Chemical Reactions of Alcohols Phenols and Ethers JEE Main PYQ - 2

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

Instructions

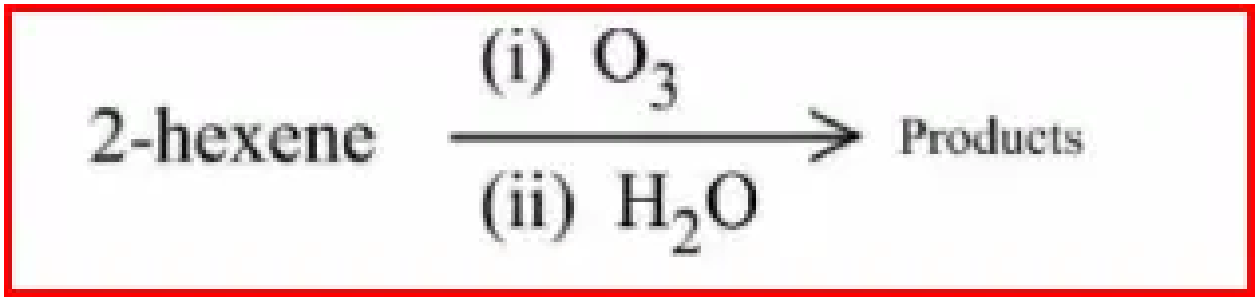
Instructions

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. **(+4, -1)**

The two products formed in above reaction are

a. Butanoic acid and acetic acid

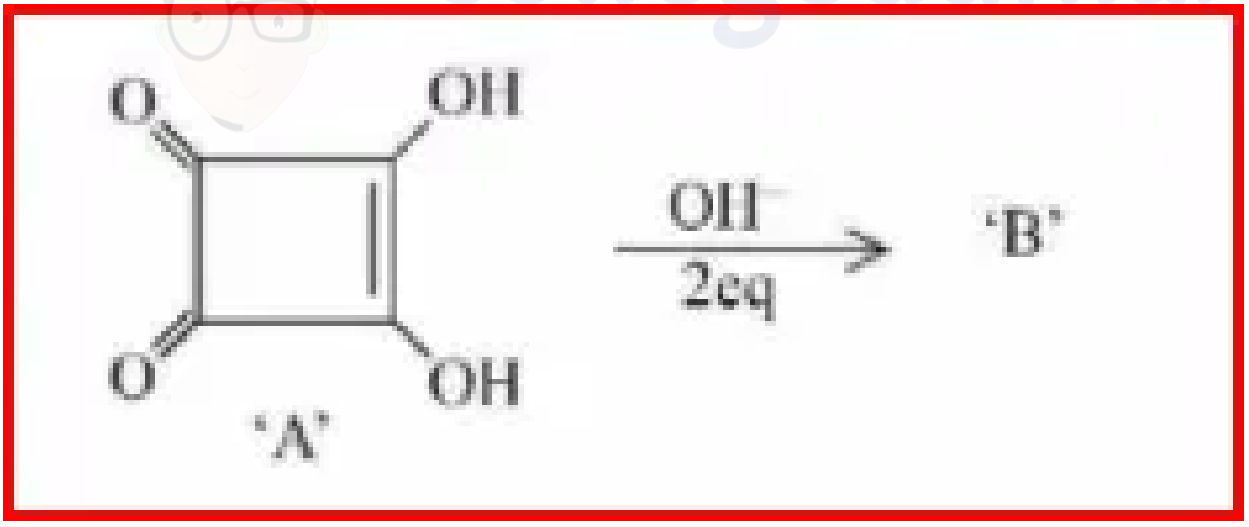
b. Butanal and acetaldehyde

c. Butanoic acid and acetaldehyde

d. Butanal and acetic acid

---

2. Correct statements for the given reaction are: **(+4, -1)**



A. Compound 'B' is aromatic
B. The completion of above reaction is very slow
C. 'A' shows tautomerism
D. The bond lengths C-C in compound B are found to be same
Choose the correct answer from the options given below

a. A, B and C only

b. B, C and D only

c. A, C and D only

d. A, B and D only

---

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

	List I		List II
A	Nitrogen oxides in air	I	Eutrophication
B	Nitrogen oxides in air	II	Eutrophication
C	Carbon dioxide	III	Global warming
D	Phosphate fertilisers in water	IV	Acid rain

Choose the correct answer from the options given below:

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

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

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

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

---

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

	List I -complex		List II-CFSE
A	$[Cu(NH_3)_6]^{2+}$	I	-6.0
B	$[Ti(H_2O)_6]^{3+}$	II	-2.0
C	$[Fe(CN)_6]^{3-}$	III	-1.2
D	$[NiF_6]^{4-}$	IV	-0.4

Choose the correct answer from the options given below:

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

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

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

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

---

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

	List I -Type of Hydride		List II-Example
A	Electron deficient hydride	I	M_gH_2
B	Electron rich hydride	II	HF
C	Electron precise hydride	III	B_2H_6
D	Saline hydride	IV	CH_4

Choose the correct answer from the options given below:

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

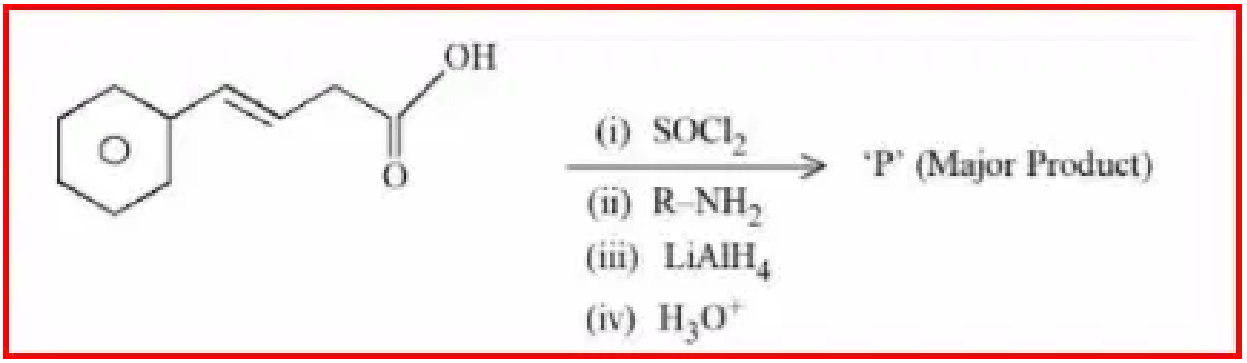
b. A-II, B-III, C-IV, D-I

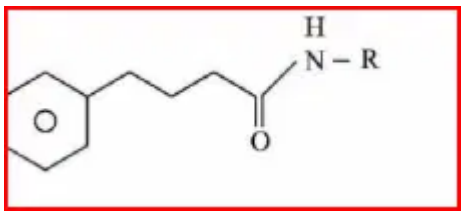
c. A-III, B-II, C-I, D-IV

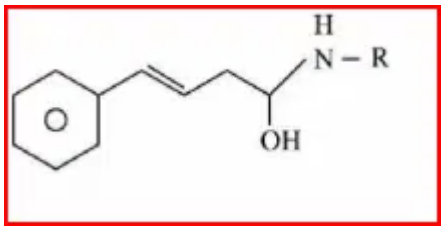
d. A-III, B-II, C-I, D-IV

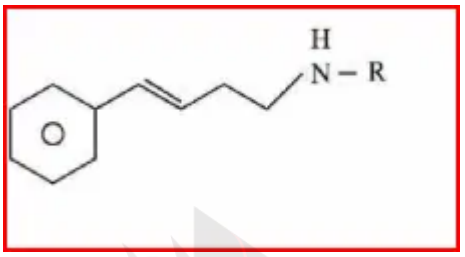
---

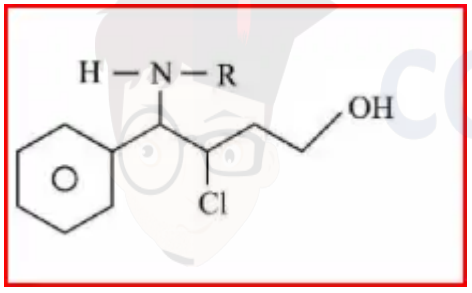
6. The major products 'P' formed in the following sequence of reaction is **(+4, -1)**



