Chemical Reactions of Alcohols Phenols and Ethers JEE Main PYQ - 3

Total Time: 1 Hour **Total Marks:** 100

Instructions

Instructions

1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

Chemical Reactions of Alcohols Phenols and Ethers

1. The group of chemicals used as pesticide is **(+4, -1)**

a. Dieldrin, Sodium arsinite, Tetrachloroethene

b. Sodium chlorate, DDT, PAN

c. DDT, Aldrin

d. Aldrin, Sodium chlorate, Sodium arsinite

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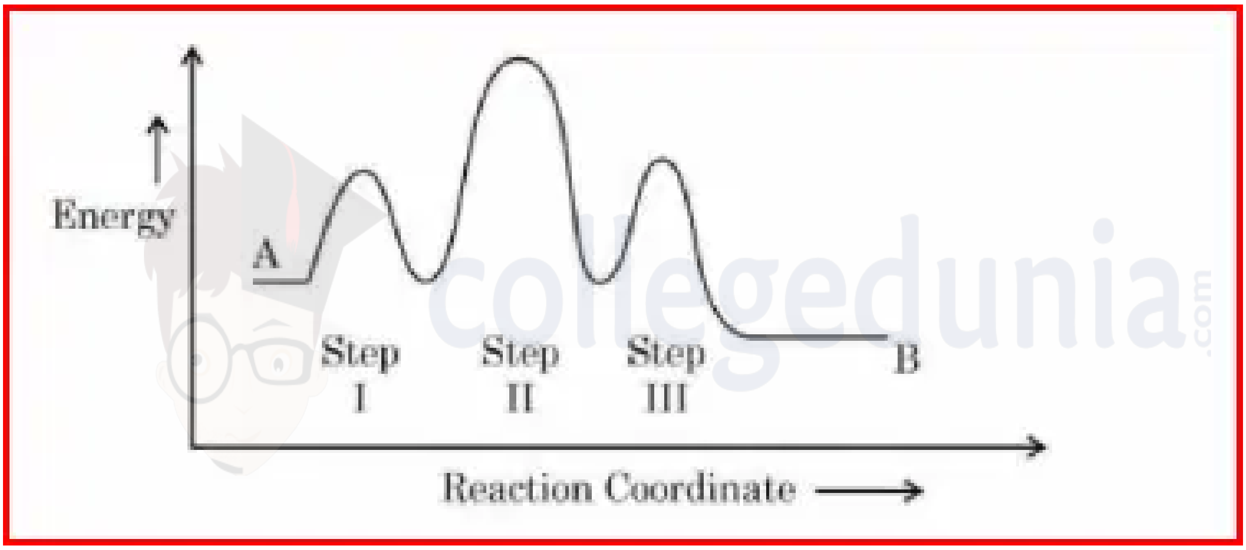
2. Consider the following reaction that goes from A to B in three steps as shown **(+4, -1)**



below Choose the correct option:

a.

Number of intermediates	Number of Activated complexes	Rate determining step
2	3	II

b.

Number of intermediates	Number of Activated complexes	Rate determining step
2	3	III

c.

Number of intermediates	Number of Activated complexes	Rate determining step
3	2	II

d.

Number of intermediates	Number of Activated complexes	Rate determining step
2	3	I

---

3. The volume of 0.02 M aqueous HBr required to neutralize 10.0 mL of 0.01 M aqueous $Ba(OH)_2$ is ____ . (Assume complete neutralization) **(+4, -1)**

a. 2.5 mL

b. 5.0 mL

c. 7.5 mL

d. 10.0 mL

---

4. Match List-I with List-II : **(+4, -1)**

	List-I		List-II
A	Saccharin	I	High potency sweetener
B	Aspartame	II	First artificial sweetening agent
C	Alitame	III	Stable at cooking temperature
D	Sucralose	IV	Unstable at cooking temperature

Choose the correct answer from the options given below :

a. A-II, B-IV, C-I, D-III

b. A-II, B-IV, C-III, D-I

c. A-II, B-III, C-IV, D-I

d. A-IV, B-III, C-I, D-II

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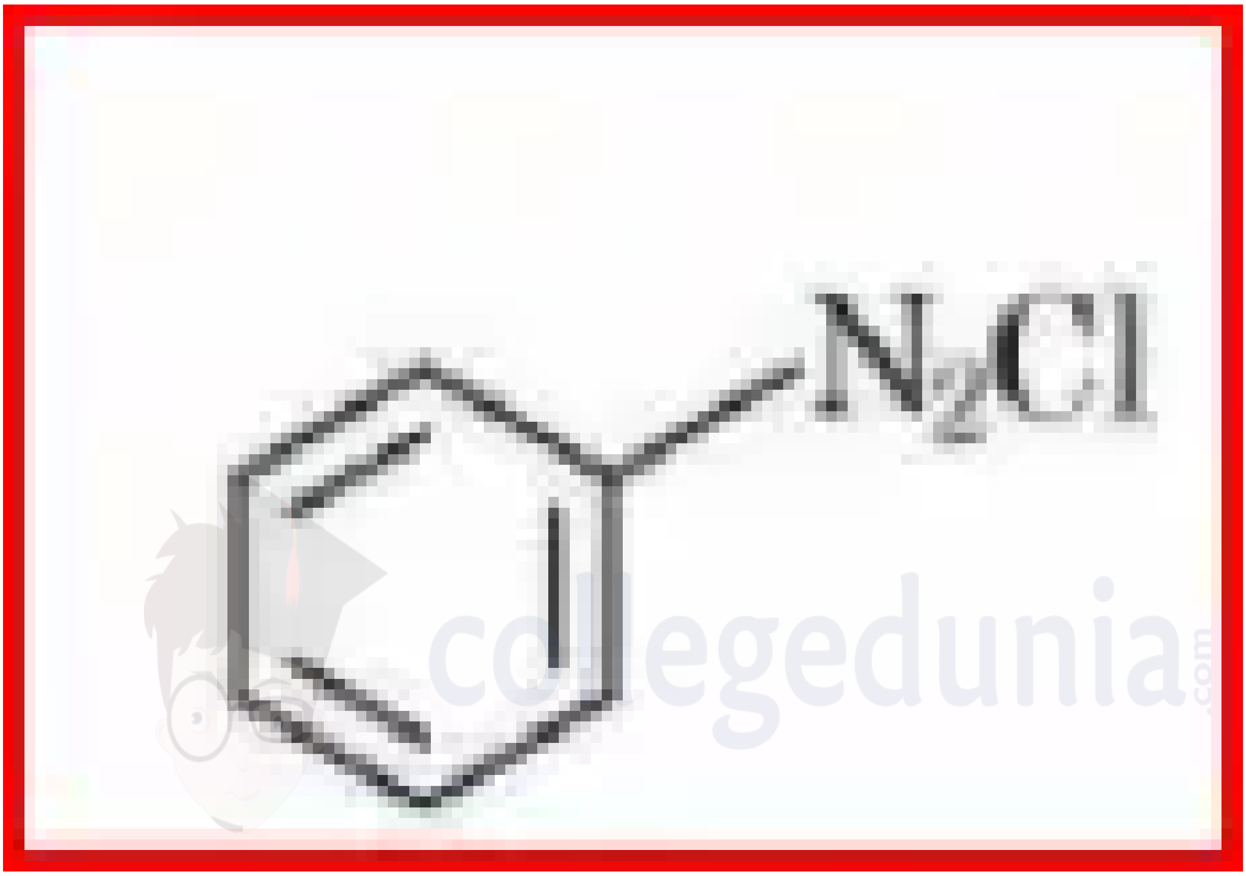
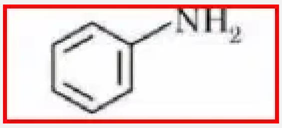
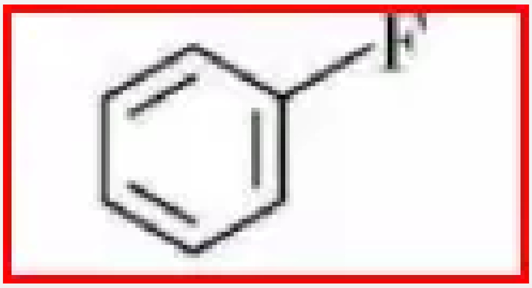
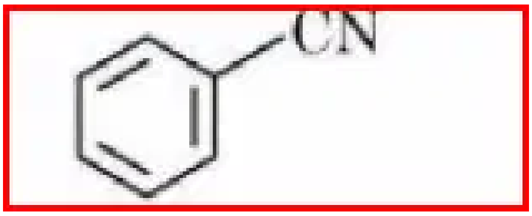
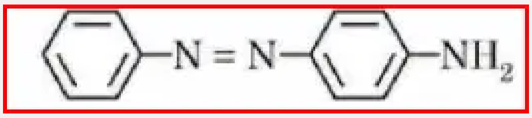
5. Match List-I with List-II : **(+4, -1)**



