Aldehydes, Ketones and Carboxylic Acids JEE Main PYQ - 1

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.

Aldehydes, Ketones and Carboxylic Acids

1. **Iodoform test can differentiate :** (+4, -1)

   a. Anisole and Acetone

   b. Acetic acid and Aniline

   c. Ethanol and Acetone

   d. Methanol and benzoic acid

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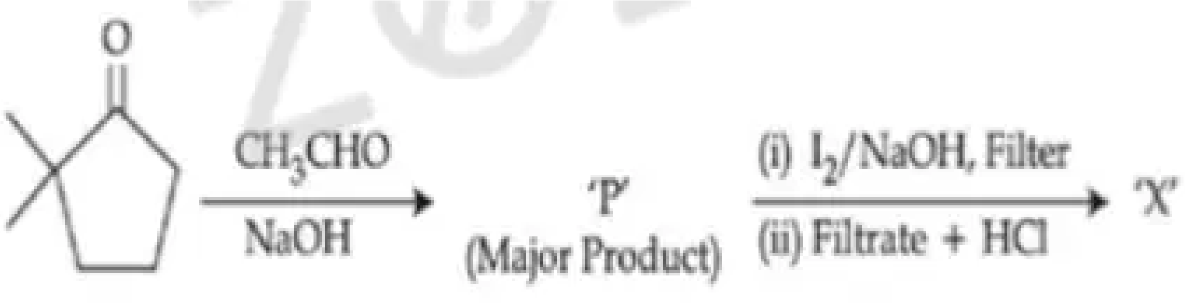
2. **Which one of the following carbonyl compounds cannot be prepared by addition of water on an alkyne in the presence of $HgSO_4$ and H_2SO_4 ?** (+4, -1)

   a. Formaldehyde

   b. Acetaldehyde

   c. Propanal

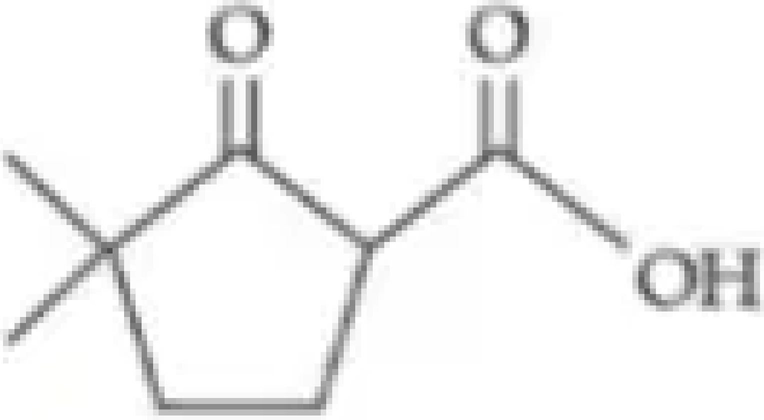
   d. 2-Butanone



3. (+4, -1)

   Consider the given reaction, the product 'X' is:

(A)



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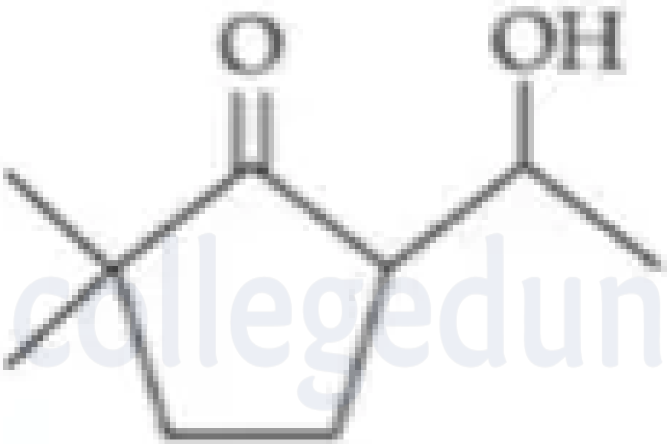
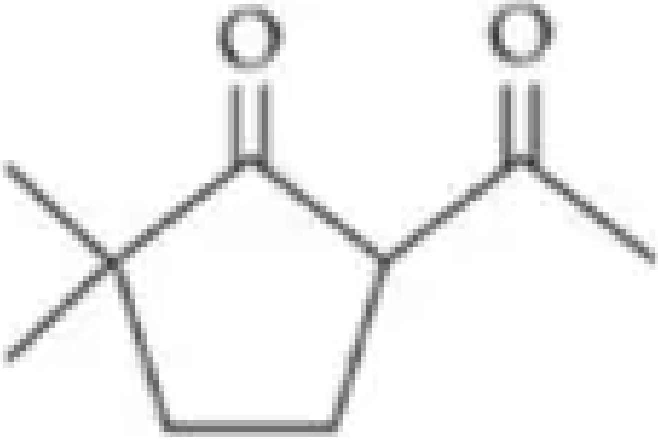


(C)



(D)

a. A

b. B

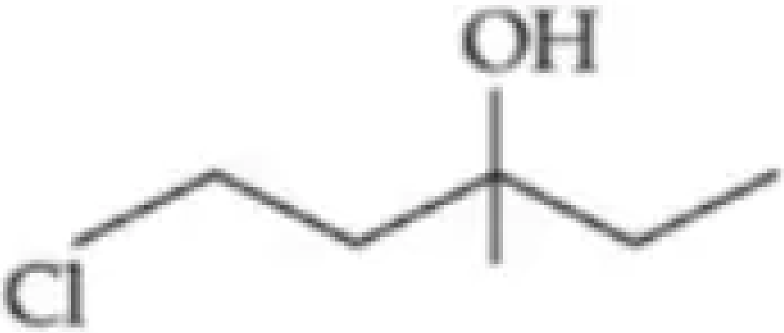
c. C

d. D

4. (+4, -1)

Consider the following reaction, the major product 'P' is:

(A)



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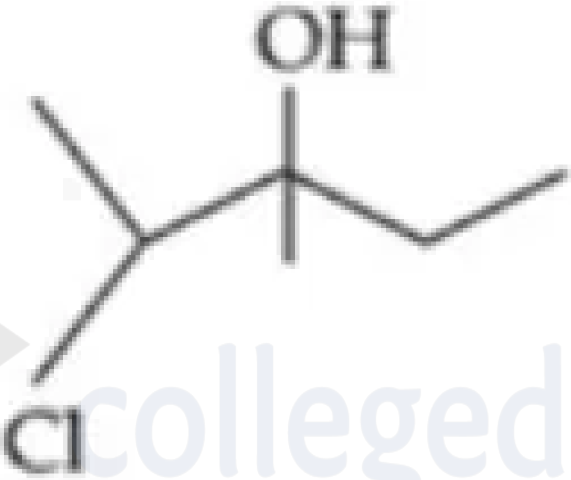
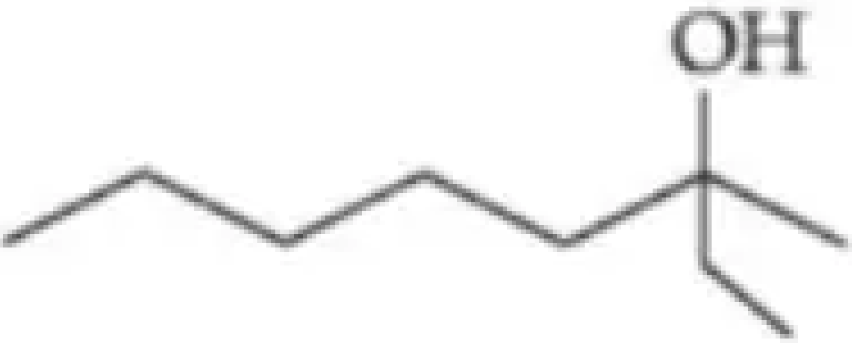


(C)



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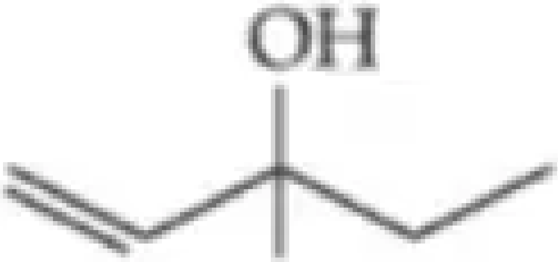


a. A

b. B

c. C

d. D

---

5. **Consider the above reaction and identify "Y".** **(+4, -1)**

$$R - CN \xrightarrow[\text{ii) } H_2O]{\text{i) DIBAL-H}} R - Y$$

a. -- COOH

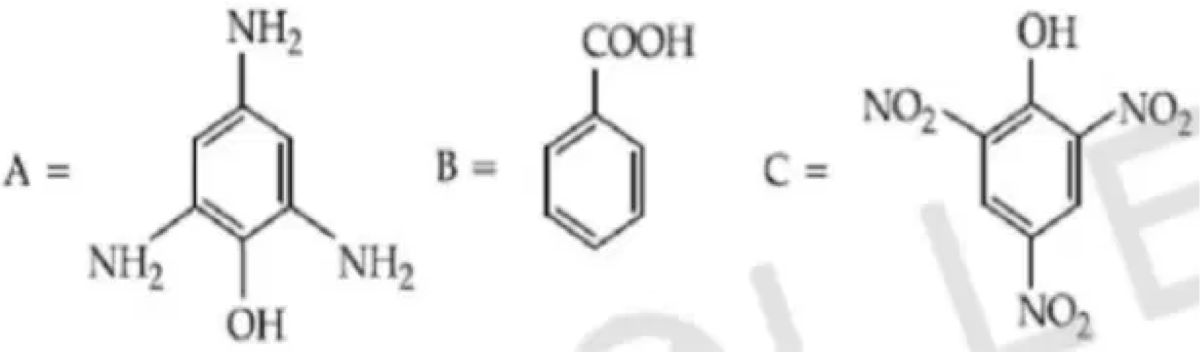
b. -- CH_2NH_2

c. -- CHO

d. -- $CONH_2$

---

6. **Compound(s) which will liberate carbon dioxide with sodium bicarbonate ($NaHCO_3$) solution is/are : A = Urea, B = Benzoic acid, C = p-Nitrophenol** **(+4, -1)**