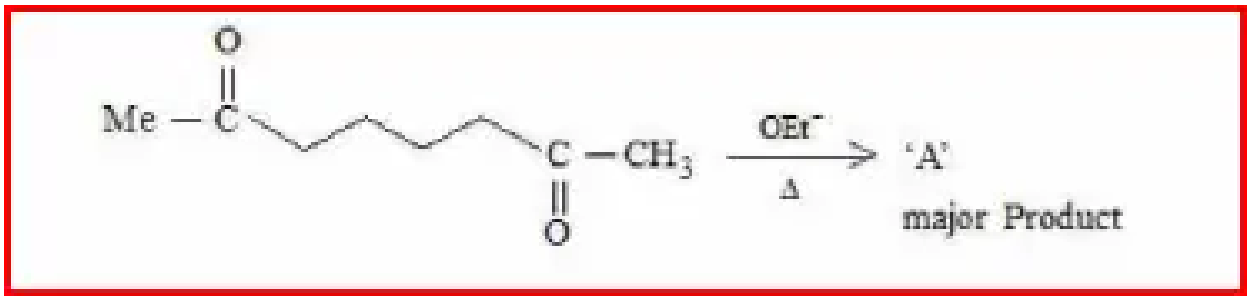
a. 

b. 

c. 

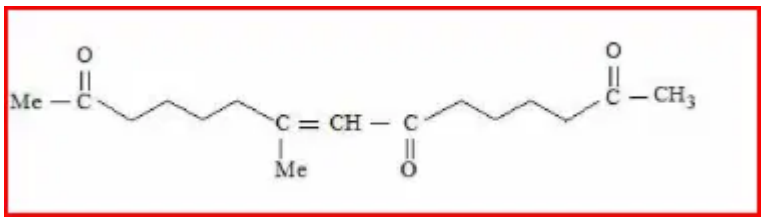
d. 

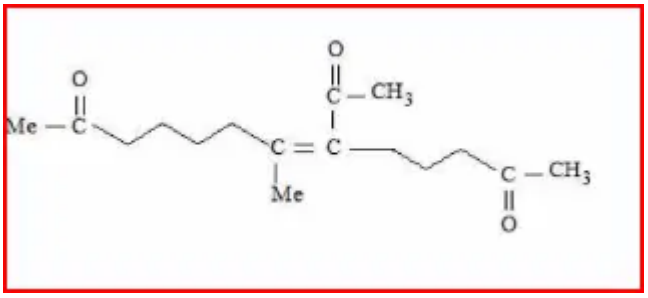
---

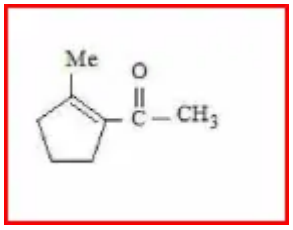
7. 

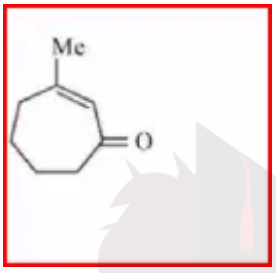
(+4, -1)

A in the above reaction is:

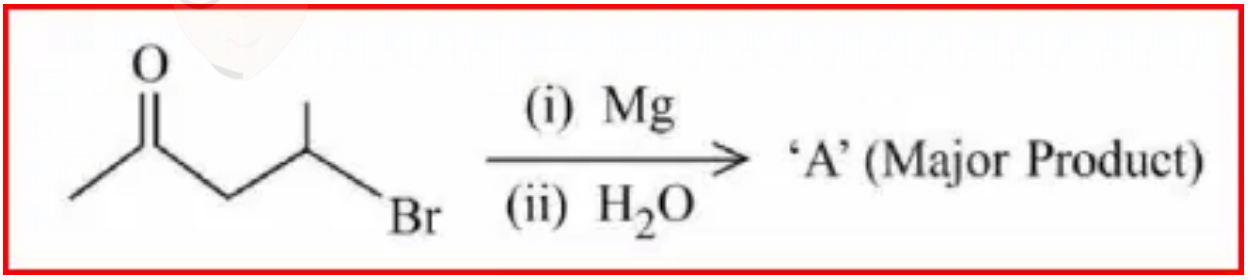
a. 

b. 

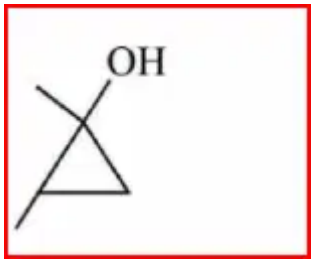
c. 

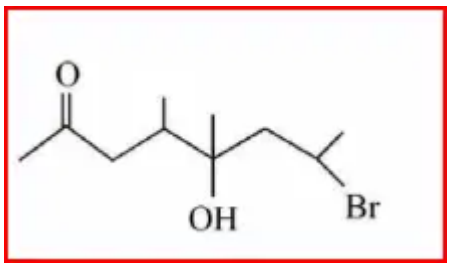
d. 

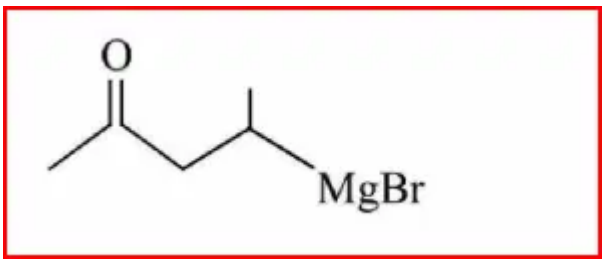
8. In the following reaction **(+4, -1)**

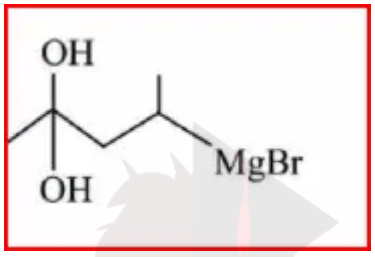


A is

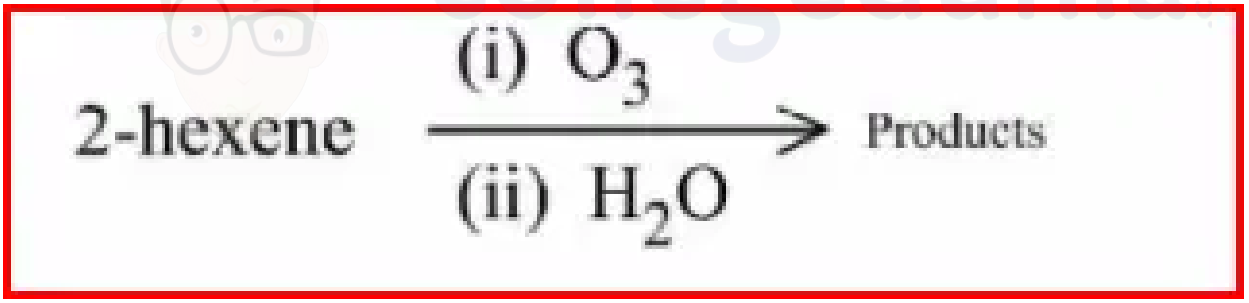
a. 

b. 

c. 

d. 