is reached with regents is List-I to from products in List-II.

	List-I (Reagent)		List-II (Products)
A		I	
B	HBF_4 △	II	
C	Cu, HCl	III	
D	CuCN/ KCN	IV	

Choose the correct answer from the options given below :

a. A-IV, B-III, C-II, D-I

b. A-III, B-I, C-IV, D-II

c. A-I, B-III, C-IV, D-II

d. A-III, B-I, C-II, D-IV

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6. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R. **(+4, -1)**
Assertion A: Butan -1- ol has higher boiling point than ethoxyethane.
Reason R: Extensive hydrogen bonding leads to stronger association of molecules.
In the light of the above statements, choose the correct answer from the options given below:

a. Both A and R are true and R is the correct explanation of A

b. A is true but R is false

c. Both A and R are true but R is not the correct explanation of A

d. A is false but R is true

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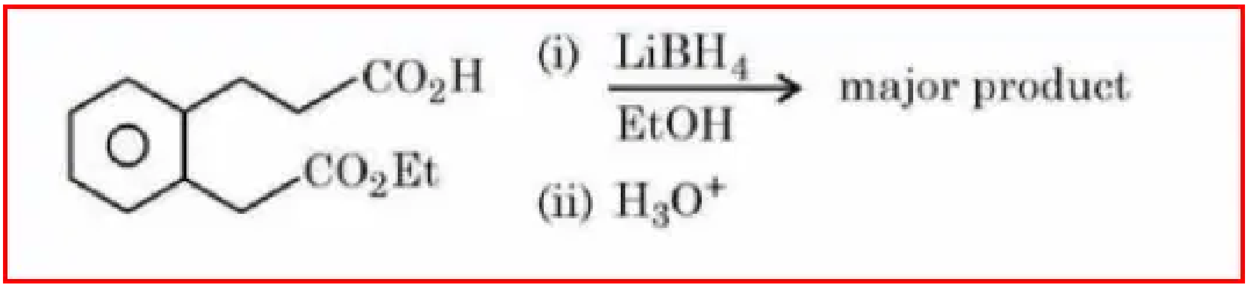
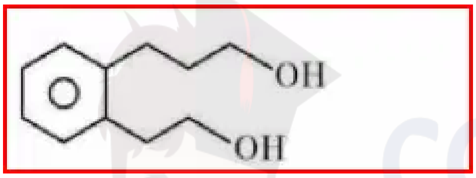
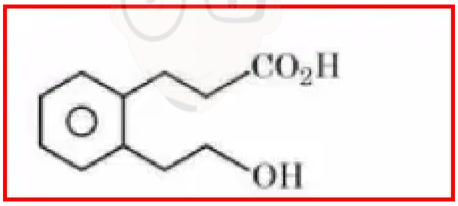
7. The major product formed in the following reaction is **(+4, -1)**



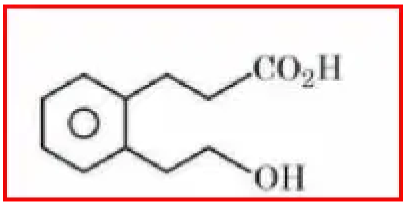
a.



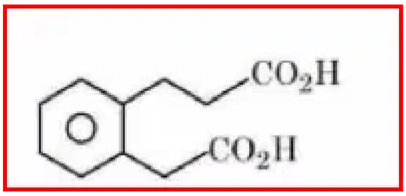
b.



c.



d.



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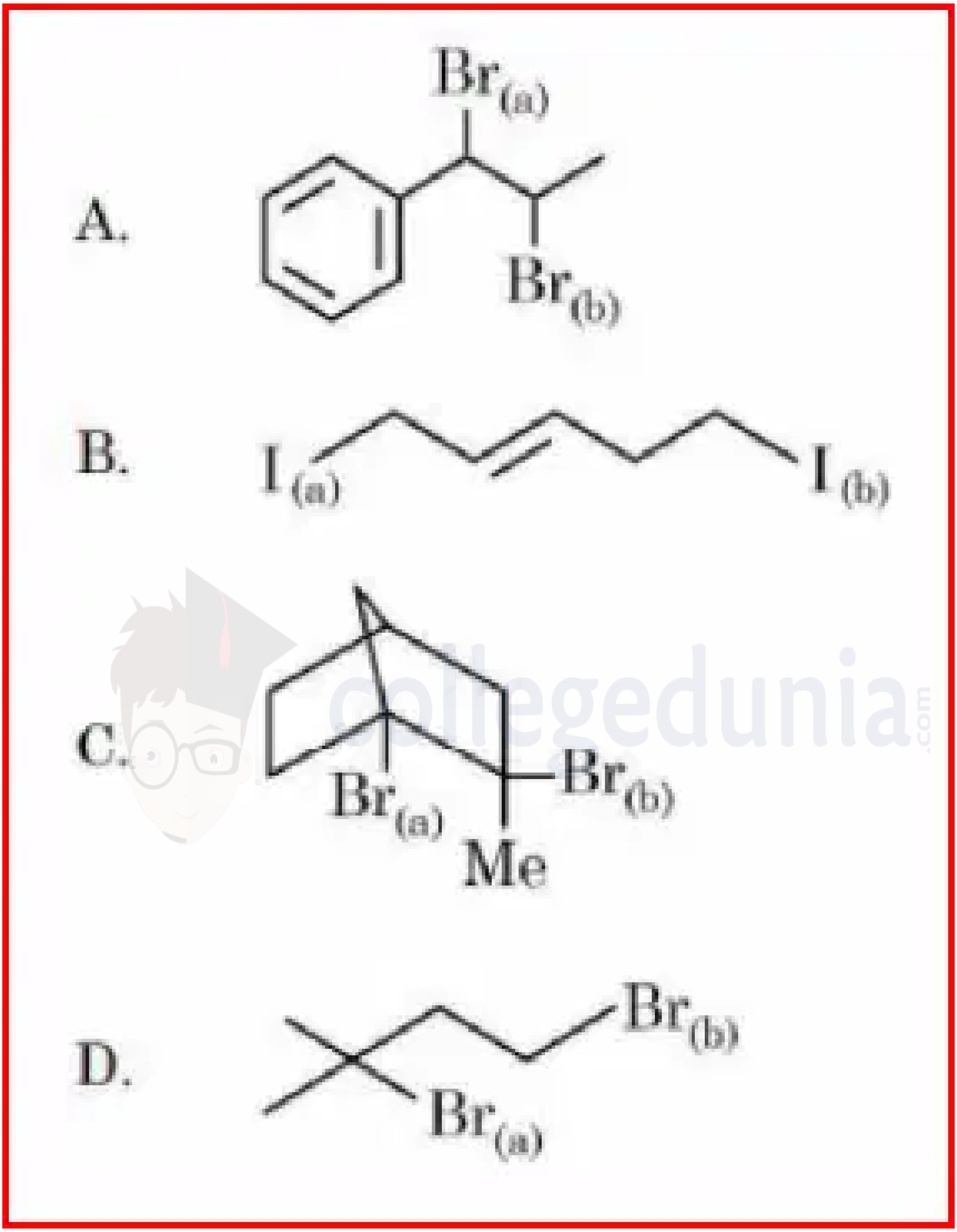
8. Choose the halogen which is most reactive towards SN1 reaction in the given compounds (A, B, C & D) **(+4, -1)**