a. A and B only

b. C only

c. B and C only

d. B only

---

7. **The major product of the following reaction is :** **(+4, -1)**
$CH_3CH_2CH{=}CH_2 + H_2/CO \xrightarrow{\text{Rh catalyst}}$

a. $CH_3CH_2CH_2CH_2CHO$

b. $CH_3CH_2CH_2CHO$

c. $CH_3CH_2CH{=}CH{-}CHO$

d. $CH_3CH_2C({=}CH_2)CHO$

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8. **The structures of A and B formed in the following reaction are : [Ph =** $-C_6H_5$ **]** **(+4, -1)**

a. A

b. B

c. C

d. D

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9. **For the reaction given below :** **(+4, -1)**
The compound which is not formed as a product in the reaction is a :

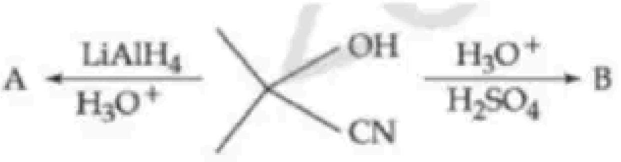
a. diol

b. dicarboxylic acid

c. compound with both alcohol and acid functional groups

d. monocarboxylic acid

10. **The major products A and B in the following set of reactions are :** **(+4, -1)**

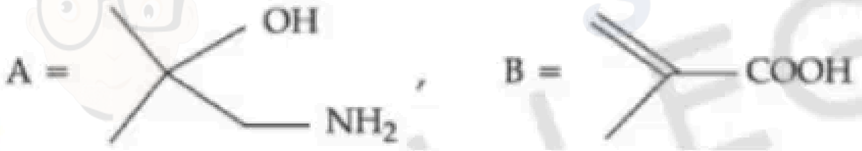


(A)

(B)

(C)

(D)



a. A

b. B

c. C

d. D

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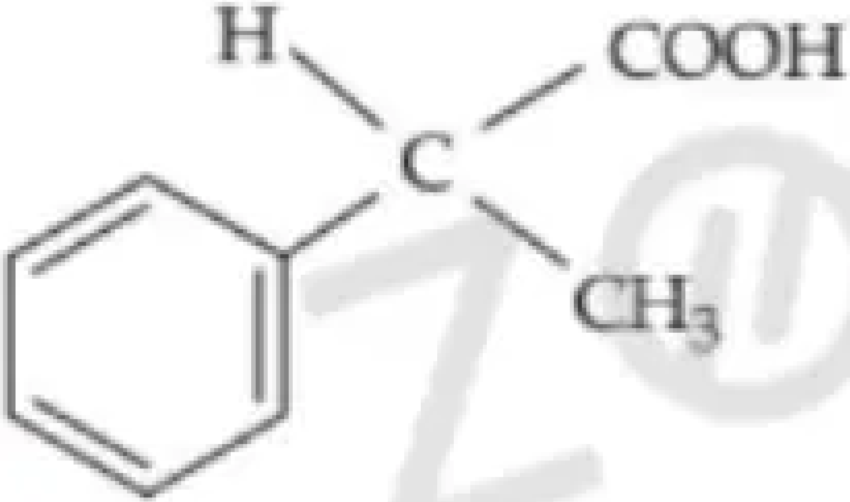
11. **The structure of product C, formed by the following sequence of reactions is :** **(+4, -1)**

$CH_3COOH + SOCl_2 \rightarrow A \xrightarrow[\text{AlCl}_3]{\text{Benzene}} B \xrightarrow[{}^{-}OH]{\text{KCN}} C$

(A)



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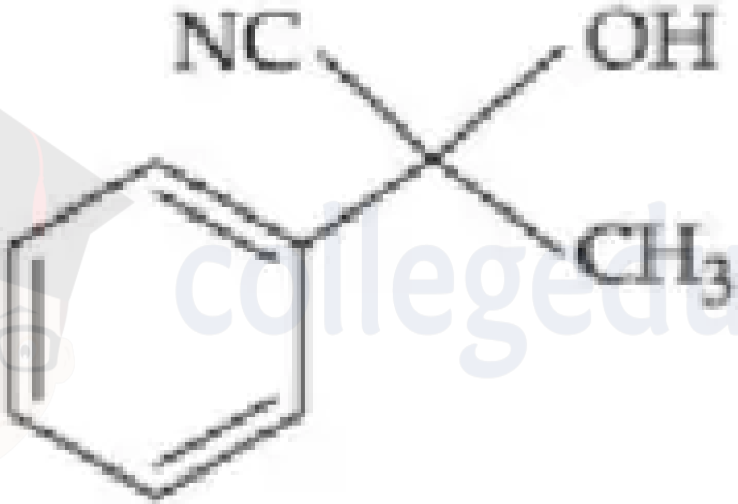
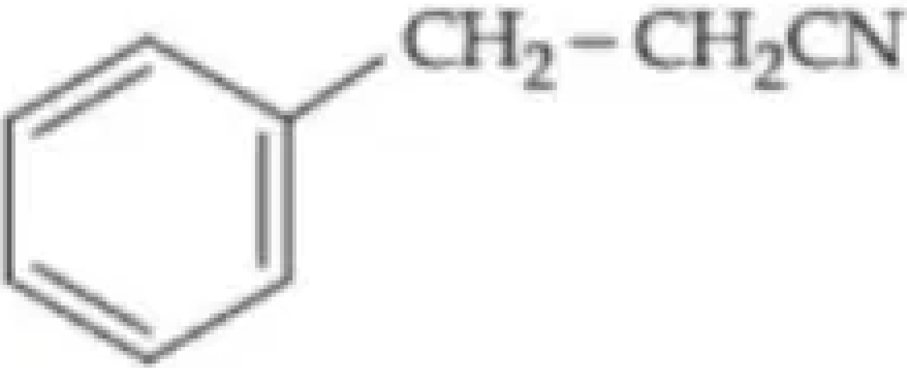
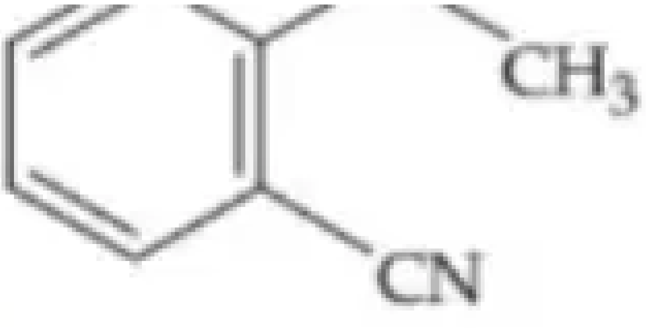


(C)



(D)



a. A

b. B

c. C

d. D

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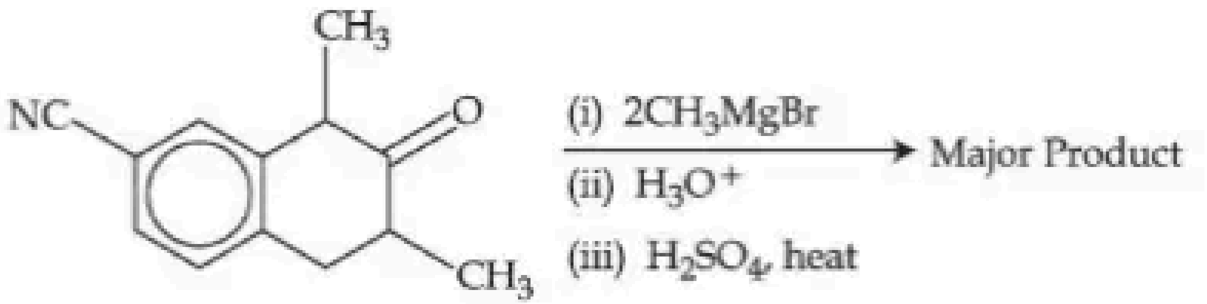
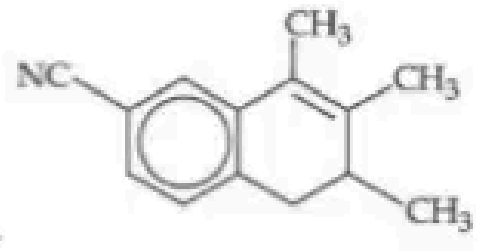
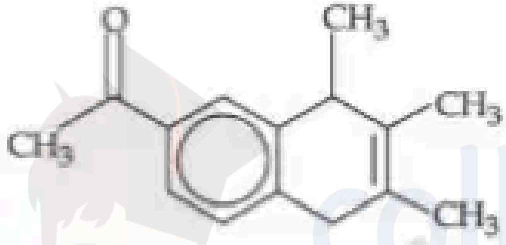
12. **Which one of the following is the major product of the given reaction ?** **(+4, -1)**