---

9. 

(+4, -1)

Products The two products formed in above reaction are

a. Butanoic acid and acetic acid

b. Butanal and acetaldehyde

c. Butanoic acid and acetaldehyd

d. Butanal and acetic acid

---

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

	List-I-Complex		List-II-CFSE
A	$[Cu(NH_3)6]2^+$	I	-0.6
B	$[Ti(H_2O)_6]^{3+}$	II	-2.0
C	$[Fe(CN)_6]^{3-}$	III	-1.2
D	$[NiF_6]^{4-}$	IV	-0.4

Choose the correct answer from the options given below:

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

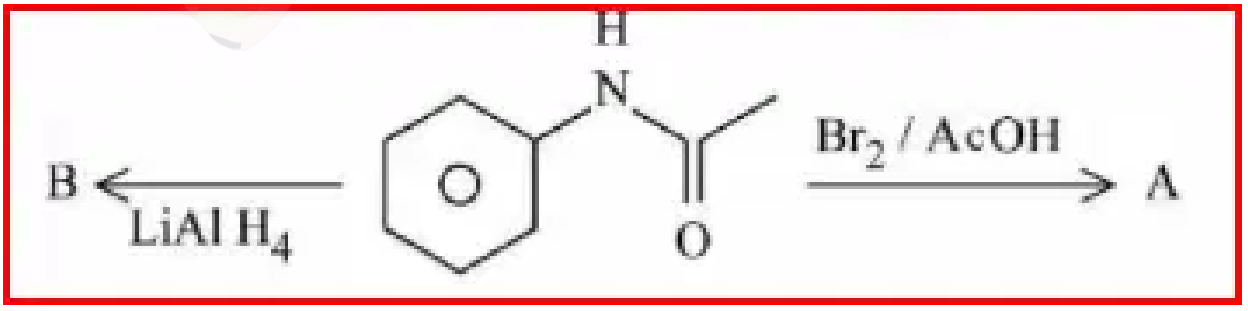
b. A-I, B-IV, C-II, D-III

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

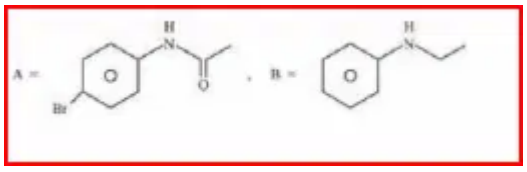
d. A-I, B-II, C-IV, D-III

---

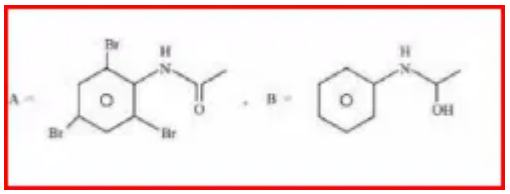
11. the major product A and B from the the following reaction are **(+4, -1)**

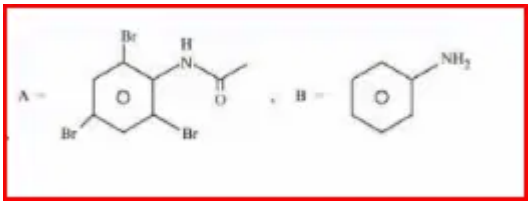


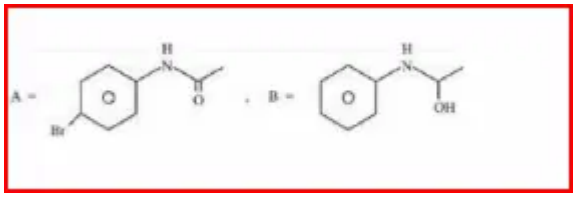
a.



b.

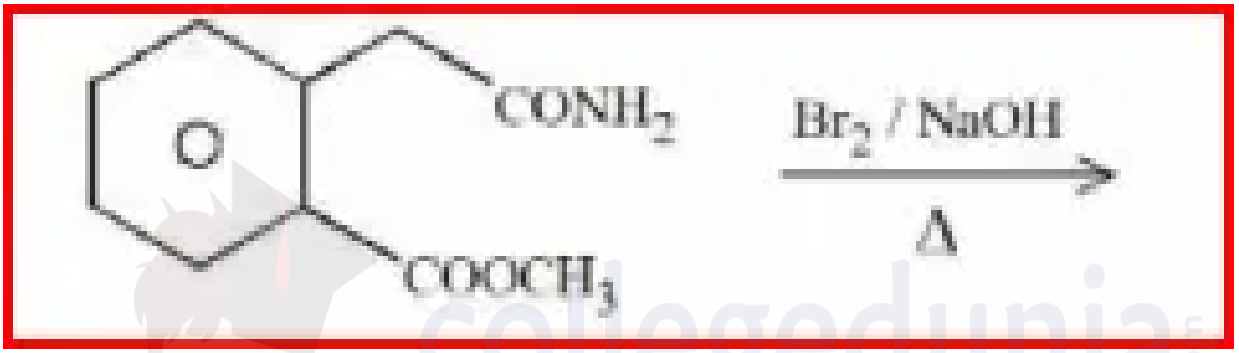


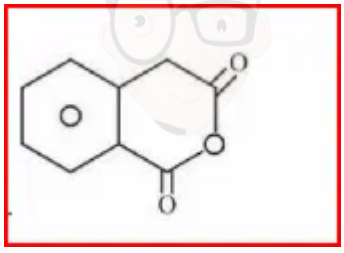
c. 

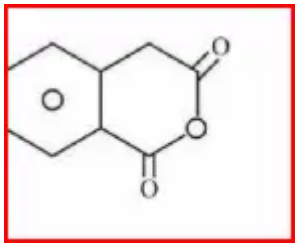
d. 

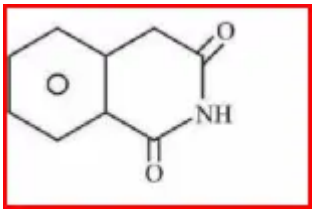
---

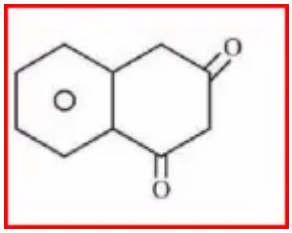
12. The major product formed in the following reaction is **(+4, -1)**



a. 

b. 

c. 

d. 

---

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

	List I Element detected		List II Reagent used/ Product formed
A	Nitrogen	I	$Na_2[Fe(CN)_5\ NO]$
B	Sulphur	II	$AgNO_3$
C	Phosphorous	III	$Fe_4[Fe(CN)_6]_3$
D	Halogen	IV	$(NH_4)_2\ MoO_4$

Choose the correct answer from the options given below:

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

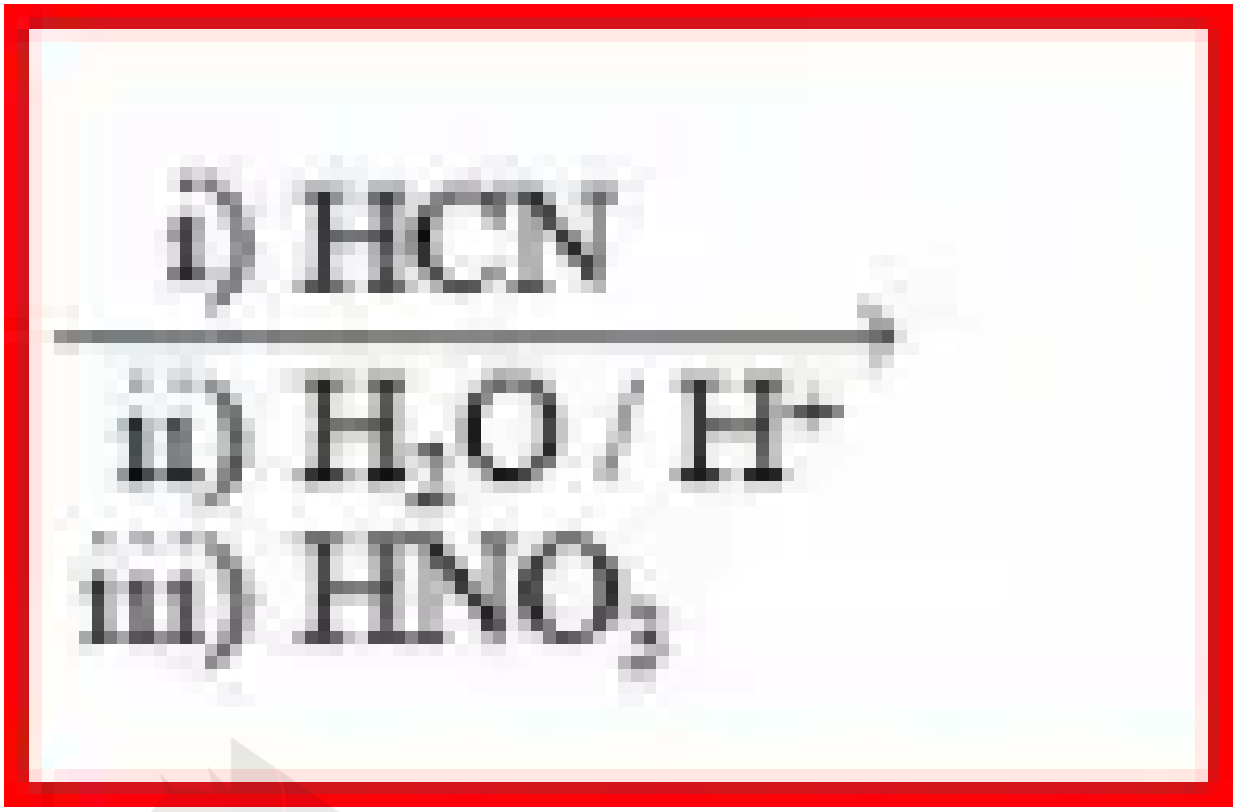
b. A-III, B-I, C-IV, D-II

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

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

---

14. D-(+)- Glyceraldehyde **(+4, -1)**



The two products formed in above reaction are

a. Two optically active products

b. One optically active and one meso product

c. wo optically inactive products

d. One optically inactive and one meso product.

---

15. Match the following **(+4, -1)**

Column-A	Column-B
Nylon 6	Natural Rubber
Vulcanized Rubber	Cross Linked
cis-1,4-polyisoprene	Caprolactam
Polychloroprene	Neoprene.

Choose the correct answer from option given below

a. a→ II, b→ III, c→ IV, d→I

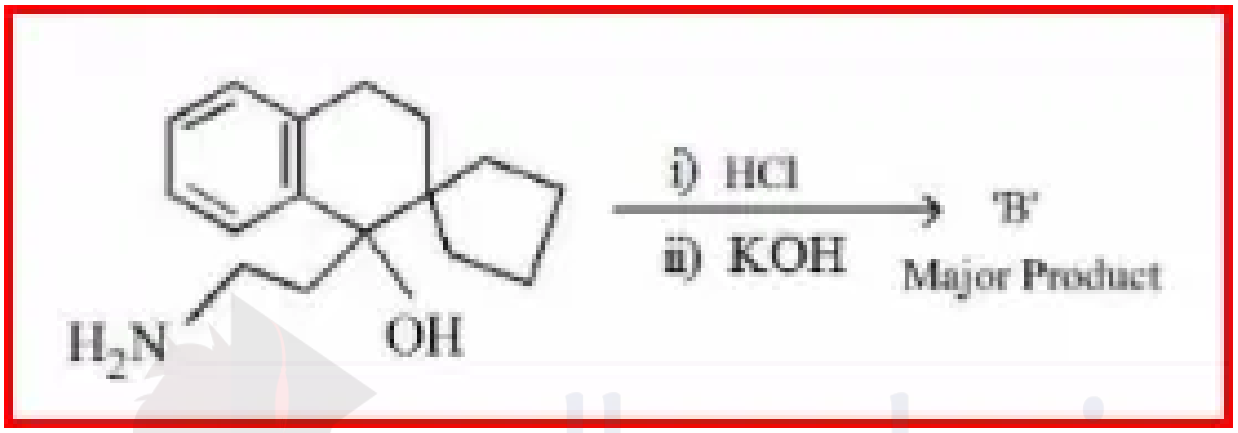
b. a→ III, b→II, c→I, d→ IV

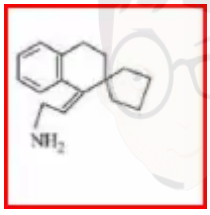
c. a→ III, b→ IV, c→I, d→ II

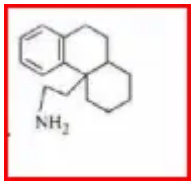
d. a→ IV, b-III, c→ II, d→I

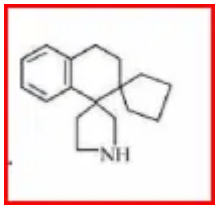
---

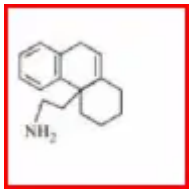
16. In the reaction given below 'B' is: **(+4, -1)**



a.


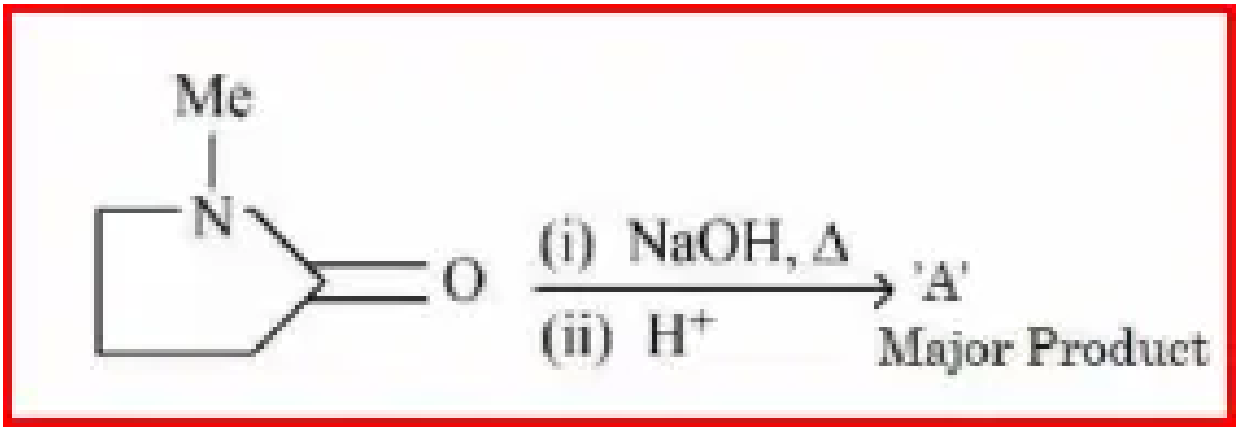
b.


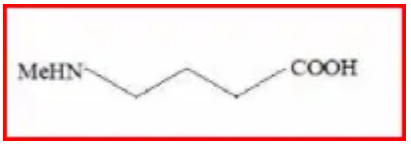
c.


