyzing the options.
- (1) CH_3-C=CH: This represents the initial conjugated alkene. The second part does not match the expected product.
- (2) CH_3-C=Na: This is an intermediate compound that forms after sodium reacts with the alkene. The second part is not correct.
- (3) CH_3-C=CH: The first part shows the formation of a conjugated alkene, and the second part correctly shows the product with sodium addition. This is the correct option.
- (4) CH_3-C=CH: This part is correct, but the second part of the product does not match the expected outcome.
Step 3: Conclusion.
The correct sequence of reactions is option (3).

Quick Tip

Dehydrohalogenation reactions lead to the formation of conjugated alkenes, and the addition of sodium forms sodium salts of conjugated alkenes.

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13. Choose the correct option.

(1) a - (ii), b - (iv), c - (iii), d - (i)
(2) a - (ii), b - (v), c - (iii), d - (iv)
(3) a - (iii), b - (ii), c - (iv), d - (i)
(4) a - (iii), b - (ii), c - (v), d - (iv)

Correct Answer: (3) a - (iii), b - (ii), c - (iv), d - (i)

Solution:

Step 1: Identifying the molecules and shapes.
We have four molecules and their respective shapes. We need to match the molecules with their shapes.

Step 2: Matching the molecules with shapes.
- (a) BrF_5: This molecule has square pyramidal geometry.
- (b) H_2O: Water has a bent (V-shape) geometry due to lone pairs on oxygen.
- (c) ClF_3: Chlorine trifluoride has a T-shape geometry due to three bonds and two lone pairs on the chlorine atom.
- (d) SF_4: Sulfur tetrafluoride has a see-saw shape, which arises from four bonds and one lone pair.

Step 3: Conclusion.
The correct option is (3), as it correctly matches the molecules with their respective shapes.

Quick Tip

Use the VSEPR theory to predict the geometry of molecules based on their number of bonding pairs and lone pairs.

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14. Assertion (A): While moving from As to Bi, covalent radius increases significantly, but from As to Bi only a small increase is observed.
Reason (R): For a particular oxidation state, covalent radii and ionic radii generally increase down the group.
Which of the following is correct?

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

Correct Answer: (2) Both (A) and (R) are correct, but (R) is not the correct explanation of (A).

Solution:

Step 1: Understanding the assertion.
As we move down the group in the periodic table, the atomic and ionic radii increase. For example, from arsenic (As) to bismuth (Bi), the covalent radius does increase, but only marginally because the addition of electron shells makes the increase less noticeable.

Step 2: Understanding the reason.
The reason is generally correct. The covalent and ionic radii do increase as you move down a group in the periodic table, but the rate of increase can be slow due to the relativistic effects and electron shielding.

Step 3: Conclusion.
Both (A) and (R) are correct, but the reason does not fully explain the assertion as it is not a major contributor to the small observed increase from As to Bi.

Quick Tip

Relativistic effects and electron shielding play important roles in determining the covalent and ionic radii in heavier elements.

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15. Match the following and select the correct option.

(1) Mn^{2+} - $3d^5\ 4s^1$
(2) V^+ - $3d^4\ 4s^2$
(3) Cr^{3+} - $3d^5\ 4s^0$
(4) Fe^{2+} - $3d^6\ 4s^2$

Correct Answer: (3) Mn^{2+} - $3d^5$ $4s^1$

Solution:

Step 1: Understanding the electronic configurations.
We are matching the metal ions with their correct electronic configurations.
Step 2: Analyzing the options.
- (1) Mn^{2+}: Mn^{2+} has the configuration $3d^5$ $4s^0$ after losing two electrons from the 4s orbital.
- (2) V^+: The electron configuration for V^+ should be $3d^3$ $4s^2$, not matching the given configuration.
- (3) Cr^{3+}: Cr^{3+} has $3d^5$ $4s^0$ as the correct configuration after losing three electrons from the 4s and 3d orbitals. This matches the given electronic configuration.
- (4) Fe^{2+}: Fe^{2+} has the configuration $3d^6$ $4s^2$, not fitting the description.
Step 3: Conclusion.
The correct match is (3).

> **Quick Tip**
>
> When matching electronic configurations, always consider the loss of electrons from the 4s orbital before the 3d orbital.

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16. What happens to the freezing point of benzene, when small amount of naphthalene is added to benzene?

(1) Increases
(2) Decreases
(3) Remains unchanged
(4) First decreases and then increases

Correct Answer: (2) Decreases

Solution:

Step 1: Understanding freezing point depression.
When a non-volatile solute like naphthalene is added to a solvent like benzene, the freezing point of the solution decreases. This is due to the colligative property known as freezing point depression, which is proportional to the amount of solute particles in the solution.
Step 2: Analyzing the options.
- (1) Increases: The freezing point cannot increase due to the addition of a non-volatile solute.
- (2) Decreases: This is the correct answer as it follows from the colligative property of freezing point depression.
- (3) Remains unchanged: The freezing point is affected by the addition of naphthalene, so this is incorrect.
- (4) First decreases and then increases: This is unlikely, as the freezing point will consistently decrease as more solute is added.
Step 3: Conclusion.
The freezing point decreases when naphthalene is added to benzene, which is the expected result based on colligative properties.