CH$_3$
NC
O
CH$_3$
(i) 2CH$_3$MgBr
(ii) H$_3$O$^+$
(iii) H$_2$SO$_4$, heat
Major Product

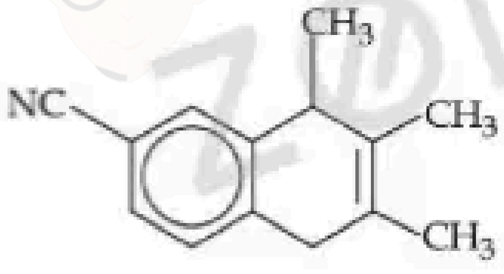
(A)


CH$_3$
NC
CH$_3$
CH$_3$

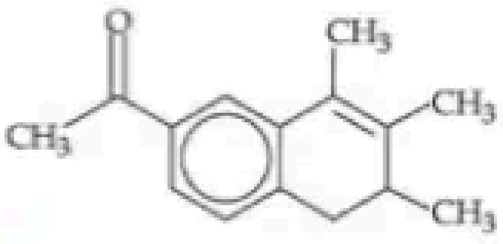
(B)


O
CH$_3$
CH$_3$
CH$_3$
CH$_3$

(C)


CH$_3$
NC
CH$_3$
CH$_3$

(D)


O
CH$_3$
CH$_3$
CH$_3$
CH$_3$

a. A

b. B

c. C

d. D

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13. Which one of the following reactions will not yield propionic acid ? **(+4, -1)**

a. $CH_3CH_2CH_3$ + $KMnO_4$(Heat), OH^-/H_3O^+

b. $CH_3CH_2CCl_3$ + OH^-/H_3O^+

c. $CH_3CH_2COCH_3$ + OI^-/H_3O^+

d. $CH_3CH_2CH_2Br$ + Mg, CO_2 dry ether$/H_3O^+$

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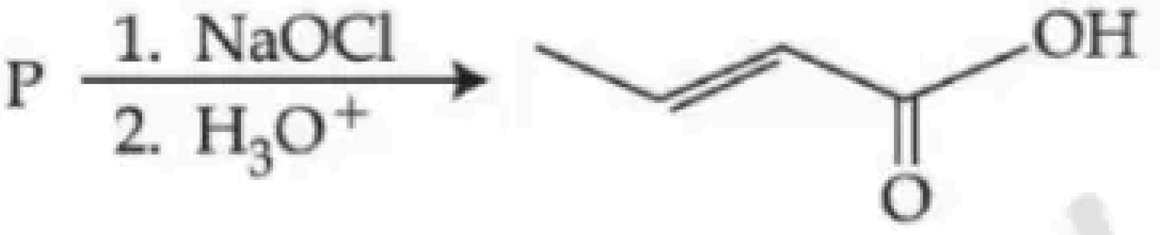
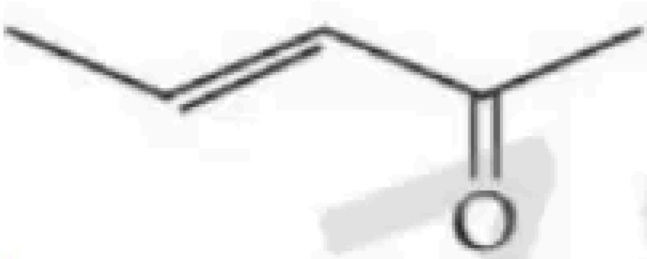
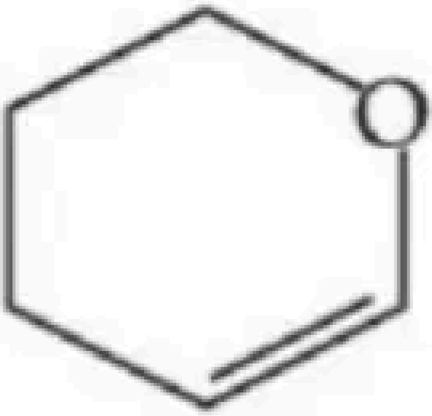
14. The structure of the starting compound P used in the reaction given below is: **(+4, -1)**



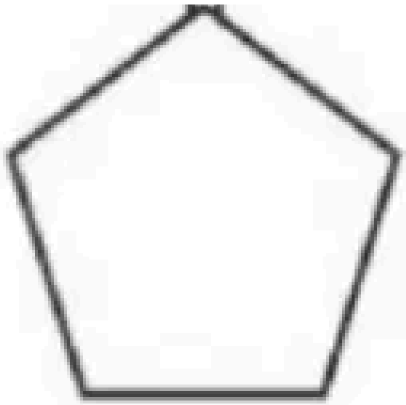


(A)

(B)



(C)

(D) 

a. A

b. B

c. C

d. D

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15. The correct sequential addition of reagents in the preparation of 3-nitrobenzoic acid from benzene is : (+4, -1)

a. $HNO_3/H_2SO_4,\ Br_2/AlBr_3,\ Mg/ether,\ CO_2,\ H_3O^+$

b. $Br_2/AlBr_3,\ NaCN,\ H_3O^+,\ HNO_3/H_2SO_4$

c. $Br_2/AlBr_3,\ HNO_3/H_2SO_4,\ NaCN,\ H_3O^+$

d. $Br_2/AlBr_3,\ HNO_3/H_2SO_4,\ Mg/ether,\ CO_2,\ H_3O^+$

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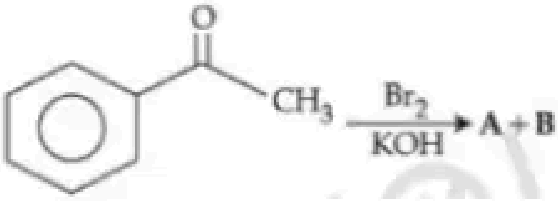
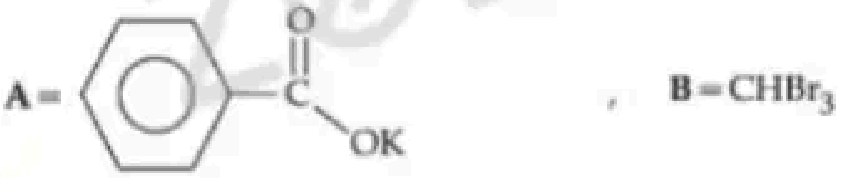
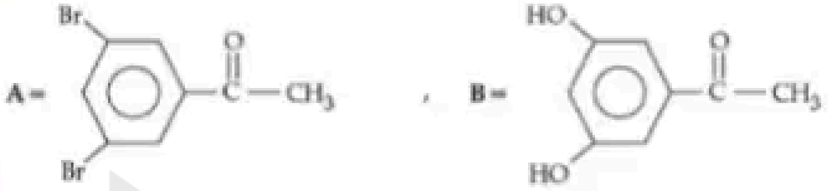
16. The major products formed in the following reaction sequence A and B are : (+4, -1)





(A)



(B)

(C)

(D)

a. A

b. B

c. C

d. D

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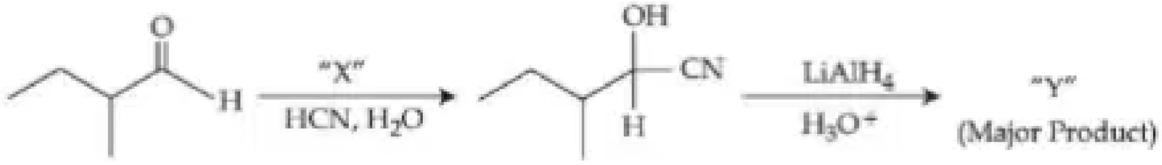
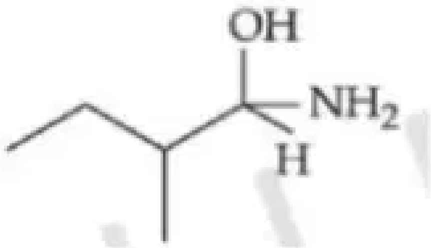
17. **Consider the given reaction, Identify 'X' and 'Y' :** **(+4, -1)**

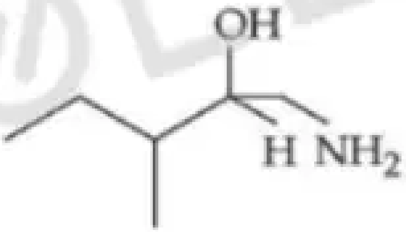


X - NaOH

Y -


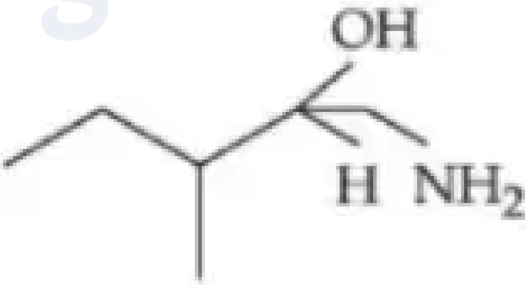
(A)

X - HNO_3

Y -


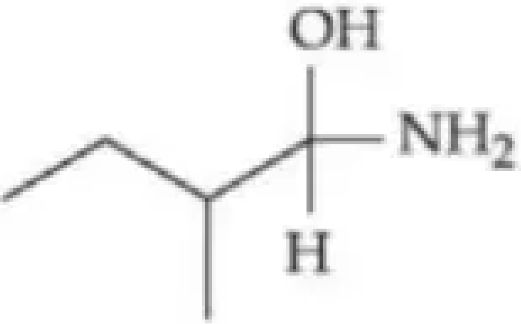
(B)