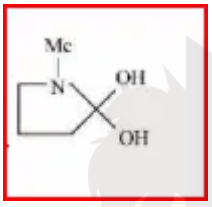
d.


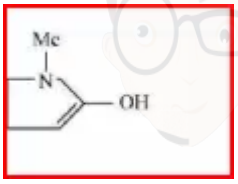
---

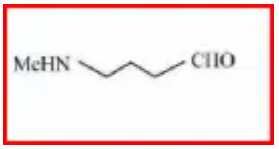
17. In the reaction given below 'A' is **(+4, -1)**

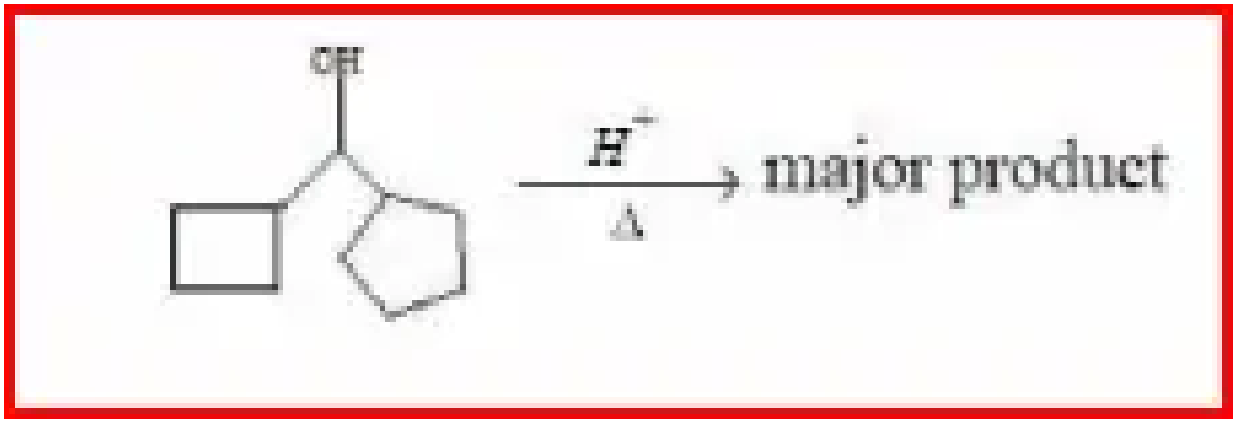


a. 

b. 

c. 

d. 



18. **(+4, -1)**

In the above reaction. Left hand side and right hand side rings are named as

'A' and 'B' respectively. They undergo ring expansion. The correct statement for this process is:

a. Finally both rings will become six membered each.

b. Finally both rings will become five membered each.

c. Ring expansion can go upto seven membered rings

d. Only 'A' will become 6 membered.

---

19. 2-Methyl propyl bromide reacts with $C_2H_5O^-$ and gives 'A' whereas on reaction with C_2H_5OH it gives 'B'. The mechanism followed in these reactions and the products 'A' and 'B' respectively are **(+4, -1)**

a. S_N2. A iso-butyl ethyl ether; S_N1, B = tert- butyl ethyl ether

b. S_N1, A tert-butyl ethyl ether; S_N2, B = iso- butyl ethyl ether

c. S_N1, A = tert-butyl ethyl ether; S_N1, B = 2- butyl ethyl ether

d. S_N2, A = 2-butyl ethyl ether; S_N2, B = iso- butyl ethyl ether

---

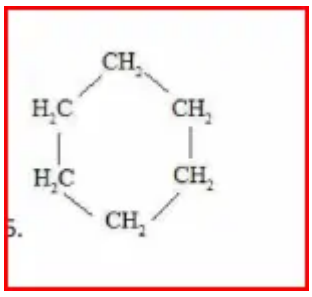
20. In the following reaction 'X' is **(+4, -1)**

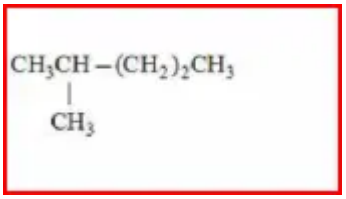
$CH_3\ (CH_2)_4\ CH_3 \xrightarrow[HCL\triangle]{Anhy.AlCl_3} X$ major product

a. $CH_3\ (CH_2)_4\ CH_2Cl$

b. $Cl\text{-}CH_2\text{-}(CH2)_4\text{-}CH_2\text{-}Cl$

c.



d. 

---

21. The mismatched combinations are **(+4, -1)**

A. Chlorophyll - Co

B. Water hardness - EDTA

C. Photography - $[Ag(CN)_2]^-$

D. Wilkinson catalyst - $[(Ph_3P)_3\ RhCl]$

E. Chelating ligand-D- Penicillamine

a. A, C and E only

b. A and C only

c. A and E only

d. D and E only

---

22. $Be(OH)_2$ reacts with $Sr(OH)_2$ to yield an ionic salt. Choose the incorrect option related to this reaction from the following: **(+4, -1)**

a. Both Sr and Be elements are present in the ionic salt.

b. The reaction is an example of acid - base neutralization reaction.

c. The element Be is present in the cationic part of the ionic salt.

d. Be is tetrahedrally coordinated in the ionic salt.

---

23. Given below are two statements : **(+4, -1)**

Statement-I: Morphine is a narcotic analgesis. It helps in relieving pain without producing sleep.

Statement-II: Morphine and its derivatives are obtained from opium poppy.

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

a. Both Statement I and Statement II are true

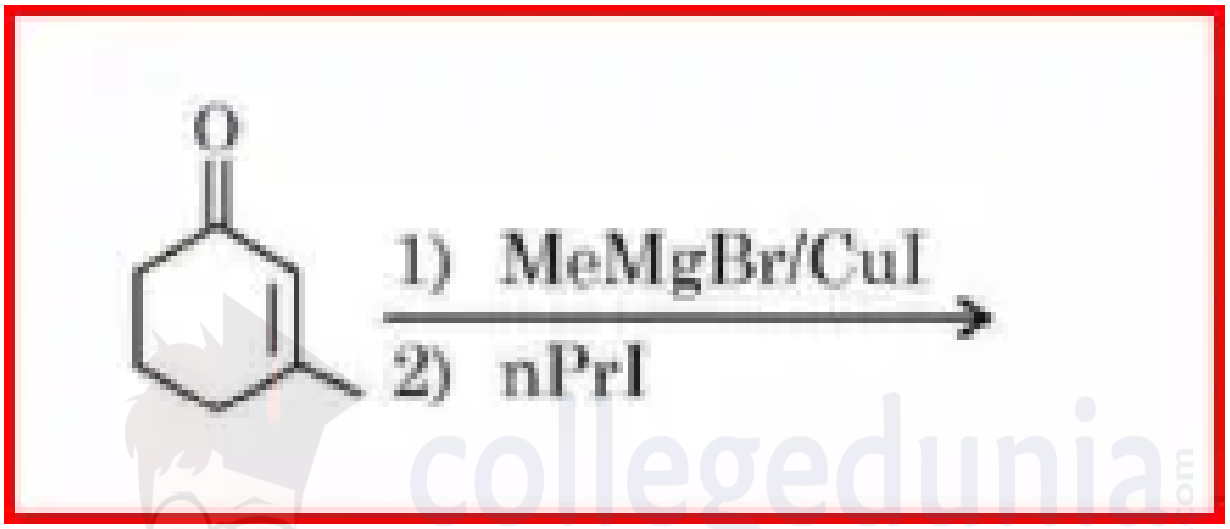
b. Both Statement I and Statement II are false

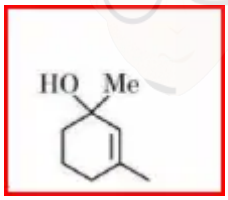
c. Statement I is true but Statement II is false

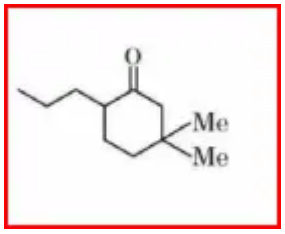
d. Statement I is false but Statement II is true

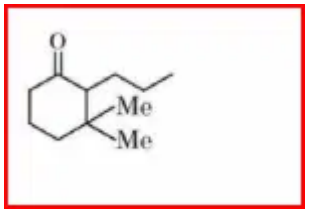
---

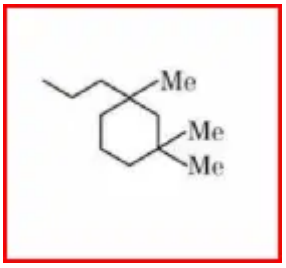
24. Find out the major product from the following reaction. **(+4, -1)**



a.