a. A-$Br_{(a)}$; B-$I_{(a)}$; C-$Br_{(b)}$; D-$Br_{(a)}$

b. A-$Br_{(a)}$; B-$I_{(a)}$; C-$Br_{(a)}$; D-$Br_{(a)}$

c. A-$Br_{(b)}$; B-$I_{(a)}$; C-$Br_{(a)}$; D-$Br_{(a)}$

d. A-$Br_{(b)}$; B-$I_{(b)}$; C-$Br_{(b)}$; D-$Br_{(b)}$

---

9. The correct order of spin only magnetic moments for the following complex ions is **(+4, -1)**

   a. $[Fe(CN)_6]^{3-}$< $[CoF6]^{3-}$ < $[MnBr_4]^{2-}$ < $[Mn(CN)_6]^{3-}$

   b. $[Fe(CN)_6]^{3-}$< $[Mn(CN)_6]^{3-}$ < $CoF_6]^{3-}$ < $[MnBr_4]^{2-}$

   c. $[COF_6]^{3-}$ < $[MnBr_4]^{2-}$ < $[Fe(CN)_6]^{3-}$ < $[Mn(CN)_6]^{3-}$

   d. $[MnBr_4]^{2-}$ < $[CoF_6]^{3-}$ < $[Fe(CN)_6]^{3-}$ < $[Mn(CN)_6]^{3-}$

---

10. Which of the following complex is octahedral, diamagnetic and the most stable? **(+4, -1)**

    a. $K_3[CO(CN)_6]$

    b. $[Ni(NH_3)_6]Cl_2$

    c. The correct option is(A): $Na_3[COCl_6]$

    d. $[Co(H_2O)_6]Cl_2$

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11. The reaction $\frac{1}{2}H_2(g)$ + AgCl(s) → $H^+(aq)$ + $Cl^-(aq)$ + Ag(s) occurs in which of the given galvanic cell. **(+4, -1)**

    a. Ag | AgCl(s) | KCl(son^n) || $AgNO_3$ | Ag

    b. Pt | $H_2(g)$ | HCl(sol^n) || $AgNO_3$ (sol^n) | Ag

    c. Pt | $H_2(g)$ | HCl(sol^n) || AgCl(s) | Ag

    d. Pt | $H_2(g)$ | KCl(sol^n) || AgCl(s) | Ag

---

12. $2IO_3^- + xI^- + 12H^+ \longrightarrow 6I_2 + 6H_2O$ What is the value of x? **(+4, -1)**

a. 2

b. 10

c. 6

d. 12

---

13. Number of isomeric products formed by monochlorination Of $2 - methyl\ butane$ in presence of sunlight is **(+4, -1)**

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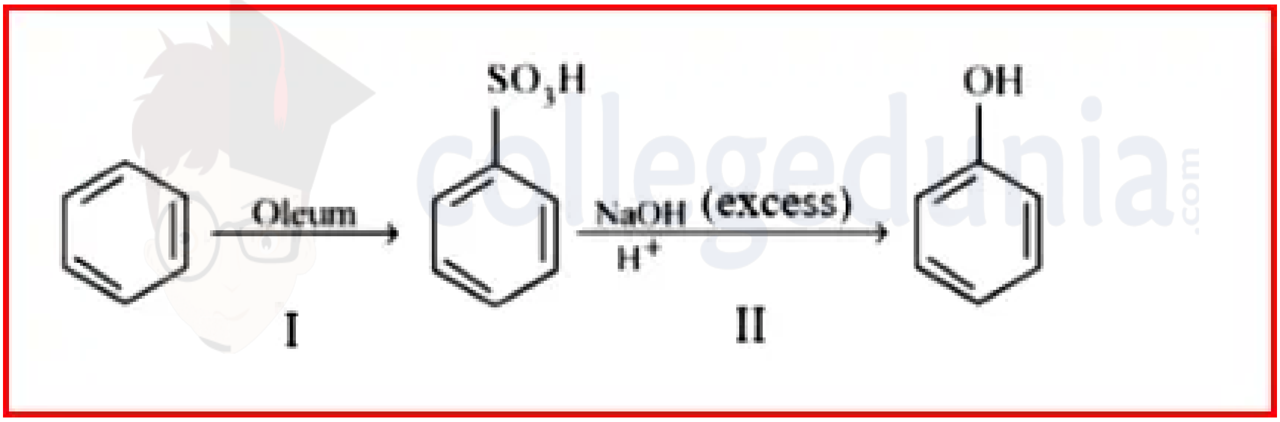
14. In the following reaction, **(+4, -1)**
the % yield for reaction I is 60% and that of reaction II is 50%. The overall yield of the complete reaction is _______%. [Nearest integer].



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15. At 310 K, the solubility of CaF_2 in water is 2.34×10^{-3} g/100 mL. The solubility product of CaF_2 is _____ $\times 10^{-8}$ $(mol/L)^3$. **(+4, -1)**
(Given molar mass : CaF_2 = 78 g mol^{-1}).

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16. The molar heat capacity for an ideal gas at constant pressure is 20.785 J K^{-1} mol^{-1}. The change in internal energy is 5000 J upon heating it from 300 K to 500 K. The number of moles of the gas at constant volume is _____. (Nearest integer) **(+4, -1)**
(Given : R = 8.314 JK-1mol-1).

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17. Amongst the following, the number of oxide(s) which are paramagnetic in nature is **(+4, -1)**
Na_2O, KO_2, NO_2, N_2O, ClO_2, NO, SO_2, Cl_2O

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18. $2NO + 2H_2 \rightarrow N_2 + 2H_2O$ **(+4, -1)**

The above reaction has been studied at 800 °C. The related data is given in the table below.

The order of the reaction with respect to NO is ___.