X - NaOH

Y -


(C)

X - HNO_3

Y -


(D)

a. A

b. B

c. C

d. D

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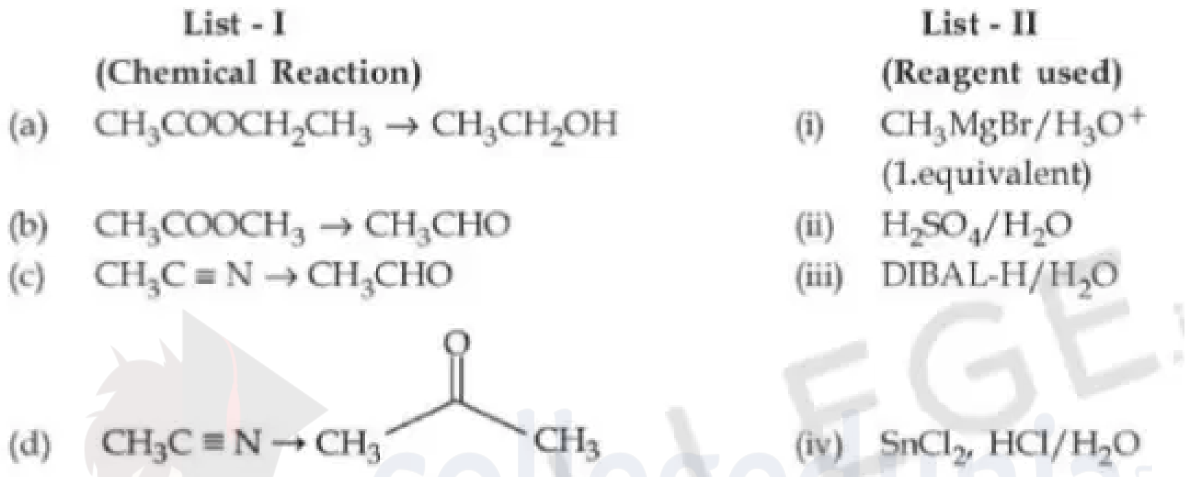
18. **Match List - I with List - II.** **(+4, -1)**



	List - I (Chemical Reaction)		List - II (Reagent used)
(a)	$CH_3COOCH_2CH_3 \rightarrow CH_3CH_2OH$	(i)	CH_3MgBr/H_3O^+ (1.equivalent)
(b)	$CH_3COOCH_3 \rightarrow CH_3CHO$	(ii)	H_2SO_4/H_2O
(c)	$CH_3C\equiv N \rightarrow CH_3CHO$	(iii)	DIBAL-H/H_2O
(d)	$CH_3C\equiv N \rightarrow CH_3COCH_3$	(iv)	$SnCl_2$, HCl/H_2O

a. (a)-(ii), (b)-(iii), (c)-(iv), (d)-(i)

b. (a)-(iii), (b)-(ii), (c)-(i), (d)-(iv)

c. (a)-(iv), (b)-(ii), (c)-(iii), (d)-(i)

d. (a)-(ii), (b)-(iv), (c)-(iii), (d)-(i)

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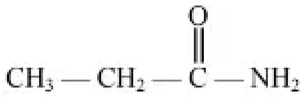
19. Consider the given reaction, identify the major product P. **(+4, -1)**

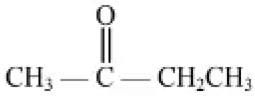
$$CH_3-COOH \xrightarrow[\text{(iv) } H_2O/\bar{O}H, \Delta]{\text{(i) } LiAlH_4 \quad \text{(ii) PCC} \quad \text{(iii) } HCN/\bar{O}H} \text{"P"}$$

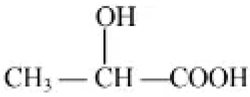
a. $CH_3-CH_2-CH_2-OH$

b.



$CH_3-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-NH_2$

c. 
$CH_3-\overset{O}{\overset{\|}{C}}-CH_2CH_3$

d. 
$CH_3-\overset{OH}{\overset{|}{CH}}-COOH$

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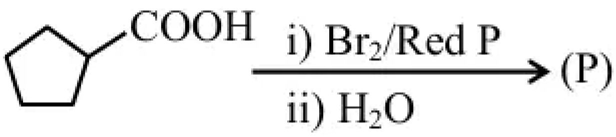
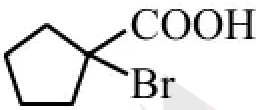
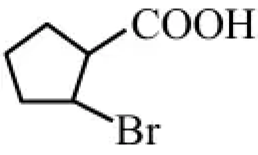
20. Identify the product (P) in the following reaction: **(+4, -1)**



a. 

b. 

c. 

d. 

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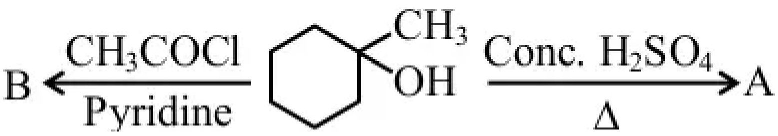
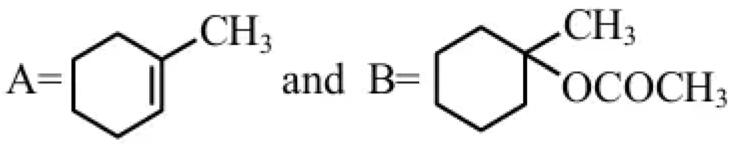
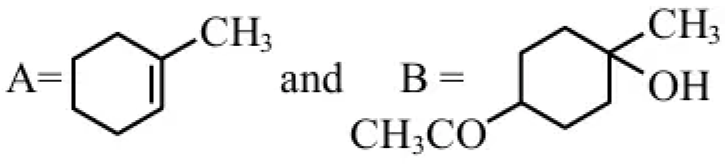
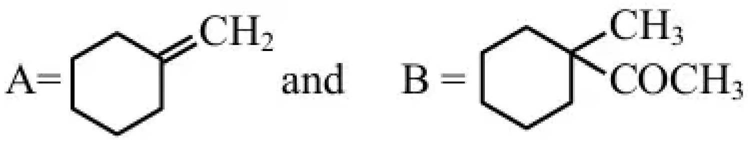
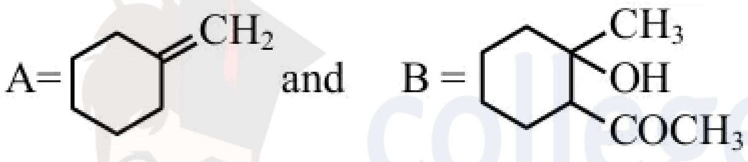
21. Identify the major products A and B respectively in the following set of reactions. **(+4, -1)**



a. 

b. 

c. 

d. 

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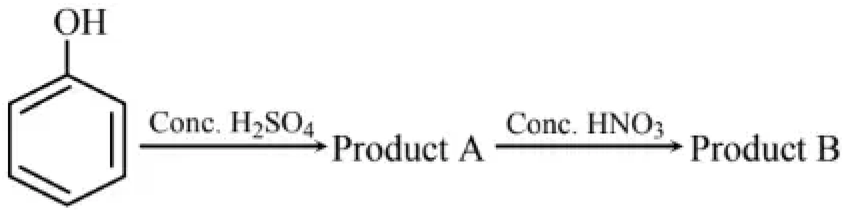
22. Consider the given chemical reaction sequence : **(+4, -1)**



Total sum of oxygen atoms in Product A and Product B are ....

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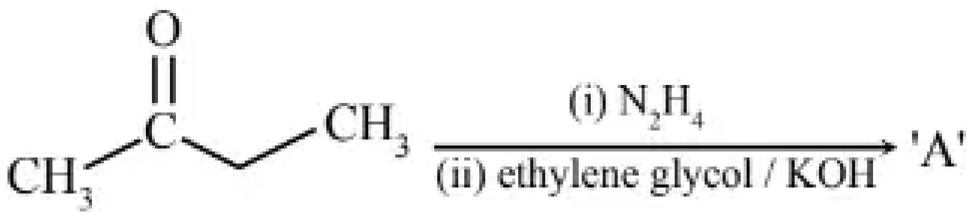
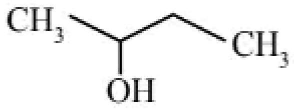
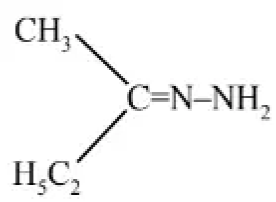
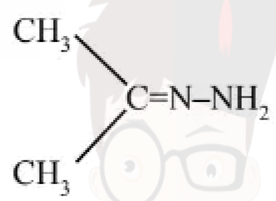
23. Identify 'A' in the following reaction : **(+4, -1)**



a. 

b. 

c. 

d. 