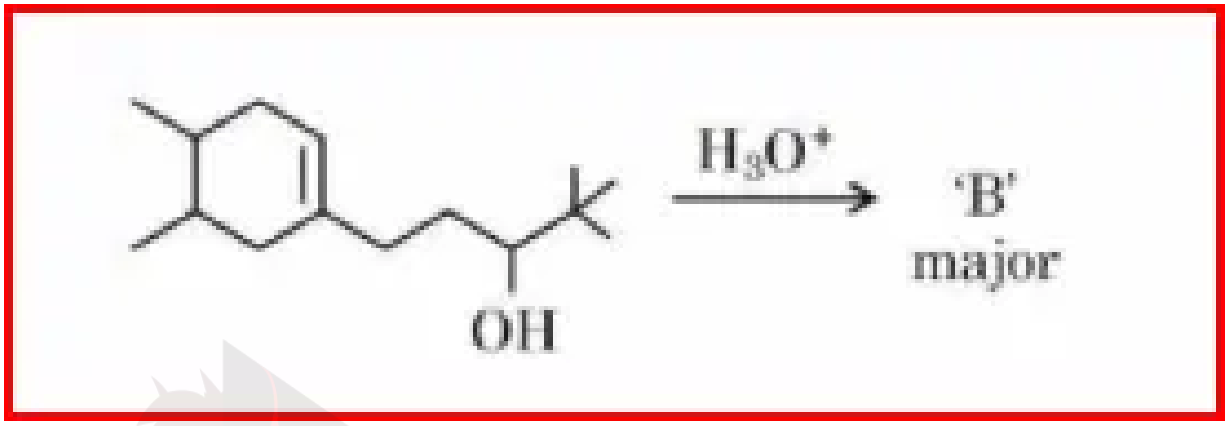
b.


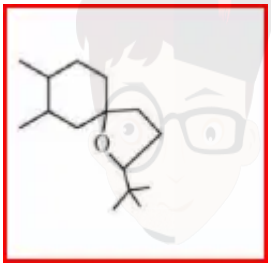
c.


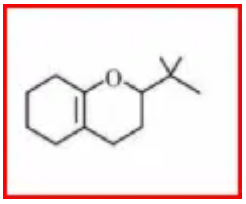
d. 

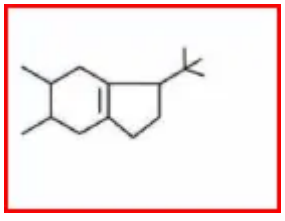
---

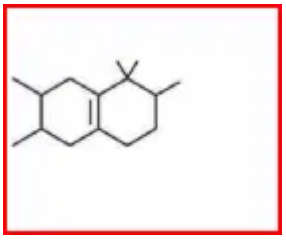
25. In the following reaction 'B' is **(+4, -1)**



a. 

b. 

c. 

d. 

Answers

1. **Answer: a**

Explanation:

The correct option is(A): Butanoic acid and acetic acid

---

2. **Answer: c**

Explanation:

The correct option is(C): A, C and D only

---

3. **Answer: c**

Explanation:

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

---

4. **Answer: b**

Explanation:

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

---

5. **Answer: c**

Explanation:

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

---

6. **Answer: c**

Explanation:

The major product P formed in the following sequence of reactions is: (i) $SOCl_2$ (ii) R-NH_2 (iii) $LiAlH_4$ (iv) H_3O^+ (1) [Structure with OH and NHR] (2) [Structure with Cl and OH] (3) [Structure with CONHR] (4) [Structure with CH_2NHR]

Explanation: 1. $SOCl_2$: Converts the carboxylic acid (-COOH) to an acyl chloride (-COCl). 2. R-NH_2: Reacts with the acyl chloride to form an amide (-CONHR). 3. $LiAlH_4$: Reduces the amide to an amine (-CH_2NHR). 4. H_3O^+: Acidic workup to protonate any intermediates. Therefore, the correct answer is (3).

---

7. Answer: b

Explanation:

The given reaction is an intramolecular Claisen condensation, also known as a Dieckmann condensation.

In this reaction, a 1,6-diketone reacts with a strong base (OEt^-) and heat to form a cyclic β-diketone. Explanation:

1. Reactant Structure: The reactant is a 1,6-diketone with the structure Me-C(=O)-$(CH_2)_4$-C(=O)-CH_3.

2. Base-Catalyzed Enolate Formation: The ethoxide base (OEt^-) will deprotonate an α-hydrogen (hydrogen adjacent to a carbonyl group). This creates an enolate.

3. Intramolecular Nucleophilic Attack: The enolate, being a nucleophile, will then attack the other carbonyl group in the same molecule. This forms a six-membered ring intermediate.

4. Elimination and Product Formation: Through a series of proton transfers and elimination steps, the final product formed is a cyclic β-diketone. Determining the Product: To determine the product, we need to consider the ring size that will be formed. In this case, a six-membered ring will be formed. The two carbonyl carbons will become part of the ring. The carbon chain between the two carbonyl carbons will form the rest of the ring. The methyl group (Me) and the CH_3 group attached to the carbonyl groups will remain as substituents on the ring. The correct product is option (3): The product is a six-membered ring with a methyl group (Me) and a CH_3 group

attached to the ring. The ring also contains two carbonyl groups (C=O) in a 1,3-relationship (β-diketone). Therefore, the answer is (3).

---

8. **Answer: a**

Explanation:

The correct answer is (3) Butanal and acetaldehyde.

Explanation: Ozonolysis of 2-hexene, followed by a reductive workup with water, cleaves the double bond. * The fragment CH3-CH= becomes CH3-CHO (acetaldehyde). * The fragment =CH-CH2-CH2-CH3 becomes O=CH-CH2-CH2-CH3 (butanal). Therefore, the products are butanal and acetaldehyde.

---

9. **Answer: a**

Explanation:

The products of the ozonolysis of 2-hexene followed by reduction with H_2O are butanal and acetaldehyde. Therefore, the correct answer is: (3) Butanal and acetaldehyde

---

10. **Answer: b**

Explanation:

Solution:
We need to match the complexes in List-I with their Crystal Field Stabilization Energy (CFSE) values in List-II.

Let's analyze each complex:

A. $[Cu(NH_3)_6]^{2+}$
Cu^{2+} has a d^9 configuration. In an octahedral field, it will have a $t_{2g}^6\ e_g^3$

configuration. Due to Jahn-Teller distortion, the CFSE is not straightforward. However, for a d^9 high spin configuration, it would be approximately $-0.6\Delta_o$.
Therefore, A matches with I (-0.6).