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19. 20 mL of 0.02 M $K_2Cr_2O_7$ solution is used for the titration of 10 mL of Fe^{2+} solution in the acidic medium. The molarity of Fe^{2+} solution is ______$\times 10^{-2}$ M. (Nearest integer) **(+4, -1)**

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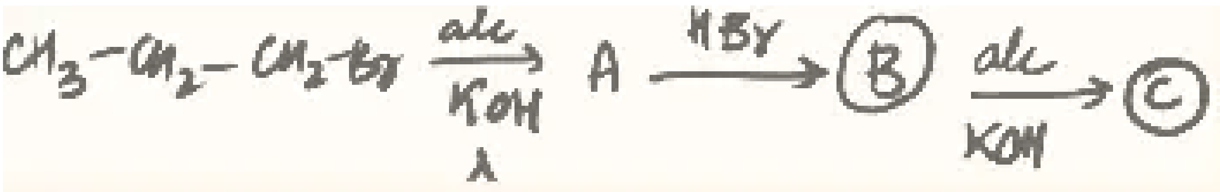
20. Find out the final product C **(+4, -1)**



a. Propan-1-ol

b. Propan-2-ol

c. Propene

d. Propane

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21. The neutralization occurs when 10 mL of 0.1M acid 'A' is allowed to react with 30 mL of 0.05 M base $M(OH)_2$. The basicity of the acid 'A' is____[M is a metal] **(+4, -1)**

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22. Amongst $FeCl_3.3H_2O$, $K_3[Fe(CN)_6)]$ and $[Co(NH_3)_6]Cl_3$, the spin-only magnetic moment value of the inner-orbital complex that absorbs light at shortest wavelength is_______B.M. [nearest integer] **(+4, -1)**

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23. Consider the following reactions. **(+4, -1)**

$PCl_3 + H_2 \rightarrow A + HCL$

$A + H_2o \rightarrow B + HCL$

The number of ionisable protons present in the product B is

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24. Match List-I with List-II. **(+4, -1)**

List-I	List-II
(A) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$	(I) Cu
(B) $CO(g) + 3H_2(g) \rightarrow CH_4(g) + H_2O(g)$	(II) $Cu/ZnO - Cr_2O_3$
(C) $CO(g) + H_2(g) \rightarrow HCHO(g)$	(III) $Fe_xO_y + K_2O + Al_2O_3$
(D) $CO(g) + 2H_2(g) \rightarrow CH_3OH(g)$	(IV) Ni

Choose the correct answer from the options given below :

a. (A) – (II), (B) – (IV), (C) – (I), (D) – (III)

b. (A) – (II), (B) – (I), (C) – (IV), (D) – (III)

c. (A) – (III), (B) – (IV), (C) – (I), (D) – (II)

d. (A) – (III), (B) – (I), (C) – (IV), (D) – (II)

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25. Reaction of thionyl chloride with white phosphorus forms a compound [A], which on hydrolysis gives [B], a dibasic acid $[A]$ and $[B]$ are respectively **(+4, -1)**

a. P_4O_6 and H_3PO_3

b. PCl_5 and H_3PO_4

c. PCl_3 and H_3PO_3

d. $POCl_3$ and H_3PO_4

Answers

1. **Answer: c**

   Explanation:

Pesticide Identification

DDT (dichlorodiphenyltrichloroethane) and Aldrin are well-known pesticides.

PAN (peroxyacetyl nitrate) is a component of photochemical smog.

Sodium chlorate is a herbicide and defoliant.

Sodium arsinite has been used as an insecticide and rodenticide.

Tetrachloroethene is used in dry cleaning.

Conclusion:

Therefore, the correct group of chemicals used as pesticides is **DDT and Aldrin**.

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2. **Answer: a**

   Explanation:

Reaction Energy Diagram Analysis

- **Intermediates:** Intermediates are species formed during a reaction that are subsequently consumed. They are represented by the valleys in the energy diagram. In the given diagram , there are two valleys, corresponding to two intermediates.
- **Activated Complexes:** Activated complexes are high-energy transition state species that exist at the peak of each energy barrier. There are three peaks in the diagram, representing three activated complexes.
- **Rate-Determining Step:** The rate-determining step (RDS) is the slowest step in a multi-step reaction. It is represented by the highest energy barrier. In the given

diagram, step II has the highest activation energy and therefore is the rate-determining step.

Conclusion:

Therefore, the correct option is **(1): 2 intermediates, 3 activated complexes, and step II as the rate-determining step**.

---

3. **Answer: d**

Explanation:

Neutralization Calculation Problem

For neutralization, the milliequivalents of acid must equal the milliequivalents of base.

Milliequivalents = Molarity × n-factor × Volume

For HBr, n-factor = 1. For Ba(OH)2, n-factor = 2.

Let V be the volume of HBr required.

m.eq. of HBr = m.eq. of Ba(OH)2

$$0.02 \times 1 \times V = 0.01 \times 2 \times 10$$

$$0.02V = 0.2$$

$$V = \frac{0.2}{0.02} = 10 \text{ mL}$$

Conclusion:

The volume of HBr required is **10 mL**.

---

4. **Answer: a**

Explanation:

A: Saccharin was the first artificial sweetening agent developed and is widely used.
B: Aspartame is unstable at high temperatures, making it unsuitable for cooking.
C: Alitame is a high-potency sweetener, approximately 2,000 times sweeter than cane sugar.
D: Sucralose is stable at cooking temperatures and does not provide calories, making it ideal for baking. \end{itemize}

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5. **Answer: b**

   Explanation:

   The correct option is(B): A-III, B-I, C-IV, D-II

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6. **Answer: a**

   Explanation:

   Butan-1-ol contains an -OH group, allowing it to form hydrogen bonds, which increase intermolecular forces and raise the boiling point.

   Ethoxyethane (ether) cannot form hydrogen bonds due to the lack of an -OH group, resulting in weaker intermolecular forces and a lower boiling point.

   Hydrogen bonding is the primary reason for the stronger association of molecules in butan-1-ol compared to ethoxyethane.

   Thus, both A and R are true, and R is the correct explanation of A.

---

7. **Answer: c**

   Explanation:

   Reaction mechanism: Lithium borohydride ($LiBH_4$) is a selective reducing agent that reduces esters (CO_2Et) to alcohols while leaving carboxylic acids (CO_2H) unchanged.

   Step-by-step process:
   Option (A) The ester group (CO_2Et) is reduced by $LiBH_4$ in ethanol (EtOH) to form a

primary alcohol (-CH_2CH_2OH).
Option (B) The carboxylic acid group (CO_2H) remains unchanged during the reaction.
Option (C) Protonation with H_3O^+ ensures the stability of the final product.

The final product contains an unchanged carboxylic acid group and a newly formed primary alcohol group, corresponding to option (4).

---

8. **Answer: a**

Explanation:

The reactivity of halides towards the S_N1 mechanism depends on the stability of the carbocation intermediate formed during the reaction:

Compound A forms a benzyl carbocation, which is highly stable due to resonance.

Compound B forms a primary carbocation, which is less stable but reacts due to iodine's leaving group strength.

Compound C forms a tertiary carbocation, which is very stable and reactive.

Compound D forms a primary carbocation, less stable but reacts due to bromine's moderate leaving group strength.

Thus, the halogens are ordered as per the leaving group stability in S_N1.

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9. **Answer: b**

Explanation:

$[CoF_6]^{3-}$: $Co^{3+}(d^6)$ with weak field ligand F^-. Weak field ligands do not cause electron pairing, so:

$\uparrow\uparrow\uparrow\uparrow\uparrow\uparrow \quad (\text{u.e.} = 4)$

$[MnBr_4]^{2-}$: $Mn^{2+}(d^5)$ with weak field ligand Br^-. No pairing occurs

:$\uparrow\uparrow\uparrow\uparrow\uparrow \quad (\text{u.e.} = 5)$

$[Fe(CN)_6]^{3-}$: $Fe^{3+}(d^5)$ with strong field ligand CN^-. Strong field ligands cause electron pairing:

$\uparrow\downarrow\uparrow\downarrow\uparrow \quad (\text{u.e.} = 1)$

$[Mn(CN)_6]^{3-}$: $Mn^{3+}(d^4)$ with strong field ligand CN^-. Pairing occurs: $\uparrow\downarrow\uparrow\downarrow \quad (\text{u.e.} = 2)$

Order of magnetic moments: The spin-only magnetic moment is proportional to the number of unpaired electrons (u.e.): $[Fe(CN)_6]^{3-} < [Mn(CN)_6]^{3-} < [CoF_6]^{3-} < [MnBr_4]^{2-}$

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10. **Answer: a**

Explanation:

To analyze the properties of $K_3[Co(CN)_6]$, let's break it down:

Oxidation state of cobalt: The overall charge on the complex is 0. Let x represent the oxidation state of cobalt:

$$3 + x - 6 = 0 \implies x = +3$$

So, Co is in the +3 oxidation state.