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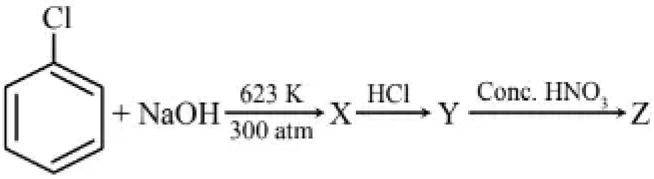
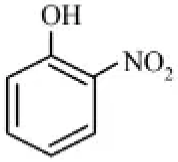
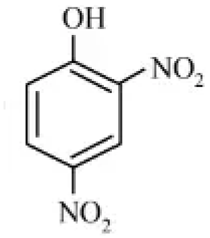
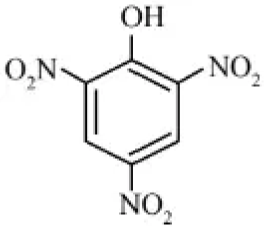
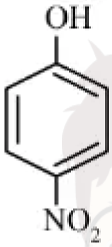
24. Identify compound (Z) in the following reaction sequence. **(+4, -1)**



a. 

b. 

c. 

d. 

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25. Which of the following compounds will give silver mirror with ammoniacal silver nitrate? **(+4, -1)**

(A) Formic acid

(B) Formaldehyde

(C) Benzaldehyde

(D) Acetone

Choose the correct answer from the options given below :

a. C and D only

b. A, B and C only

c. A only

d. B and C only

Answers

1. Answer: a

Explanation:

Step 1: Iodoform test is a qualitative test used to identify compounds containing either:

$$R - CO - CH_3 \quad \text{(methyl ketone)}$$

or

$$R - CH(OH) - CH_3 \quad \text{(methyl carbinol)}$$

Step 2: Anisole $(Ph - O - CH_3)$ is an ether. It does not contain either $COCH_3$ or $CH(OH)CH_3$ group.
Hence, anisole gives **negative** iodoform test. Step 3: Acetone $(CH_3 - CO - CH_3)$ is a methyl ketone.
On treatment with $I_2/NaOH$, it gives yellow precipitate of iodoform (CHI_3). Step 4: Since anisole does not respond and acetone responds positively, they can be clearly differentiated. Hence, correct answer is **(1) Anisole and Acetone**.

---

2. Answer: a

Explanation:

Step 1: Hydration of alkynes (Kucherov Reaction) follows Markovnikov's rule.
Step 2: Ethyne $(HC \equiv CH)$ gives Acetaldehyde (CH_3CHO).
Step 3: Higher alkynes always give **ketones**. For example, Propyne gives Acetone (CH_3COCH_3).
Step 4: Since the reaction requires at least two carbons (the alkyne), **Formaldehyde** (1-carbon) cannot be formed. Furthermore, higher aldehydes like **Propanal** cannot be formed because the -OH group attaches to the more substituted carbon, yielding a ketone.

---

3. Answer: a

Explanation:

Step 1: Understanding the Concept:

The sequence involves:

1. Base-catalyzed Aldol condensation between a cyclic ketone and an aldehyde.
2. Iodoform reaction $(I_2/NaOH)$ followed by acidification. The iodoform reaction typically converts methyl ketones $(R-CO-CH_3)$ into carboxylic acids $(R-COOH)$ and CHI_3.

Step 2: Key Formula or Approach:

1. Identify the acidic α-hydrogens in 2,2-dimethylcyclopentanone.
2. Conduct the Aldol condensation with acetaldehyde (CH_3CHO).
3. Apply oxidative cleavage/iodoform logic to the product 'P'.

Step 3: Detailed Explanation:

1. **Aldol Condensation:** 2,2-dimethylcyclopentanone has α-protons only at the C-5 position. These react with CH_3CHO in the presence of $NaOH$ to form 5-ethylidene-2,2-dimethylcyclopentanone after dehydration.
2. **Iodoform Reaction:** The ethylidene group $(=CH-CH_3)$ in α,β-unsaturated ketones can undergo oxidative cleavage under iodoform conditions $(I_2/NaOH)$ if it can tautomerize or be further oxidized. Specifically, if the reaction produces a β-hydroxy ketone intermediate that can be cleaved, or if the system mimics a methyl ketone structure, a carboxylic acid is formed on the ring.
3. **Workup:** The resulting sodium salt is acidified by HCl to the free carboxylic acid.

Step 4: Final Answer:

The final product 'X' is the cyclopentanone ring with a carboxylic acid group at the 5th position, as shown in Option (A).

---

4. Answer: a

Explanation:

Step 1: Understanding the Concept:

Grignard reagents $(RMgX)$ undergo nucleophilic addition to carbonyl groups. With α,β-unsaturated ketones, alkyl Grignard reagents typically prefer 1,2-addition to the carbonyl group over 1,4-addition. The second step involving aqueous acid workup with HCl not only protonates the alkoxide to alcohol but can also lead to the addition of HCl across the double bond if present in excess.

Step 2: Key Formula or Approach:

1. Nucleophilic addition of Et^- to the $C = O$ carbon.
2. Protonation of O^- to OH.
3. Electrophilic addition of HCl to the remaining alkene.

Step 3: Detailed Explanation:

1. **Addition of Grignard:** The starting material is but-3-en-2-one ($CH_2 = CH - COCH_3$). Reaction with C_2H_5MgBr occurs at the carbonyl group (1,2-addition) to give the intermediate alkoxide: $CH_2 = CH - C(O^-MgBr)(CH_3)(C_2H_5)$.
2. **Acidic Workup:** Addition of H_2O/HCl results in the formation of the alcohol: 3-methyl-pent-1-en-3-ol, $CH_2 = CH - C(OH)(CH_3)(C_2H_5)$.
3. **Reaction with HCl:** The presence of HCl facilitates the addition across the double bond. Following Markovnikov's rule (and considering the stability of the carbocation intermediate), the chloride ion adds to the more substituted/stable position. In many competitive exam contexts for this specific reaction, the final product involves the addition of the halogen to the double bond.

Step 4: Final Answer:

The major product is the tertiary alcohol with the halogen added to the alkyl chain, matching Option (A).

---

5. **Answer: c**

Explanation:

The reagent used is DIBAL-H, which stands for Diisobutylaluminium hydride. It is a selective reducing agent.
DIBAL-H is commonly used to reduce esters and nitriles to aldehydes. It is a bulky and electrophilic reducing agent.
The reaction proceeds in two steps:
(i) The nitrile (R-CN) reacts with one equivalent of DIBAL-H. The DIBAL-H adds a hydride to the carbon of the nitrile group, forming an intermediate imine-aluminium complex. The reaction is typically carried out at low temperatures (e.g., -78°C) to prevent further reduction.
$\text{R-C}\equiv\text{N} + \text{H-Al(i-Bu)}_2 \rightarrow \text{R-CH=N-Al(i-Bu)}_2$
(ii) The intermediate complex is then hydrolyzed by adding water (H_2O). The hydrolysis cleaves the C=N bond and replaces it with a C=O bond, yielding an aldehyde (R-CHO).
$\text{R-CH=N-Al(i-Bu)}_2 + H_2O \rightarrow \text{R-CHO} + \text{other products}$
Therefore, the functional group "Y" is an aldehyde group, --CHO.

6. **Answer: d**

Explanation:

Step 1: A compound liberates CO_2 from $NaHCO_3$ if it is a **stronger acid than carbonic acid** (H_2CO_3).
Step 2: Benzoic acid (Carboxylic acids) are stronger than H_2CO_3 and give a positive test.
Step 3: Phenols (including p-nitrophenol) are generally weaker than H_2CO_3 and do not react with bicarbonate (Exception: 2,4,6-trinitrophenol or Picric acid).
Step 4: Urea is basic/neutral and does not react.

---

7. **Answer: a**

Explanation:

The given reaction is the hydroformylation of an alkene (but-1-ene) using synthesis gas (a mixture of CO and H_2) in the presence of a rhodium catalyst. This reaction is also known as the Oxo process.
In this reaction, a hydrogen atom (H) and a formyl group (-CHO) are added across the double bond.
For an unsymmetrical alkene like but-1-ene, the addition can occur in two ways:
1. Addition to the terminal carbon: This results in a linear aldehyde.
$\mathrm{CH_3CH_2CH = CH_2 \rightarrow CH_3CH_2CH_2CH_2CHO}$ (pentanal)
2. Addition to the second carbon: This results in a branched aldehyde.
$\mathrm{CH_3CH_2CH = CH_2 \rightarrow CH_3CH_2CH(CHO)CH_3}$ (2-methylbutanal)
The choice of catalyst and reaction conditions influences the ratio of the linear to branched product (n/iso ratio).
Rhodium-based catalysts, especially those with phosphine ligands, are known to be highly selective for the formation of the linear aldehyde. The linear product is generally the desired major product in industrial applications.
Therefore, the major product of this reaction is the linear aldehyde, pentanal.

---

8. **Answer: a**

Explanation:

Step 1: Understanding the Concept:
The sequence consists of a Friedel-Crafts acylation with a cyclic anhydride, followed by a Clemmensen reduction.
Step 2: Detailed Explanation:
1. **Formation of A:** Benzene reacts with succinic anhydride in the presence of $AlCl_3$ (a Lewis acid catalyst). The anhydride ring opens, and the acyl group attaches to the benzene ring. The final product of this acylation step is **4-phenyl-4-oxobutanoic acid** ($Ph - CO - CH_2 - CH_2 - COOH$).
2. **Formation of B:** The keto-acid A is treated with zinc amalgam (Zn/Hg) and concentrated hydrochloric acid (HCl). This is the **Clemmensen reduction**, which specifically reduces the carbonyl group ($C = O$) of ketones or aldehydes to a methylene group (CH_2).

$$Ph - CO - CH_2 - CH_2 - COOH \xrightarrow{Zn/Hg,HCl} Ph - CH_2 - CH_2 - CH_2 - COOH$$

The product B is **4-phenylbutanoic acid**.
Step 3: Final Answer:
Structure A is the γ-keto acid and B is the saturated fatty acid derivative, as shown in option (A).