B. $[Ti(H_2O)_6]^{3+}$

Ti^{3+} has a d^1 configuration. In an octahedral field, it will have a $t_{2g}^1 e_g^0$ configuration. The CFSE is $-0.4\Delta_o$.
Therefore, B matches with IV (-0.4).

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

Fe^{3+} has a d^5 configuration. CN^- is a strong field ligand, so it will be a low spin complex with a $t_{2g}^5 e_g^0$ configuration. The CFSE is $-2.0\Delta_o$.
Therefore, C matches with II (-2.0).

D. $[NiF_6]^{4-}$

Ni^{2+} has a d^8 configuration. F^- is a weak field ligand, so it will be a high spin complex with a $t_{2g}^6 e_g^2$ configuration. The CFSE is $-1.2\Delta_o$.
Therefore, D matches with III (-1.2).

Matching:
A - I (-0.6)
B - IV (-0.4)
C - II (-2.0)
D - III (-1.2)

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

---

11. Answer: a

Explanation:

The given reaction involves two steps:

1. **Reduction with $LiAlH_4$:**
   - $LiAlH_4$ is a strong reducing agent that reduces amides to primary amines.

- The amide group is reduced to form **B**, which is Cyclohexylamine ($C_6H_{11}NH_2$).

2. **Reaction with Br_2/AcOH (Hoffmann Bromamide Reaction):**
   - Bromine (Br_2) in the presence of acetic acid ($AcOH$) facilitates the Hoffmann bromamide reaction.
   - This leads to the formation of an alkyl isocyanate intermediate, which hydrolyzes to yield the final product **A**.
   - **A** is Cyclohexanone ($C_6H_{10}O$).

Final Products:

- **B:** Cyclohexylamine ($C_6H_{11}NH_2$)
- **A:** Cyclohexanone ($C_6H_{10}O$)

---

12. **Answer: a**

Explanation:

The reaction given involves the treatment of the compound with **bromine (Br_2)** in the presence of **sodium hydroxide (NaOH)** under heat (Δ). This is a classic example of the **Hofmann Bromamide Degradation Reaction**.

Steps in the Reaction

1. **Amide Group Conversion:** The amide group ($-CONH_2$) undergoes degradation in the presence of **Br_2/NaOH**, forming a primary amine ($-NH_2$).
2. **Retention of Other Groups:** The ester group ($-COOCH_3$) remains intact during this reaction as it does not participate in the Hofmann degradation.
3. **Formation of the Product:** The resulting product is a compound where the $-CONH_2$ group is replaced by a $-NH_2$ group, while the ester group remains unchanged.

Major Product

The major product formed in this reaction is:

Cyclohexanone derivative with an amine group (-NH_2) and an ester group (-$COOCH_3$) intact.

Key Points

- This reaction selectively degrades the amide group to a primary amine.
- The ester group remains unaltered.
- This is an example of the **Hofmann Bromamide Reaction**, which is widely used for amide to amine conversion.

---

13. Answer: b

Explanation:

- **A: Nitrogen – $Fe_4[Fe(CN)_6]_3$**
  - Nitrogen is detected by converting it into Prussian blue ($Fe_4[Fe(CN)_6]_3$) using the Lassaigne's test.
- **B: Sulphur – $Na_2[Fe(CN)_5NO]$**
  - Sulphur reacts to form sodium nitroprusside ($Na_2[Fe(CN)_5NO]$), which gives a violet color, indicating the presence of sulfur.
- **C: Phosphorus – $(NH_4)_2MoO_4$**
  - Phosphorus is detected as ammonium phosphomolybdate, which forms a yellow precipitate.
- **D: Halogen – $AgNO_3$**
  - Halogens are detected by forming a precipitate with $AgNO_3$. The precipitate's color varies depending on the halogen: white (chloride), pale yellow (bromide), or yellow (iodide).

---

14. Answer: b

Explanation:

When D–(+) Glyceraldehyde undergoes the given reactions, the stereochemistry of the products is determined by the formation of new chiral centers and the possibility of internal symmetry leading to meso compounds.

Reaction with HCN:

The addition of HCN to D−(+) Glyceraldehyde leads to the formation of cyanohydrins. This reaction creates a new chiral center, resulting in the formation of a product that is optically active due to the presence of two stereocenters without internal symmetry.

Reaction with H_2O/H^+:

This step likely involves hydrolysis or another transformation that maintains or affects the stereochemistry established in the previous step. However, the critical transformation comes in the next step.

Reaction with HNO_3:

Oxidation with HNO_3 can lead to the formation of a diketone or similar structure. If the molecule develops an internal plane of symmetry during this oxidation, it becomes a meso compound. Meso compounds have multiple stereocenters but are optically inactive due to internal symmetry.

Therefore, the overall reaction sequence results in:

One optically active product (from the initial addition of HCN forming a chiral molecule without internal symmetry).

One meso product (from oxidation leading to internal symmetry).

This corresponds to option (3).

---

15. Answer: b

Explanation:

Solution:

a) Nylon 6 is synthesized from **Caprolactam**, hence a→III

b) Vulcanized Rubber involves **cross-linking**, hence b→II

c) **cis–1,4–polyisoprene** is the polymer form of **Natural Rubber**, hence c→I

d) **Polychloroprene** is commercially known as **Neoprene**, hence d→IV

Therefore, the correct matching is option (3).

---

16. **Answer: d**

Explanation:

The correct option is(D):

---

17. **Answer: a**

Explanation:

The correct option is: (A)

---

18. **Answer: a**

Explanation:

In ring expansion reactions, smaller rings typically convert to larger rings to achieve greater stability and reduce ring strain. When both rings 'A' and 'B' undergo ring expansion, they both increase in size. The most common and stable outcome of such expansions is the formation of six-membered rings, which are energetically favorable due to their optimal bond angles and minimal ring strain. Therefore, both rings 'A' and 'B' will become six-membered rings after the expansion process.

---

19. **Answer: a**

Explanation:

2-Methyl propyl bromide, also known as isobutyl bromide ($CH_3CH_2CH(CH_3)Br$), reacts differently with $C_2H_5O^-$ and C_2H_5OH due to their differing nucleophilicity and basicity.

Reaction with $C_2H_5O^-$ (Ethoxide Ion):

Ethoxide ion is a strong, bulky nucleophile.

The reaction proceeds via an **SN_2** mechanism due to the strong nucleophilic nature of $C_2H_5O^-$.

The substitution occurs at the less hindered primary carbon, leading to the formation of **iso-butyl ethyl ether** ($CH_3CH_2CH(CH_3)OC_2H_5$).

Reaction with C_2H_5OH (Ethanol):

Ethanol is a weak nucleophile and cannot effectively participate in **SN_2** reactions.

The reaction proceeds via an **SN_1** mechanism, which involves the formation of a carbocation intermediate.

Upon ionization, the secondary carbocation formed can rearrange to a more stable **tertiary carbocation**.

This leads to the formation of **tert-butyl ethyl ether** ($(CH_3)_3COC_2H_5$).

Therefore, the correct mechanism and products are:

A = iso-butyl ethyl ether via **SN_2** mechanism.

B = tert-butyl ethyl ether via **SN_1** mechanism.

This corresponds to option (3).

---

20. Answer: d

Explanation:

n-alkanes on heating in this presence of anhydrous A1Cl3 and hydrogen chloride gas isomerise to branched chain alkanes.

The major product has one methyl side chain.

---

21. Answer: b

Explanation:

- Chlorophyll contains magnesium (Mg), not cobalt (Co), so the combination A is mismatched.
- Water hardness is treated using EDTA, which is correct.
- Photography involves silver salts like AgCl, not $[\mathrm{Ag(CN)_2}]$, so the combination C is mismatched.
- Wilkinson catalyst is indeed $[(Ph_3P)_3\mathrm{RhCl}]$, which is correct.
- D-Penicillamine is a chelating ligand, which is correct.