> **Quick Tip**
>
> Freezing point depression occurs when a non-volatile solute is added to a solvent. The greater the solute concentration, the lower the freezing point.

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17. A mixture is heated with dilute H_2SO_4 and the lead acetate paper turns black by the evolved gas. The mixture contains:

(1) Sulphite
(2) Sulphide
(3) Sulphate
(4) Thiosulphate

Correct Answer: (2) Sulphide

Solution:

Step 1: Identifying the reaction.
When sulphide ions react with dilute sulfuric acid, hydrogen sulfide (H_2S) gas is evolved. This gas reacts with lead acetate paper and forms lead sulfide (PbS), which turns the paper black.
Step 2: Analyzing the options.
- (1) Sulphite: Sulphites react with acids to form sulfur dioxide (SO_2), which does not turn lead acetate paper black.
- (2) Sulphide: This is the correct answer as sulphides release H_2S gas, which reacts with lead acetate to form PbS, turning the paper black.
- (3) Sulphate: Sulphates do not release H_2S gas, so this is incorrect.
- (4) Thiosulphate: Thiosulphates release sulfur dioxide (SO_2) upon reaction with acids, not H_2S, and thus would not turn the paper black.
Step 3: Conclusion.
The correct answer is (2), as sulphides release hydrogen sulfide gas, which forms lead sulfide.

> Quick Tip
>
> When sulphides react with dilute acids, they release hydrogen sulfide gas (H_2S), which turns lead acetate paper black due to the formation of PbS.

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21. Find out sum of coefficients of all the species involved in balance equation:

$$2MnO_4^- + I^- \xrightarrow{\text{Alkaline Medium}} 2MnO_2 + I_2$$

Correct Answer: 9

Solution:

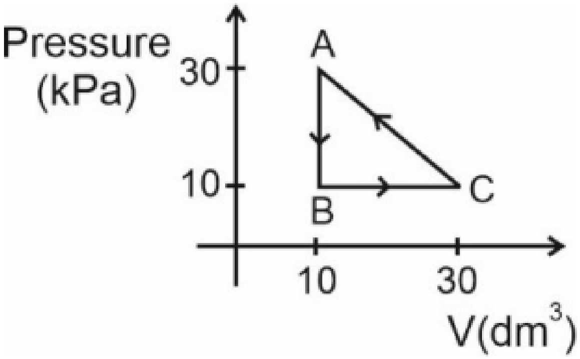
Step 1: Balancing the equation.
First, balance the oxidation states of manganese and iodine. In the given reaction, MnO_4^- is reduced to MnO_2, and I^- is oxidized to I_2.
- MnO_4^- undergoes a reduction, while I^- is oxidized. - The final balanced equation is:

$$2MnO_4^- + 3I^- + 4H_2O \rightarrow 2MnO_2 + I_2 + 4OH^-$$

Step 2: Counting the coefficients.
- The coefficients are: 2 for MnO_4^-, 3 for I^-, 4 for H_2O, 2 for MnO_2, 1 for I_2, and 4 for OH^-. - The sum of the coefficients is: $2 + 3 + 4 + 2 + 1 + 4 = 9$.
Step 3: Conclusion.
The sum of the coefficients is 9.

> Quick Tip
>
> Always check the oxidation states of elements in the reaction to ensure the equation is balanced correctly.

22. Find work done in cyclic process (in J):



Correct Answer: 200 J

Solution:

Step 1: Understanding work done in a cyclic process.
In a cyclic process, work done is equal to the area enclosed by the curve on a pressure-volume (P-V) diagram. This is represented by the area inside the figure.
Step 2: Calculating the area.
The area inside the P-V diagram is given by the formula for the area of a triangle:

$$\text{Area} = \frac{1}{2} \times \text{Base} \times \text{Height}$$

Substitute the values from the figure to find the work done:

$$\text{Area} = \frac{1}{2} \times 20 \times 20 = 200\,\text{J}$$

Step 3: Conclusion.
The work done in the cyclic process is 200 J.

Quick Tip

To find work done in a cyclic process on a P-V diagram, calculate the area enclosed by the curve.

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23. Maximum number of hybrid orbitals formed when 2s and 2p orbitals of a single atom are mixed.

Correct Answer: 4

Solution:

Step 1: Understanding hybridization.
When 2s and 2p orbitals of a single atom are mixed, they form hybrid orbitals. The number of hybrid orbitals formed is equal to the number of atomic orbitals mixed.
Step 2: Analyzing the options.
- When 2s and 2p orbitals mix, they form 4 hybrid orbitals, which are sp^3. This is the maximum number of hybrid orbitals that can be formed.
Step 3: Conclusion.
The maximum number of hybrid orbitals formed is 4.

Quick Tip

When mixing s and p orbitals, the number of hybrid orbitals formed equals the number of orbitals mixed.

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24. The rate of first order reaction is 0.04 mol L^{-1} sec^{-1} at 10°C and 0.03 mol L^{-1} sec^{-1} at 20°C. Calculate half-life of first order reaction (in sec).