---

9. Answer: b

Explanation:

Step 1: Understanding the Concept:
The starting material is p-hydroxybenzaldehyde. Treatment with concentrated $NaOH$ and heat, followed by acidification, indicates a **Cannizzaro reaction**. This reaction occurs in aldehydes that lack α-hydrogens.
Step 2: Detailed Explanation:
In the Cannizzaro reaction, the aldehyde undergoes self-disproportionation (simultaneous oxidation and reduction):
1. One molecule of p-hydroxybenzaldehyde is reduced to **p-hydroxybenzyl alcohol** ($HO - C_6H_4 - CH_2OH$). This molecule contains two hydroxyl groups (one phenolic and one benzylic), making it a **diol**.
2. Another molecule is oxidized to the salt of **p-hydroxybenzoic acid** ($HO - C_6H_4 -$

COO^-Na^+). Upon acidification (H_3O^+), it yields p-hydroxybenzoic acid ($HO - C_6H_4 - COOH$).
- This acid is a **monocarboxylic acid**.
- It is also a **compound with both alcohol (phenolic -OH) and acid functional groups**.

Since there is only one aldehyde group per benzene ring, there is no pathway to generate a second carboxylic acid group on the same molecule.

Step 3: Final Answer:

A **dicarboxylic acid** is not formed in this process.

---

10. Answer: d

Explanation:

Step 1: Understanding the Concept:

The starting material is acetone cyanohydrin. This molecule contains both a hydroxyl group ($-\mathrm{OH}$) and a nitrile group ($-\mathrm{CN}$). The reactions involve functional group transformations of the nitrile group.

Step 2: Detailed Explanation:

Formation of Product A:

Acetone cyanohydrin is treated with $\mathrm{LiAlH_4}$, which is a powerful reducing agent. It reduces the nitrile ($-\mathrm{CN}$) group to a primary amine ($-\mathrm{CH_2NH_2}$) group. The alcohol group remains unchanged.

$$\mathrm{(CH_3)_2C(OH)CN} \xrightarrow{\mathrm{LiAlH_4/H_3O^+}} \mathrm{(CH_3)_2C(OH)CH_2NH_2}$$

Thus, A is 1-amino-2-methylpropan-2-ol.

Formation of Product B:

The nitrile group undergoes acidic hydrolysis when treated with $\mathrm{H_3O^+}$ and $\mathrm{H_2SO_4}$. Complete hydrolysis of a nitrile group yields a carboxylic acid group ($-\mathrm{COOH}$).

$$\mathrm{(CH_3)_2C(OH)CN} \xrightarrow{\mathrm{H_3O^+/H_2SO_4}} \mathrm{(CH_3)_2C(OH)COOH}$$

Thus, B is 2-hydroxy-2-methylpropanoic acid (also known as α-hydroxyisobutyric acid).

Step 3: Final Answer:

Comparing the chemical logic with the provided options, Option (D) represents the correct structures.

---

11. Answer: b

Explanation:

Step 1: Understanding the Concept:
This is a multi-step synthesis involving functional group transformations and a Friedel-Crafts acylation followed by nucleophilic addition.
Step 2: Detailed Explanation:
1. **Step 1 (Acid to Acid Chloride):** Acetic acid reacts with thionyl chloride ($SOCl_2$) to form acetyl chloride.

$$CH_3COOH + SOCl_2 \rightarrow CH_3COCl\ (\text{A}) + SO_2 + HCl$$

2. **Step 2 (Friedel-Crafts Acylation):** Acetyl chloride reacts with benzene in the presence of anhydrous $AlCl_3$ to form acetophenone.

$$C_6H_6 + CH_3COCl \xrightarrow{AlCl_3} C_6H_5COCH_3\ (\text{B}) + HCl$$

3. **Step 2 (Nucleophilic Addition):** Acetophenone reacts with KCN in a basic medium (OH^-) to undergo nucleophilic addition to the carbonyl group, forming a cyanohydrin.

$$C_6H_5COCH_3 + CN^- \rightarrow C_6H_5 - C(OH)(CH_3)(CN)\ (\text{C})$$

The product is 2-hydroxy-2-phenylpropanenitrile.
Step 3: Final Answer:
The final product C is the cyanohydrin of acetophenone.

---

12. Answer: b

Explanation:

Step 1: Understanding the Question:
This is a multi-step synthesis involving a starting material with two functional groups (a ketone and a nitrile) that react with a Grignard reagent, followed by dehydration. We need to predict the final major product.

Step 2: Detailed Explanation:

Step (i) & (ii): Reaction with 2CH_3MgBr followed by H_3O^+ workup.

The starting material has two electrophilic sites: the carbonyl carbon of the ketone and the carbon of the nitrile group ($-C\equiv N$). Grignard reagents react with both. Since two equivalents are used, both groups will react.

- **Reaction at the Ketone:** The first equivalent of CH_3MgBr will attack the ketone carbonyl carbon. The workup step (H_3O^+) protonates the resulting alkoxide to form a tertiary alcohol.
- **Reaction at the Nitrile:** The second equivalent of CH_3MgBr attacks the nitrile carbon. The initial adduct, upon hydrolysis with H_3O^+, forms an imine which is then further hydrolyzed to a ketone. The nitrile group ($-CN$) is converted into a methyl ketone group ($-C(=O)CH_3$).

The intermediate product after these two steps has a tertiary alcohol where the original ketone was, and an acetyl group where the original nitrile was.

Step (iii): H_2SO_4, heat.

This step causes the acid-catalyzed dehydration of the tertiary alcohol formed in the previous step.

1. The $-OH$ group is protonated by the acid to form a good leaving group, $-OH_2{}^+$.
2. The leaving group departs, forming a stable tertiary, benzylic carbocation.
3. A proton is eliminated from an adjacent carbon to form an alkene. Elimination of a proton from the more substituted adjacent carbon (Zaitsev's rule) leads to the more stable, more substituted alkene. In this case, removing a proton from the adjacent carbon in the ring forms an endocyclic double bond. This double bond is also conjugated with the benzene ring, making it the highly favored major product.

4. Identifying the Final Product:

The final product will have:

- The original nitrile group converted to an acetyl group ($-COCH_3$).
- The original ketone group converted to a C=C double bond within the six-membered ring, with a methyl group attached to one of the carbons of the double bond.

This structure corresponds exactly to option (B).

Step 3: Final Answer:

The major product of the given reaction sequence is the structure shown in option (B).

---

13. **Answer: a**

Explanation:

Step 1: Understanding the Question:
We need to analyze four different reactions and determine which one will not produce propionic acid (CH_3CH_2COOH) as the major product.

Step 2: Detailed Explanation:

- **(A) $CH_3CH_2CH_3$ + $KMnO_4$ (Heat), OH^-/H_3O^+:** This represents the vigorous oxidation of propane. Simple alkanes are very resistant to oxidation. Under such harsh conditions, C-C bond cleavage occurs, leading to a mixture of smaller carboxylic acids (like acetic and formic acid), ketones, and complete combustion to CO_2 and H_2O. This is not a synthetic method to produce propionic acid. Therefore, this reaction will **not yield** propionic acid.
- **(B) $CH_3CH_2CCl_3$ + OH^-/H_3O^+:** This is the alkaline hydrolysis of a gem-trihalide (1,1,1-trichloropropane). The three chlorine atoms on the terminal carbon are replaced by hydroxyl groups to form an unstable gem-triol, $CH_3CH_2C(OH)_3$. This intermediate readily loses a water molecule to form propionic acid. The final acidification step ensures the product is in its acidic form. This reaction **yields** propionic acid.
- **(C) $CH_3CH_2COCH_3$ + OI^-/H_3O^+:** This is the haloform reaction. The substrate, butan-2-one, is a methyl ketone (a compound with a CH_3CO- group). Methyl ketones react with hypoiodite (OI^-) to form iodoform (CHI_3) and the salt of a carboxylic acid with one less carbon atom. In this case, butan-2-one will give iodoform and sodium propionate ($CH_3CH_2COO^-Na^+$). Subsequent acidification yields propionic acid. This reaction **yields** propionic acid.
- **(D) $CH_3CH_2CH_2Br$ + Mg, CO_2 dry ether/H_3O^+:** This is a Grignard synthesis of a carboxylic acid. Propyl bromide (a 3-carbon compound) first forms propylmagnesium bromide ($CH_3CH_2CH_2MgBr$). This Grignard reagent then reacts with carbon dioxide (CO_2) to add a carboxyl group. The final product after hydrolysis is butyric acid ($CH_3CH_2CH_2COOH$), which is a 4-carbon acid. This reaction **does not yield** propionic acid.

Step 3: Final Answer:
The oxidation of propane with $KMnO_4$ will not yield propionic acid.

---

14. Answer: a

Explanation:

Step 1: Understanding the Question:
We are given the product of a reaction and the reagents used. We need to deduce the structure of the starting material P.