Thus, the mismatched combinations are A and C.

---

22. Answer: c

Explanation:

- In the reaction between $\mathrm{Be(OH)_2}$ and $\mathrm{Sr(OH)_2}$, an ionic salt is formed. The reaction is an acid-base neutralization, where the hydroxide ions from both compounds combine to form water, leaving the cations of Be and Sr.
- Be is not present in the cationic part of the salt. Instead, it forms an ionic bond with the hydroxide ions in the product, and Sr is present in the cationic part of the salt. Therefore, option (3) is incorrect.
- The reaction is indeed an acid-base neutralization because both $\mathrm{Be(OH)_2}$ and $\mathrm{Sr(OH)_2}$ are bases. Hence, option (2) is correct.
- Be is tetrahedrally coordinated in the ionic salt, which is a characteristic of its coordination in such compounds, making option (1) correct.
- Both Be and Sr are present in the ionic salt formed from the reaction. Hence, option (4) is correct. Thus, the incorrect statement is (3).

---

23. Answer: d

Explanation:

Morphine Properties Analysis

Let's analyze both statements:

Statement I: Morphine is a narcotic analgesic. However, it is known to induce sleep and drowsiness. So, Statement I is false.

Statement II: Morphine and its derivatives are indeed obtained from opium poppy. So, Statement II is true.

Conclusion:

Therefore, the correct option is **(4): Statement I is false, but Statement II is true**.

---

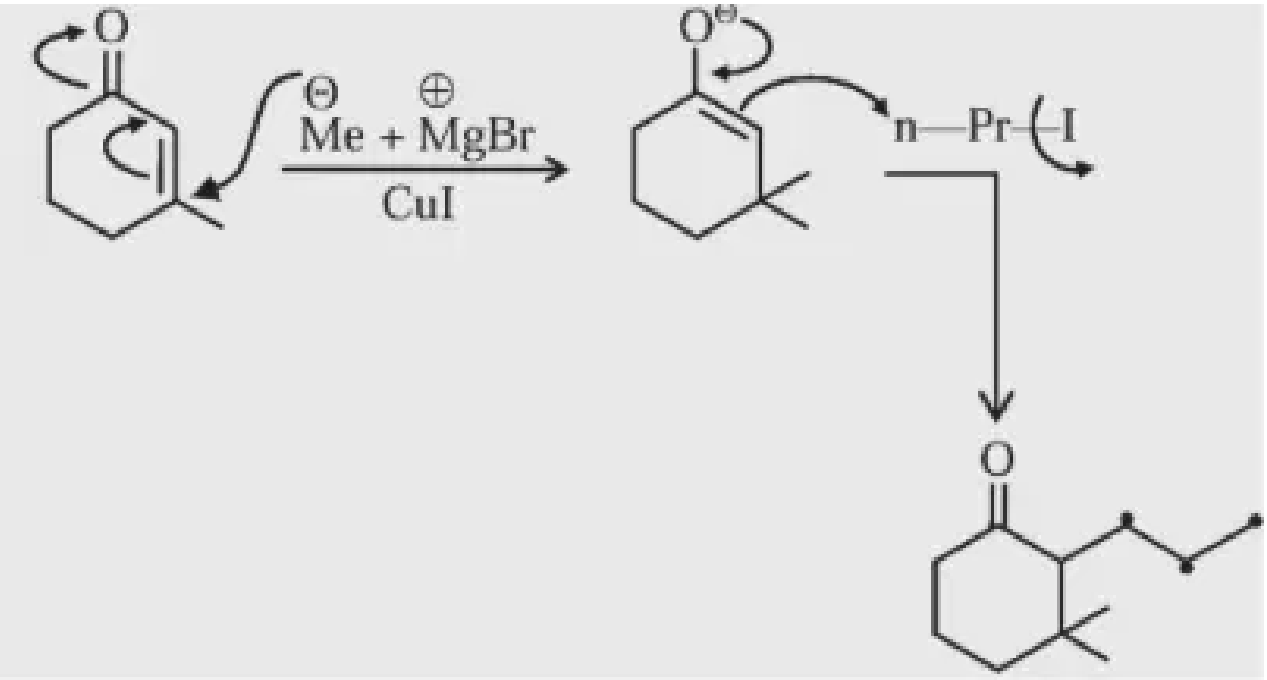
24. **Answer: c**

Explanation:

Organocuprate Reaction Mechanism

The reaction proceeds in two steps:

1. **1,4-addition of the organocuprate:** The organocuprate reagent (MeMgBr/CuI) adds to the α, β-unsaturated ketone in a 1,4-conjugate addition manner. This results in the formation of a ketone with a methyl group at the β position.
2. **Alkylation of the ketone:** The resulting ketone reacts with n-propyl iodide (nPrI) in an alkylation reaction. The enolate of the ketone attacks the alkyl halide, adding the n-propyl group to the α-carbon.



Conclusion:

Therefore, the major product is **option (3)**.

---

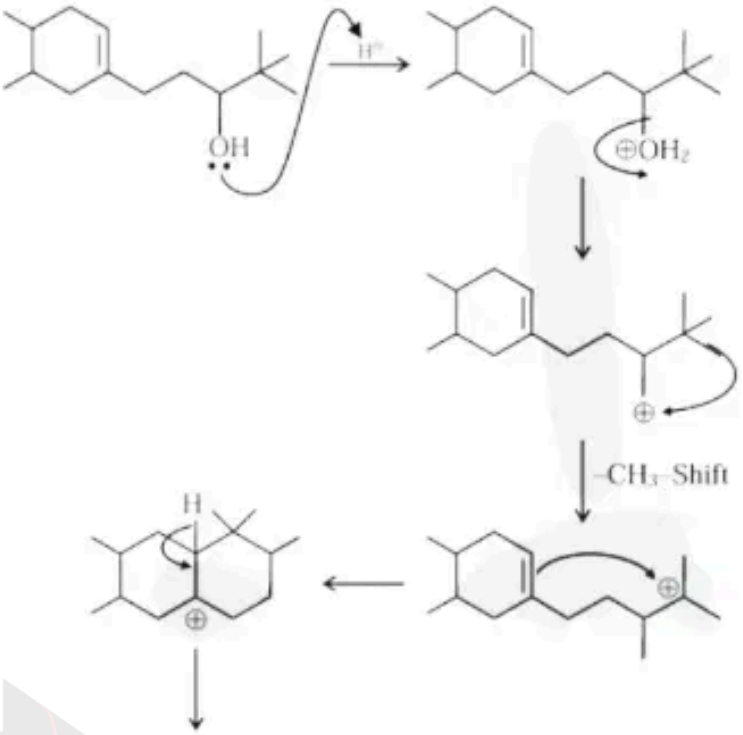
25. **Answer: d**

Explanation:

Acid-Catalyzed Cyclization Mechanism

The given reaction is an acid-catalyzed intramolecular cyclization of an unsaturated alcohol. The mechanism involves:

1. **Protonation of the alcohol:** The hydroxyl group is protonated by H_3O^+, making it a better leaving group.
2. **Carbocation formation:** Water leaves, generating a secondary carbocation.
3. **Cyclization:** The double bond attacks the carbocation, forming a six-membered ring. This results in a tertiary carbocation. Crucially, this carbocation is formed adjacent to the oxygen in the newly formed ring.
4. **Deprotonation:** A proton is lost to give the final cyclic ether product.



The correct product, resulting from the more stable tertiary carbocation and forming the six-membered ring, is option (4).