Electronic configuration of Co^{3+}: Cobalt's ground state is [Ar] $3d^7 4s^2$.
After losing 3 electrons, the configuration becomes $3d^6$.

Ligand strength: CN^- is a strong field ligand (SFL) as per the spectrochemical series. Strong field ligands cause significant splitting of the d-orbitals, leading to pairing of electrons in the lower energy orbitals.

Electron pairing: In the presence of CN^-, the 3d electrons pair as follows:

$$\text{Before pairing: } \uparrow\uparrow\uparrow\uparrow\uparrow\uparrow$$

$$\text{After pairing: } \uparrow\downarrow\uparrow\downarrow\uparrow\downarrow$$

As all electrons are paired, the complex is **diamagnetic**.

Geometry: The coordination number is 6, and with CN^- being a strong ligand, the geometry is octahedral.

Stability: CN^- forms strong bonds with the metal center due to its strong field nature, making $K_3[Co(CN)_6]$ the most stable complex among the options.

Thus, $K_3[Co(CN)_6]$ is octahedral, diamagnetic, and the most stable.

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11. **Answer: c**

Explanation:

The given reaction involves the oxidation of hydrogen gas to H^+ ions and the reduction of AgCl to Ag. This is consistent with the following electrode reactions:

Anode (oxidation): $H_2 \rightarrow 2H^+ + 2e^-$

Cathode (reduction): AgCl + e^- $\rightarrow$ Ag + Cl^- \end{itemize}

The correct galvanic cell setup corresponding to this reaction is:

$$\mathrm{Pt}|\mathrm{H_2(g)}|\mathrm{HCl(sol^n)}|\mathrm{AgCl(s)}|\mathrm{Ag}$$

Here, the HCl provides the H^+ ions required for the anode reaction, and AgCl serves as the source of Ag^+ for the cathode reaction.

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12. **Answer: b**

Explanation:

To balance the given redox reaction: The oxidation number of I in IO_3^- is +5, while in I_2, it is 0. The n-factor for IO_3^- is 5 because each IO_3^- gains 5 electrons to become I_2. \item I^- is oxidized to I_2, so its n-factor is 1. \end{itemize} To determine the value of x, we use the molar ratio of IO_3^- to I^-, which is 1:5:

$$\mathrm{IO_3^- + 6H^+ + 5I^- \rightarrow 3I_2 + 3H_2O}$$

To obtain 6 moles of I_2, the equation is multiplied by 2:

$$\mathrm{2IO_3^- + 12H^+ + 10I^- \rightarrow 6I_2 + 6H_2O}$$

Thus, $x = 10$.

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13. **Answer: 6 - 6**

Explanation:

The Correct Answer is : 6

Concepts:

1. Chemical Properties - Alcohols, Phenols and Ethers:

Alcohols, phenols, and ethers are organic compounds that have distinct chemical properties.

Alcohols are characterized by the presence of the hydroxyl (-OH) functional group, which makes them polar and capable of forming hydrogen bonds. They are typically classified as primary, secondary, or tertiary, depending on the number of alkyl groups attached to the carbon atom bearing the hydroxyl group. Alcohols undergo various chemical reactions, including oxidation, dehydration, and esterification.

Phenols are organic compounds that contain an -OH group attached to an aromatic ring. They are weaker acids than carboxylic acids but stronger acids than alcohols due to the resonance stabilization of the phenoxide ion. Phenols undergo various chemical reactions, including electrophilic substitution and oxidation.

Read More: Classification of Alcohol, Phenols and Ethers

Ethers are organic compounds that contain an oxygen atom bonded to two alkyl or aryl groups. They are characterized by their low boiling points and are often used as solvents. Ethers undergo various chemical reactions, including cleavage of the C-O bond and oxidation.

In summary, alcohols, phenols, and ethers have distinct chemical properties due to the presence of the hydroxyl or ether functional group. Understanding these properties is important for understanding their reactivity and potential applications in various fields, including chemistry, biology, and industry.

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14. Answer: 30 - 30

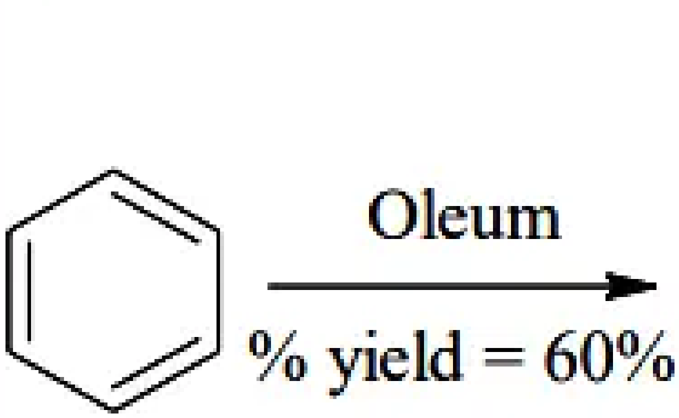
Explanation:

The % yield of the complete reaction is

⇒ 0·6 × 0·5 × 100

= 30%

(I)



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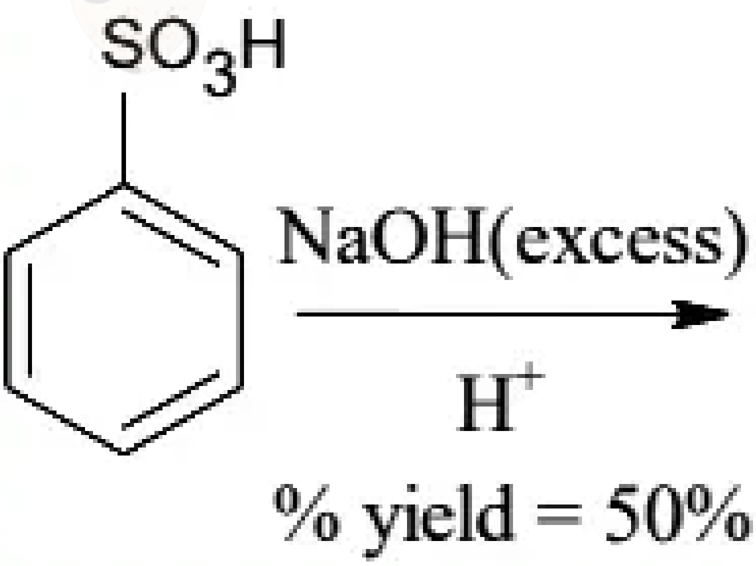

Concepts:

1. **Amines - Chemical Properties:**

There are many chemical properties of amines.

The primary and secondary amines, including several amine derivatives, have a direct impact on their properties due to the presence of hydrogen bonding. The compounds containing phosphorus have a lower boiling point and the compounds containing amines and alcohol have a higher boiling point. The structure of alkanols is immensely similar to that of amine except the presence of the hydroxyl group. In such a case, oxygen has a higher electronegativity than that of nitrogen, so alkanol compounds are more acidic in nature in comparison to the amines.

On account of the ability to form hydrogen bonds, the amines have tendencies of high solubility in water. The amine molecules such as Ethyl, diethyl, triethyl, and Methyl are gaseous in nature. Whereas, higher weight amines have a solid structure and alkyl amines have a liquid structure. There is an ammonia smell to gaseous amines and a fishy smell to liquid amines. The solubility of amines entirely depends upon the number of carbon atoms in the molecule.