Step 2: Key Formula or Approach:
The reagents are 1. NaOCl (sodium hypochlorite) and 2. H_3O^+ (acid workup). This set of reagents is used for the **haloform reaction**. The haloform reaction is a characteristic reaction of **methyl ketones** (compounds containing the R-C(=O)-CH_3 group) or alcohols that can be oxidized to methyl ketones. The reaction converts a methyl ketone into a carboxylate salt and a haloform (in this case, chloroform, $CHCl_3$). The subsequent acid workup protonates the carboxylate to give a carboxylic acid.

$$\text{R-C}(=\text{O})\text{CH}_3 \xrightarrow{\text{1. NaOCl}} \text{R-COO}^- + \text{CHCl}_3 \xrightarrow{\text{2. H}_3\text{O}^+} \text{R-COOH}$$

Step 3: Detailed Explanation:
We can identify the structure of the starting material P by working backward from the product. The given product is an α, β-unsaturated carboxylic acid.

$$\text{Product} = \text{CH}_3\text{-CH}=\text{C}(\text{CH}_3)\text{-COOH}$$

This product has the structure R-COOH, where the 'R' group is:

$$\text{R} = \text{CH}_3\text{-CH}=\text{C}(\text{CH}_3)\text{-}$$

Since the haloform reaction converts a starting material of the form R-C(=O)CH_3 into R-COOH, the starting material P must have had this 'R' group attached to a methyl ketone group (-C(=O)CH_3). Let's construct the structure of P:

$$\text{P} = \underbrace{\text{CH}_3\text{-CH}=\text{C}(\text{CH}_3)\text{-}}_{\text{R group}}\ \underbrace{\text{C}(=\text{O})\text{CH}_3}_{\text{Methyl ketone group}}$$

The starting material P is 3,4-dimethylpent-3-en-2-one.

Step 4: Final Answer:
Comparing this deduced structure with the options, it matches the structure in option (A).

---

15. Answer: a

Explanation:

Step 1: Understanding the Concept:
To prepare 3-nitrobenzoic acid, we need a carboxyl group and a nitro group in a

meta relationship. This requires utilizing the directing effects of existing groups on the benzene ring.

Step 2: Detailed Explanation:

1. **Nitration:** Reaction with HNO_3/H_2SO_4 converts benzene to nitrobenzene.
2. **Bromination:** The $-NO_2$ group is a strong deactivating and meta-directing group. Reaction with $Br_2/AlBr_3$ yields 1-bromo-3-nitrobenzene.
3. **Grignard formation:** Reaction with Mg/ether converts the aryl bromide to a Grignard reagent, 3-nitrophenylmagnesium bromide.
4. **Carboxylation:** Reaction with CO_2 followed by acid hydrolysis (H_3O^+) converts the Grignard reagent into the carboxylic acid.

Result: 3-nitrobenzoic acid.

Other options fail because bromobenzene followed by nitration gives ortho/para products.

Step 3: Final Answer:

The correct sequence is (A).

---

16. Answer: a

Explanation:

Step 1: Understanding the Concept:

The reaction of a methyl ketone with a halogen (Br_2) in the presence of a strong base (KOH) is known as the Haloform Reaction. It is a diagnostic test for the $CH_3C = O$ group.

Step 2: Detailed Explanation:

The starting material is acetophenone ($C_6H_5COCH_3$).

1. In the presence of KOH and Br_2, the alpha-methyl group undergoes exhaustive bromination to form a trihalomethyl ketone intermediate: $C_6H_5COCBr_3$.
2. The hydroxide ion then attacks the carbonyl carbon, followed by the cleavage of the $C - C$ bond to release the CBr_3^- ion.
3. Proton transfer occurs between the resulting benzoic acid and the CBr_3^- ion to form a carboxylate salt and bromoform ($CHBr_3$).

Reaction: $C_6H_5COCH_3 + 3Br_2 + 4KOH \rightarrow C_6H_5COOK + CHBr_3 + 3KBr + 3H_2O$.

Product A is potassium benzoate (C_6H_5COOK) and product B is bromoform ($CHBr_3$).

Step 3: Final Answer:

The major products are A = Potassium benzoate and B = $CHBr_3$.

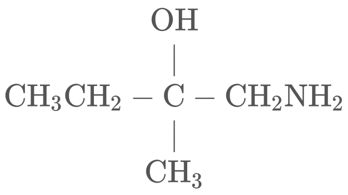
---

17. Answer: c

Explanation:

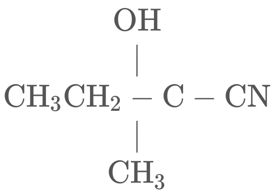
Step 1: Analyzing the Reaction Sequence
The reaction involves two main steps:
1. Reaction of a carbonyl compound with HCN in the presence of a catalyst 'X' to form a cyanohydrin.
2. Reduction of the cyanohydrin with $LiAlH_4$ followed by hydrolysis (H_3O^+) to give the final product 'Y'.

Step 2: Identifying the Starting Material and Reagent 'X'
The first step is the formation of a cyanohydrin. This is a nucleophilic addition of CN^- to a carbonyl group. Since HCN is a weak acid, a basic catalyst is required to generate a sufficient concentration of the nucleophile CN^-. Therefore, 'X' must be a base, such as NaOH or KCN. This eliminates options (B) and (D).
Let's analyze the structure of the product 'Y' given in the correct option (C) to deduce the starting material. The structure of 'Y' in option (C) is 1-amino-2-methylbutan-2-ol:



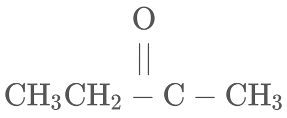
$$\begin{array}{c} OH \\ | \\ CH_3CH_2-C-CH_2NH_2 \\ | \\ CH_3 \end{array}$$

This product is formed by the reduction of a nitrile group (-CN) to an amino group (-CH_2NH_2). Reversing this step, the intermediate cyanohydrin must have been:



$$\begin{array}{c} OH \\ | \\ CH_3CH_2-C-CN \\ | \\ CH_3 \end{array}$$

This cyanohydrin is formed by the addition of HCN to a ketone. Reversing the cyanohydrin formation, the original carbonyl compound must have been Butan-2-one (or methyl ethyl ketone):



$$\begin{array}{c} O \\ \| \\ CH_3CH_2-C-CH_3 \end{array}$$

So, the reaction starts with Butan-2-one, even if the diagram in the question is ambiguous.

Step 3: Verifying the Reaction and Identifying 'Y'
Reaction 1: Formation of cyanohydrin.

$$\text{Butan-2-one} + \text{HCN} \xrightarrow{\text{NaOH (X)}} \text{2-hydroxy-2-methylbutanenitrile}$$

Reaction 2: Reduction of the nitrile group.

$$\text{2-hydroxy-2-methylbutanenitrile} \xrightarrow{\text{1. LiAlH}_4 \text{ 2. H}_3\text{O}^+} \text{1-amino-2-methylbutan-2-ol (Y)}$$

The reducing agent LiAlH_4 reduces the -CN group to a $\text{-CH}_2\text{NH}_2$ group.

Step 4: Final Answer
The catalyst 'X' is NaOH, and the final product 'Y' is 1-amino-2-methylbutan-2-ol. This matches option (C).

---

18. **Answer: a**

Explanation:

Step 1: Understanding the Task
We need to match each chemical transformation in List-I with the correct reagent(s) from List-II that would accomplish it.
Step 2: Analyzing Each Transformation
(a) $\text{CH}_3\text{COOCH}_2\text{CH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{OH}$: This shows the conversion of ethyl acetate to ethanol. This occurs during the acid-catalyzed hydrolysis of the ester. The full reaction is $\text{CH}_3\text{COOCH}_2\text{CH}_3 + \text{H}_2\text{O} \xrightarrow{H^+} \text{CH}_3\text{COOH} + \text{CH}_3\text{CH}_2\text{OH}$. The reagent $\text{H}_2\text{SO}_4/\text{H}_2\text{O}$ (ii) facilitates this reaction.
Match: (a) $\rightarrow$ (ii)
(b) $\text{CH}_3\text{COOCH}_3 \rightarrow \text{CH}_3\text{CHO}$: This shows the partial reduction of an ester (methyl acetate) to an aldehyde (acetaldehyde). This specific transformation is achieved using Diisobutylaluminium hydride (DIBAL-H) at low temperatures, followed by hydrolysis. DIBAL-H is a selective reducing agent for this purpose.
Match: (b) $\rightarrow$ (iii)
(c) $\text{CH}_3\text{C} \equiv \text{N} \rightarrow \text{CH}_3\text{CHO}$: This is the conversion of a nitrile (acetonitrile) to an aldehyde (acetaldehyde). This is a classic example of the **Stephen reduction**. The

nitrile is first reduced by tin(II) chloride ($SnCl_2$) in the presence of hydrochloric acid (HCl) to an iminium salt, which upon hydrolysis (H_2O) yields the aldehyde.

Match: (c) → (iv)

(d) $CH_3C \equiv N \rightarrow CH_3COCH_3$: This reaction converts a nitrile to a ketone (acetone). This is achieved by reacting the nitrile with a Grignard reagent (CH_3MgBr). The nucleophilic methyl group from the Grignard reagent attacks the nitrile carbon, and subsequent hydrolysis of the intermediate imine yields the ketone.