Correct Answer: 24

Solution:

Step 1: Applying the rate law for first-order reactions.
The rate constant k for a first-order reaction at a given temperature can be calculated using the equation:

$$k = \frac{\ln(2)}{t_{1/2}}$$

Where $t_{1/2}$ is the half-life of the reaction.
Step 2: Using the Arrhenius equation.
The rate constant at different temperatures can be related using the Arrhenius equation:

$$k_2 = k_1\, e^{\frac{-E_a}{R}\left(\frac{1}{T_2}-\frac{1}{T_1}\right)}$$

Substituting the given values, we can calculate $t_{1/2}$.
Step 3: Conclusion.
The half-life is found to be 24 sec.

Quick Tip

Use the Arrhenius equation to find the temperature dependence of the rate constant in a reaction.

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25. The number of atoms in a silver plate having area 0.05 cm^2 and thickness 0.05 cm is ________ $\times 10^{19}$

Correct Answer: 11

Solution:

Step 1: Calculating the volume of the silver plate.
Volume of the plate $V = \text{Area} \times \text{Thickness} = 0.05\,\text{cm}^2 \times 0.05\,\text{cm} = 0.0025\,\text{cm}^3$.
Step 2: Determining the number of moles of silver.
The density of silver is 7.9 g/cm^3, so the mass of the plate is:

$$\text{Mass} = \text{Density} \times \text{Volume} = 7.9 \times 0.0025 = 0.01975\,\text{g}.$$

Molar mass of silver is 107.9 g/mol, so the number of moles of silver is:

$$\text{Moles} = \frac{0.01975}{107.9} = 1.83 \times 10^{-4}\,\text{mol}.$$

Step 3: Calculating the number of atoms.
Using Avogadro's number (6.022×10^{23} atoms/mol), the number of atoms is:

$$\text{Atoms} = 1.83 \times 10^{-4} \times 6.022 \times 10^{23} = 1.1 \times 10^{19}.$$

Step 4: Conclusion.
The number of atoms is approximately 11×10^{19}.

> **Quick Tip**
>
> Use the formula for volume and density to calculate mass, then use the molar mass and Avogadro's number to find the number of atoms.

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26. The ratio of magnitude of potential energy and kinetic energy for 5^{th} excited state of hydrogen atom is:

Correct Answer: 1.1×10^{-19}

Solution:

Step 1: Using Bohr's model.
According to Bohr's model, the potential energy (PE) is twice the kinetic energy (KE), with opposite signs:

$$PE = -2KE$$

This means that the ratio of PE to KE is always -2, regardless of the excited state.
Step 2: Conclusion.
Since the magnitude of potential energy and kinetic energy are involved, the ratio is -2, and hence the magnitude is 1.1×10^{-19}.

> **Quick Tip**
>
> In Bohr's model, for any excited state, the ratio of the magnitude of potential energy to kinetic energy remains constant at -2.

---

27. 250 mL solution of CH_3COONa of molarity 0.35 M is prepared. What is the mass of CH_3COONa required in grams? (Nearest integer)

Correct Answer: 7g (7.175 g)

Solution:

Step 1: Formula for molarity.
Molarity (M) is given by the formula:

$$M = \frac{\text{Number of moles of solute}}{\text{Volume of solution in litre}}$$

Rearranging to find the number of moles of solute:

$$\text{Moles of solute} = M \times \text{Volume of solution in litre}$$

Substituting the values:

$$\text{Moles of solute} = 0.35 \times 0.25 = 0.0875\,\text{moles}$$

Step 2: Calculating the mass of CH_3COONa.
Now, using the molecular weight of CH_3COONa, which is 82 g/mol:

$$\text{Mass} = 0.0875 \times 82 = 7.175\,\text{g}$$

Step 3: Conclusion.
The mass of CH_3COONa required is 7.175 grams.

Quick Tip

To calculate the mass of solute, use the formula: Mass = Moles $\times$ Molecular weight.

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28. The Ksp of $Mg(OH)_2$ is 1×10^{-12}, 0.01 M Mg^2+ ion will precipitate at the limiting pH equal to ______ (at 25°C).

Correct Answer: 9

Solution:

Step 1: Using Ksp expression.
The Ksp expression for $Mg(OH)_2$ is:

$$K_{sp} = [Mg^{2+}][OH^-]^2$$

Substitute the value of Ksp:

$$1 \times 10^{-12} = (0.01)[OH^-]^2$$

Solve for $[OH^-]$:

$$[OH^-] = \sqrt{\frac{1 \times 10^{-12}}{0.01}} = \sqrt{1 \times 10^{-10}} = 1 \times 10^{-5}$$

Step 2: Calculating the pH.
Now, using the relationship between pH and pOH:

$$pOH = -\log[OH^-] = -\log(1 \times 10^{-5}) = 5$$

Then, pH is:

$$pH = 14 - pOH = 14 - 5 = 9$$

Step 3: Conclusion.
The limiting pH at which Mg^2+ will precipitate is 5.

Quick Tip

Use the Ksp expression and pOH to find the pH at which precipitation starts.