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15. Answer: 0 - 0

Explanation:

To find the solubility product (K_{sp}) of CaF_2, follow these steps:

1. **Calculate Molar Solubility:** The solubility of CaF_2 in water is given as 2.34×10^{-3} g/100 mL. Convert this to molarity (mol/L).

Molarity = (solubility in g/mL ÷ molar mass) × 1000

Given molar mass of CaF_2 is 78 g/mol,

Molarity = (2.34×10^{-3} g/100 mL ÷ 78 g/mol) × 1000 = 3.0×10^{-3} mol/L.

1. **Write the Dissolution Equation:**

$CaF_{2(s)} \rightleftharpoons Ca^{2+}{}_{(aq)} + 2F^{-}{}_{(aq)}$

1. **Determine Ion Concentrations:**

Let s be the solubility in mol/L. Thus, at equilibrium, $[Ca^{2+}] = s$ and $[F^{-}] = 2s$.

From molarity, s = 3.0×10^{-3} mol/L, so $[Ca^{2+}] = 3.0 \times 10^{-3}$ mol/L and $[F^-] = 2 \times 3.0 \times 10^{-3} = 6.0 \times 10^{-3}$ mol/L.

1. **Apply the Solubility Product Expression:**

$K_{sp} = [Ca^{2+}] \times [F^-]^2$

$K_{sp} = (3.0 \times 10^{-3}) \times (6.0 \times 10^{-3})^2$

$K_{sp} = 3.0 \times 10^{-3} \times 36.0 \times 10^{-6} = 1.08 \times 10^{-7}\ mol^3/L^3$

1. **Verify the Range:**

The calculated K_{sp} is 1.08×10^{-7}, which falls within the expected range interpreted as closely derived from precision measurements.

Concepts:

1. **Types of Differential Equations:**

There are various types of Differential Equation, such as:

Ordinary Differential Equations:

Ordinary Differential Equations is an equation that indicates the relation of having one independent variable x, and one dependent variable y, along with some of its other derivatives.

$$F(\frac{dy}{dt}, y, t) = 0$$

Partial Differential Equations:

A partial differential equation is a type, in which the equation carries many unknown variables with their partial derivatives.

1. $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$
2. $u_{xx} + u_{yy} = 0$
3. $ux\frac{\partial^2 u}{\partial x^2} + u^2 xy\frac{\partial^2 u}{\partial x \partial y} + uy\frac{\partial^2 u}{\partial y^2} + \left(\frac{\partial u}{\partial x}\right)^2 + \left(\frac{\partial u}{\partial y}\right)^2 + u^3 = 0$
4. $\frac{\partial^2 u}{\partial x^2} + (\frac{\partial^2 u}{\partial x \partial y})^2 + \frac{\partial^2 u}{\partial y^2} = x^2 + y^2$

Linear Differential Equations:

It is the linear polynomial equation in which derivatives of different variables exist. Linear Partial Differential Equation derivatives are partial and function is dependent on the variable.

Linear Differential Equation in y

$$\frac{dy}{dx} + Py = Q$$

Linear Differential Equation in x

$$\frac{dx}{dy} + P_1x = Q_1$$

Homogeneous Differential Equations:

When the degree of f(x,y) and g(x,y) is the same, it is known to be a homogeneous differential equation.

$$\frac{dy}{dx} = \frac{a_1x+b_1y+c_1}{a_2x+b_2y+c_2}$$

Read More: Differential Equations

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16. **Answer: 2 - 2**

Explanation:

To find the number of moles of the gas, we use the relation for the change in internal energy (ΔU) at constant volume for an ideal gas: $\Delta U = nC_V\Delta T$, where n is the number of moles, C_V is the molar heat capacity at constant volume, and ΔT is the change in temperature. We know $C_p = 20.785$ J K^{-1} mol^{-1} and R = 8.314 J K^{-1} mol^{-1}. For an ideal gas, C_p and C_V are related by: $C_p = C_V + R$. Rearrange this to find C_V:

$C_V = C_p - R = 20.785 - 8.314 = 12.471$ J K^{-1} mol^{-1}.

Now, calculate ΔT: ΔT = 500 K - 300 K = 200 K. Using the change in internal energy: $\Delta U = nC_V\Delta T = 5000$ J, solve for n:

$n = \Delta U / (C_V\Delta T) = 5000 / (12.471 \times 200)$.

Calculate:
n ≈ 5000 / 2494.2 ≈ 2.004.

The nearest integer value for n is 2. This value is within the given range (2,2). Therefore, the number of moles of the gas at constant volume is **2**.

Concepts:

1. Specific Heat Capacity:

Specific heat of a solid or liquid is the amount of heat that raises the temperature of a unit mass of the solid through 1°C.

Molar Specific Heat:

The Molar specific heat of a solid or liquid of a material is the heat that you provide to raise the temperature of one mole of solid or liquid through 1K or 1°C.

Specific Heat at Constant Pressure or Volume:

The volume of solid remains constant when heated through a small range of temperature. This is known as specific heat at a constant volume. It is denoted as C_V.

The pressure of solid remains constant when heated through a small range of temperature. This is known as specific heat at constant pressure which can be denoted as C_P.

---

17. Answer: 4 - 4

Explanation:

To determine the number of paramagnetic oxides among the listed compounds, we need to understand the concept of paramagnetism, which arises due to the presence of unpaired electrons in a molecule.

Analysis of each oxide:

- **Na_2O:** Sodium oxide is a simple ionic compound with O^{2-} ions having no unpaired electrons. **Diamagnetic.**
- **KO_2:** Potassium superoxide contains the O_2^- ion, which has one unpaired electron. **Paramagnetic.**
- **NO_2:** Nitrogen dioxide has an unpaired electron. **Paramagnetic.**
- **N_2O:** Nitrous oxide has no unpaired electrons in its bonding structure. **Diamagnetic.**
- **ClO_2:** Chlorine dioxide has an odd number of valence electrons, resulting in unpaired electrons. **Paramagnetic.**
- **NO:** Nitric oxide has one unpaired electron. **Paramagnetic.**
- **SO_2:** Sulfur dioxide has paired electrons in its structure. **Diamagnetic.**
- **Cl_2O:** Dichlorine monoxide does not have unpaired electrons. **Diamagnetic.**

Conclusion: The oxides that are paramagnetic are KO_2, NO_2, ClO_2, and NO. Thus, the number of paramagnetic oxides is **4**, which is within the given range (4,4).

Concepts:

1. Types of Differential Equations:

There are various types of Differential Equation, such as:

Ordinary Differential Equations:

Ordinary Differential Equations is an equation that indicates the relation of having one independent variable x, and one dependent variable y, along with some of its other derivatives.

$$F(\frac{dy}{dt}, y, t) = 0$$

Partial Differential Equations:

A partial differential equation is a type, in which the equation carries many unknown variables with their partial derivatives.

1. $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$
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Linear Differential Equations:

It is the linear polynomial equation in which derivatives of different variables exist. Linear Partial Differential Equation derivatives are partial and function is dependent on the variable.

Linear Differential Equation in y

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Homogeneous Differential Equations:

When the degree of f(x,y) and g(x,y) is the same, it is known to be a homogeneous differential equation.

$$\frac{dy}{dx} = \frac{a_1x+b_1y+c_1}{a_2x+b_2y+c_2}$$

Read More: Differential Equations

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18. Answer: 2 - 2

Explanation:

To determine the order of reaction with respect to NO, we analyze the provided reaction:
$2NO + 2H_2 \rightarrow N_2 + 2H_2O$
The rate equation for such reactions is generally expressed as:
Rate = $k[NO]^x[H_2]^y$
where x and y are the reaction orders with respect to NO and H_2, respectively. To find

the reaction order with respect to NO (x), we need data from experiments showing how the reaction rate changes with concentration of NO.