Match: (d) → (i)

Step 3: Compiling the Final Match

The correct matches are:

(a) - (ii)

(b) - (iii)

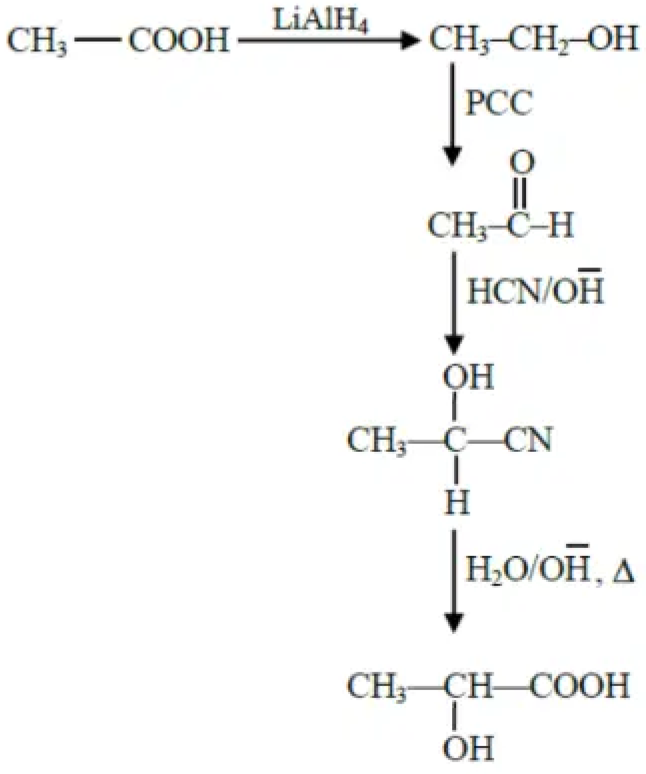
(c) - (iv)

(d) - (i)

This corresponds to option (A).

19. **Answer: d**

Explanation:



Thus the correct answer is Option 4.

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20. Answer: a

Explanation:

To identify the product (P) in the given reaction, we need to analyze the reaction conditions and the reactants involved.

1. The starting material is a carboxylic acid, specifically a cyclic one as seen in the image provided.
2. The reaction involves $\mathrm{Br_2/Red\ P}$ followed by hydrolysis $(\mathrm{H_2O})$. This is characteristic of the Hell-Volhard-Zelinsky (HVZ) reaction, which is used to brominate carboxylic acids at the α-position.
3. In the HVZ reaction:
    - $\mathrm{Br_2}$ in the presence of red phosphorus (Red P) forms $\mathrm{PBr_3}$, a brominating agent.
    - The carboxylic acid forms an acyl bromide intermediate, which then undergoes α-halogenation.
    - Subsequent treatment with water (hydrolysis) converts the acyl bromide back to the carboxylic acid but with a bromine atom at the α-position.
4. Thus, the product (P) should be the original cyclic carboxylic acid with a bromine atom attached to the α-carbon, adjacent to the carboxyl group.
5. By examining the options, the correct structure of the α-brominated product is represented by the following figure:

This option depicts the cyclic structure with a bromine atom attached to the α-carbon, consistent with the reaction mechanism.

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21. Answer: a

Explanation:

To identify the major products A and B, let's analyze the reactions step by step:

1. The given compound is a cyclohexanol derivative with a methyl group attached to it.
2. The first reaction involves treating this alcohol with concentrated $\mathrm{H_2SO_4}$ under heating.
3. This treatment typically leads to dehydration of alcohols, resulting in the formation of an alkene.
4. The most likely alkene product, given the starting material, involves the elimination of water (H_2O) across the least hindered carbon atoms, following Zaitsev's rule.
5. Product A is thus a cyclohexene derivative.
6. Next, the alkene is treated with acetyl chloride (CH_3COCl) in the presence of pyridine.
7. Pyridine acts as a catalyst to promote the reaction between the alkene and acid chloride, leading to electrophilic addition or formation of a more stable stereoisomer.
8. The major product B will be an acylated cyclohexane.

Therefore, the correct answer is the image representing these transformations. This is consistent with the given correct answer option.

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22. **Answer: 14 - 14**

Explanation:

Picric acid is prepared by treating phenol first with concentrated sulphuric acid which converts it to phenol-2,4-disulphonic acid and then with concentrated nitric acid to get 2, 4, 6 trinitrophen

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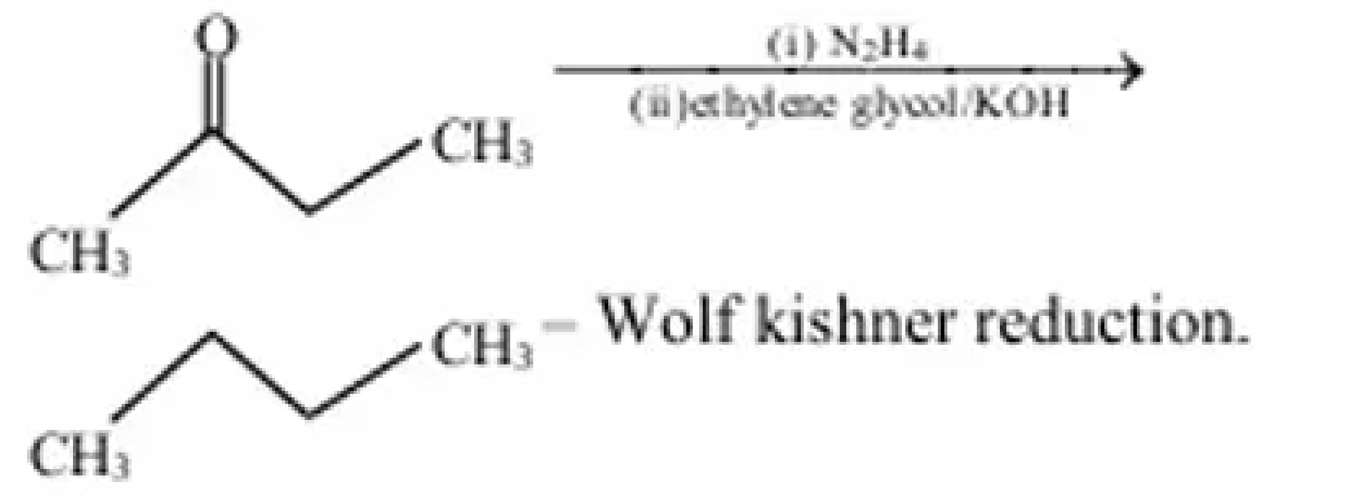
23. **Answer: b**

Explanation:

The given reaction is a **Wolff-Kishner reduction**, which is used to reduce carbonyl groups (aldehydes and ketones) to alkanes.



The first step involves the formation of a hydrazone derivative:

$$CH_3 - CO - CH_2 - CH_3 \xrightarrow{N_2H_4} CH_3 - C(NHNH_2) - CH_2 - CH_3.$$

In the presence of ethylene glycol and KOH, the hydrazone undergoes decomposition to form:

$$CH_3 - CH_2 - CH_2 - CH_3.$$

Thus, the product 'A' is butane.

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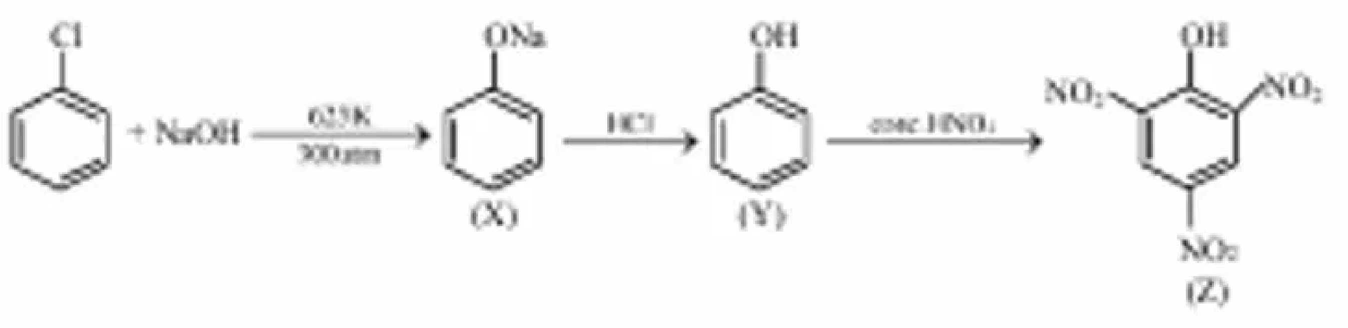
24. **Answer: c**

Explanation:



Thus, the correct answer is Option C.

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25. **Answer: b**

Explanation:

To determine which of the given compounds will give a silver mirror with ammoniacal silver nitrate, we need to understand the chemistry behind the Tollens' test. This test is used to identify aldehydes. When aldehydes react with Tollens' reagent, which is a solution of ammoniacal silver nitrate, they are oxidized to carboxylic acids, and the reagent forms a silver mirror on the test tube as metallic silver is precipitated. Let's analyze each compound given:

1. **Formic acid (A):** Formic acid is capable of giving a positive Tollens' test, even though it is not an aldehyde. This is because formic acid is easily oxidized to carbon dioxide and water, producing a silver mirror in the process.
2. **Formaldehyde (B):** Being a simple aldehyde, formaldehyde readily undergoes oxidation with Tollens' reagent, forming a silver mirror. Therefore, formaldehyde will give a positive Tollens' test.
3. **Benzaldehyde (C):** Benzaldehyde is also an aldehyde, and it will be oxidized to benzoic acid by the Tollens' reagent, producing a silver mirror. Thus, it also gives a positive tollens test.
4. **Acetone (D):** Acetone is a ketone, and ketones generally do not react with Tollens' reagent because they are not oxidizable under the conditions of the test. Hence, acetone will not give a silver mirror.

Based on the analysis above, the correct compounds that will give a silver mirror with ammoniacal silver nitrate are Formic acid (A), Formaldehyde (B), and Benzaldehyde (C). Therefore, the correct answer is:

A, B, and C only