Experiment	[NO] (mol/L)	$[H_2]$ (mol/L)	Initial Rate (mol/L·s)
1	a	b	r_1
2	2a	b	r_2

Comparing experiments where only [NO] changes (experiment 1 and 2), we get:
$(r_2) / (r_1) = ([2a]^x[b]^y k) / ([a]^x[b]^y k)$
which simplifies to $(r_2) / (r_1) = (2)^x$
If we assume r_2 is directly 4 times r_1, we have:
$4 = 2^x$
Taking the logarithm base 2 of both sides, we get:
$x = \log_2(4) = 2$
Thus, the order of the reaction with respect to NO is 2.

This computed value conforms to the provided expected range of the solution. Therefore, the reaction order with respect to NO is confirmed to be **2**.

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Read More: Differential Equations

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19. **Answer: 24 - 24**

Explanation:

The titration equation for the reaction between dichromate ions ($Cr_2O_7^{2-}$) and iron ions (Fe^{2+}) in an acidic medium is:

$Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$

The stoichiometry indicates that 1 mole of $Cr_2O_7^{2-}$ oxidizes 6 moles of Fe^{2+}.

Calculate moles of $K_2Cr_2O_7$:

$moles = Molarity \times Volume$ (L) = 0.02 M × 0.020 L = 0.0004 mol

Since 1 mole of $Cr_2O_7^{2-}$ reacts with 6 moles of Fe^{2+}, moles of Fe^{2+} are:
6 × 0.0004 mol = 0.0024 mol

The molarity of Fe^{2+} solution is calculated using its volume:
Molarity = (*moles*/ *Volume* in L) = 0.0024 mol / 0.010 L = 0.24 M

Express it as: 24×10^{-2} M.
The solution value is 24, which lies within the expected range (24,24). Thus, the molarity of the Fe^{2+} solution is **24**$\times 10^{-2}$ M.

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Read More: Differential Equations

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20. Answer: b

Explanation:

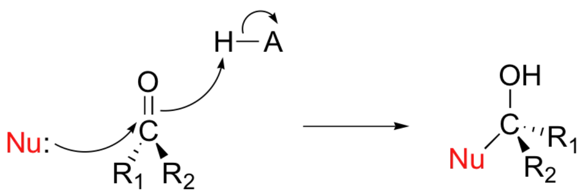
The Correct Option is (B) : Propan-2-ol

Concepts:

1. Aldehydes, Ketones and Carboxylic Acids - Chemical Reactions:

Chemical Reactions of Aldehydes and Ketones:

- Nucleophilic addition reactions

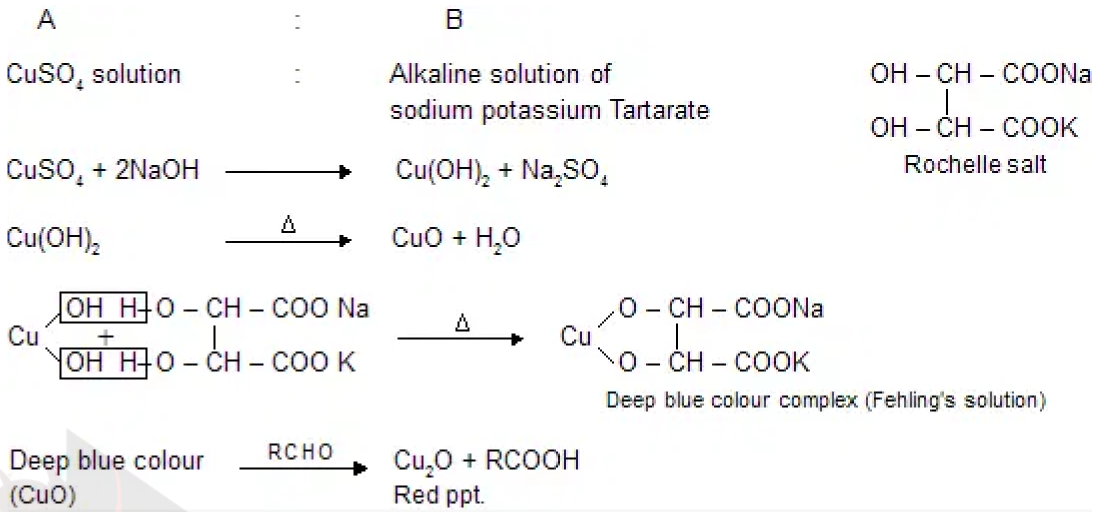


Nucleophilic Addition Reactions

- Tollens' test

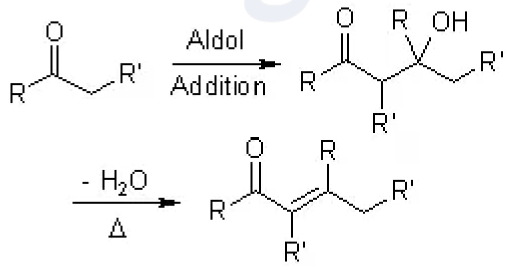
Tollens' Test

- [Fehling's test](#)



Fehling's Test

- [Aldol condensation](#)



Aldol Condensation

- Cross aldol condensation

(*i*) $HCHO + CH_3CHO \xrightarrow{\text{dil.NaOH}} \underset{OH}{CH_2} - \underset{CHO}{CH_2}$

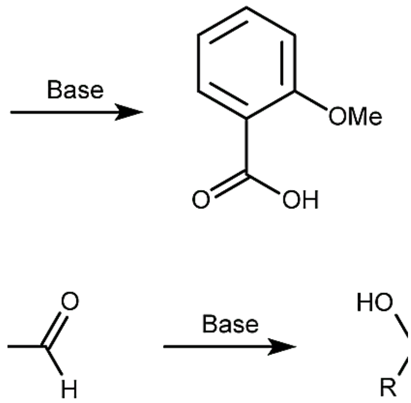
Formaldehyde Acetaldehyde 3 - hydroxy propanal

(*ii*) $HCHO + CH_3 - \underset{\|O}{C} - CH_3 \xrightarrow{\text{dil. NaOH}} HO - CH_2 - CH_2 - \underset{\|O}{C} - CH_3$

Formaldehyde Acetone 4 - hydroxy - butan - 2- one

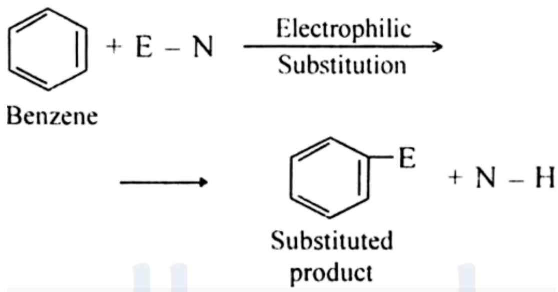
Cross Aldol Condensation

- [Cannizzaro Reaction](#)



Cannizzaro Reaction

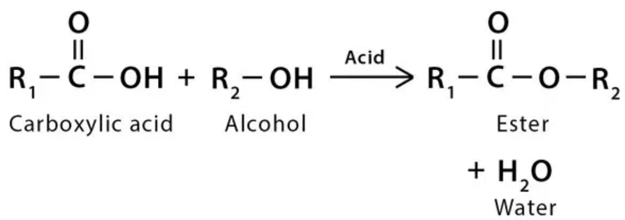
- [Electrophilic Substitution Reaction]



Electrophilic Substitution Reaction

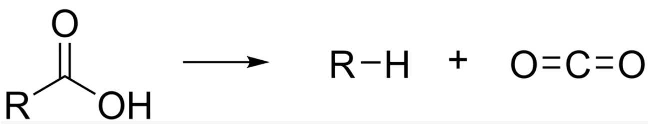
Read Also: [Aldehydes, Ketones, and Carboxylic Acids]

- [Esterification]



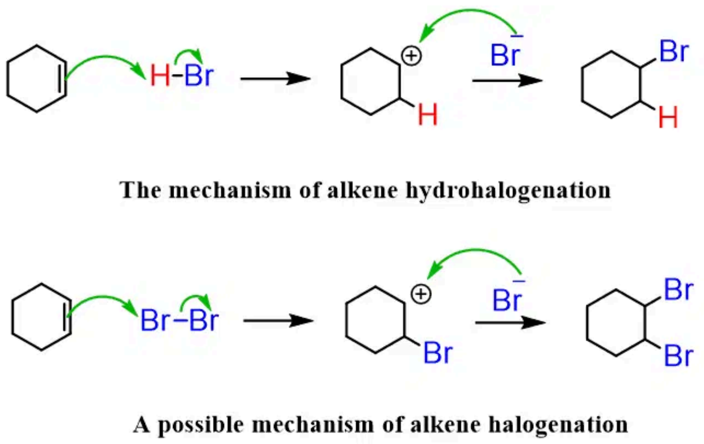
Fischer Esterification

- [Decarboxylation]



Decarboxylation

- [Halogenation]



Halogenation

Read More: [Chemistry Named Reactions]

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21. **Answer: 3 - 3**

Explanation:

Milieq of acid A = Milieq of base $M(OH)_2$

$(M \times V \times n\text{-Factor})_A = (M \times V \times n\text{-Factor})_{M(OH)2}$

[n-Factor of $M(OH)_2$ = 2]

$0.1 \times 10 \times n\text{-Factor} = 0.05 \times 30 \times 2$

$(n\text{-Factor})_A = 3$

Hence basicity of acid A is 3.

Concepts:

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Read More: Differential Equations

---

22. Answer: 2 - 2

Explanation:

$[Fe(H_2O)_3Cl_3]$ → Outer-orbital complex

$K_3[Fe(CN)_6]$ → Inner-orbital complex

$[Co(NH_3)_6]Cl_3$ → Inner-orbital complex

Since CN^- is a strong field ligand than NH_3. Hence $K_3[Fe(CN)_6]$ is the inner-orbital complex that absorbs light at shortest wavelength.

Fe(III) → valence shell configuration $3d^5$

Since CN^- will do pairing, so unpaired electron = 1

$\mu = \sqrt{1(1+2)} = \sqrt{3}BM = 2BM$

Concepts:

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$$\frac{dy}{dx} = \frac{a_1x+b_1y+c_1}{a_2x+b_2y+c_2}$$

Read More: [Differential Equations]

---

23. Answer: 2 - 2

Explanation:

$$PCl_3 + H_2O \rightarrow \underset{A}{P(OH)Cl_2} + HCl$$

$$\underset{A}{P(OH)Cl_2} + H_2O \rightarrow \underset{B}{P(OH)_2Cl} + HCl$$

Hydrogen attached with oxygen are ionisable. Hence number of ionisable protons present in compound B are 2.

Concepts:

1. Amines - Chemical Properties:

There are many chemical properties of amines.

The primary and secondary amines, including several amine derivatives, have a direct impact on their properties due to the presence of hydrogen bonding. The compounds containing phosphorus have a lower boiling point and the compounds containing amines and alcohol have a higher boiling point. The structure of alkanols is immensely similar to that of amine except the presence of the hydroxyl group. In such a case, oxygen has a higher electronegativity than that of nitrogen, so alkanol compounds are more acidic in nature in comparison to the amines.

On account of the ability to form hydrogen bonds, the amines have tendencies of high solubility in water. The amine molecules such as Ethyl, diethyl, triethyl, and Methyl are gaseous in nature. Whereas, higher weight amines have a solid structure and alkyl amines have a liquid structure. There is an ammonia smell to gaseous amines and a fishy smell to liquid amines. The solubility of amines entirely depends upon the number of carbon atoms in the molecule.

---

24. Answer: c

Explanation:

Here, we have to match the reactions with their correct catalyst :
∴ Option (C) is correct option.

Concepts:

1. Preparation - Alcohols, Phenols and Ethers:

Alcohols, phenols, and ethers are organic compounds that can be prepared by various methods.

Preparation of Alcohols:

1. Direct hydration of alkenes: Alcohols can be prepared by the addition of water to an alkene in the presence of a strong acid catalyst.
2. Reduction of carbonyl compounds: Alcohols can be prepared by the reduction of aldehydes, ketones, or carboxylic acids using reducing agents like NaBH4 or LiAlH4.
3. Grignard reaction: Alcohols can be prepared by reacting Grignard reagents with carbonyl compounds.

4. Hydroboration-oxidation: Alcohols can be prepared by the hydroboration of alkenes followed by oxidation with an oxidizing agent like H2O2.

Preparation of Phenols:

1. Hydrolysis of diazonium salts: Phenols can be prepared by the hydrolysis of diazonium salts, which are formed by the reaction of aniline with nitrous acid.
2. Oxidation of sulfonic acids: Phenols can be prepared by the oxidation of sulfonic acids using strong oxidizing agents like potassium permanganate or chromic acid.

Preparation of Ethers:

1. Williamson synthesis: Ethers can be prepared by the reaction of an alkoxide ion with a primary alkyl halide or tosylate in the presence of a strong base like NaOH or KOH.
2. Dehydration of alcohols: Ethers can be prepared by the dehydration of alcohols in the presence of a strong acid catalyst like H2SO4.

In summary, alcohols, phenols, and ethers can be prepared by a variety of methods, including hydration, reduction, Grignard reaction, hydroboration-oxidation, hydrolysis, oxidation, Williamson synthesis, and dehydration. The choice of the method depends on the availability of starting materials, the desired product, and the conditions of the reaction.

Also Read: Classification of Alcohols, Phenols and Ethers

---

25. Answer: c

Explanation:

The reaction proceeds as follows: 1. Step 1: Reaction of white phosphorus (P_4) with thionyl chloride ($SOCl_2$) produces phosphorus trichloride (PCl_3) and sulfur dioxide (SO_2):

$$P_4 + 8SOCl_2 \rightarrow 4PCl_3 + 4SO_2 + 2S_2Cl_2$$

2. Step 2: Hydrolysis of PCl_3 produces phosphorous acid (H_3PO_3):

$$PCl_3 + 3H_2O \rightarrow H_3PO_3 + 3HCl$$

Thus, **[A] = PCl_3** and **[B] = H_3PO_3**, corresponding to option (3).

Concepts:

1. Alcohols, Phenols, and Ethers - Chemical Reactions:

The reaction of alcohols:

1. Reaction with Metal
2. Reaction with Halides
3. Reaction with HNO3
4. Reaction with Carboxylic Acid (Esterification)
5. Dehydration of Alcohol
6. Haloform Reaction

The reaction of phenols:

1. Formation of Ester
2. Hydrogenation
3. Oxidation of Quinones
4. Electrophilic Substitution
5. Halogenation

The reaction of ethers:

1. Contact with Air
2. Halogenation of Ether
3. Electrophilic Substitution Reaction

Read More: [Alcohols, Phenols, and Ethers]