Organic Chemistry JEE Main PYQ - 3

Total Time: 1 Hour : 15 Minute **Total Marks:** 120

Instructions

Instructions

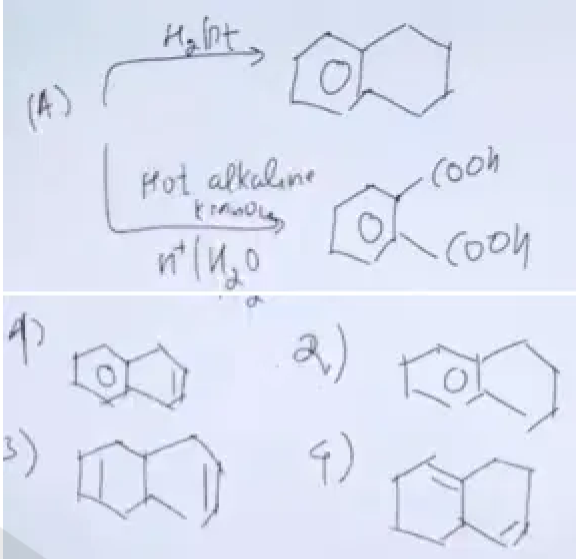
1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

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.

Organic Chemistry

1. An organic compound (A) on catalytic hydrogenation with H_2/Pt gives tetralin, and on oxidation with hot alkaline $KMnO_4$ followed by acidification gives phthalic acid. Identify compound (A). (+4, -1)



a. Option a

b. Option b

c. Option c

d. Option d

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2. Match List - I and List - II. List - I : (a) R-COCl → R-CHO (b) R-CH2-COOH → R-CH-Cl-COOH (c) R-CONH2 → R-NH2 (d) R-COCH3 → R-CH2-CH3 List - II : (i) Br2/NaOH (ii) H2/Pd-BaSO4 (iii) Zn(Hg)/Conc. HCl (iv) Cl2/Red P, H2O (+4, -1)

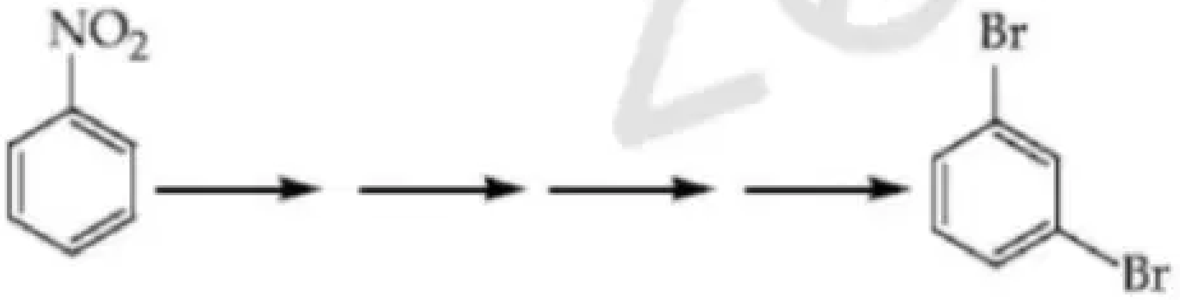
a. (a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)

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

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

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

3. **What is the correct sequence of reagents used for converting nitrobenzene into m-dibromobenzene ?** **(+4, -1)**



a. Sn/HCl / KBr / Br2 / H+

b. NaNO2 / HCl / KBr / H+

c. Sn/HCl / NaNO2/HCl / CuBr/HBr

d. Br2/Fe / Sn/HCl / NaNO2/HCl / CuBr/HBr

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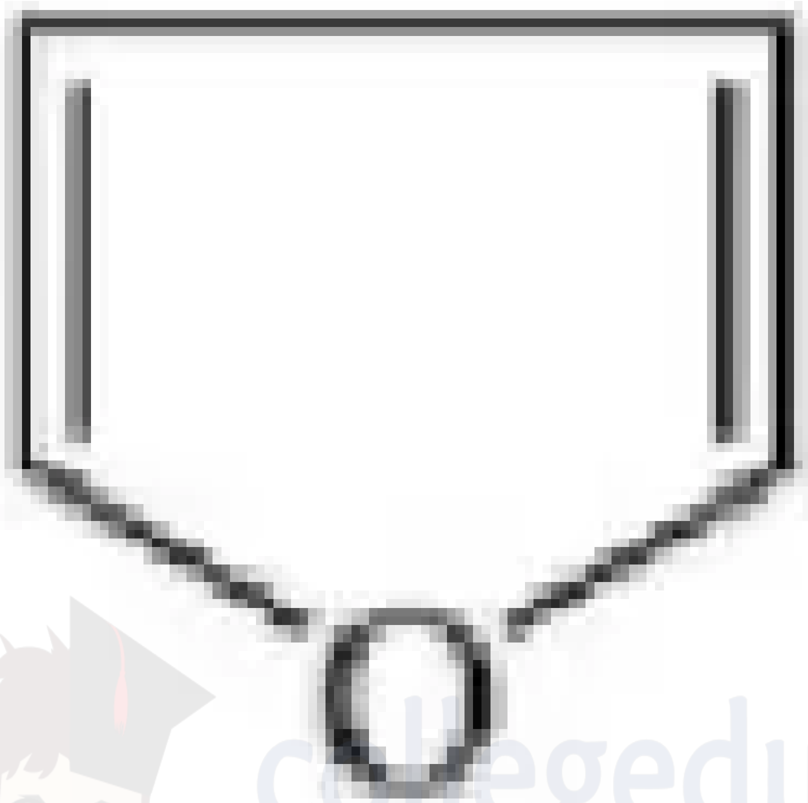
4. **Which one of the following compounds is non-aromatic ?** **(+4, -1)**



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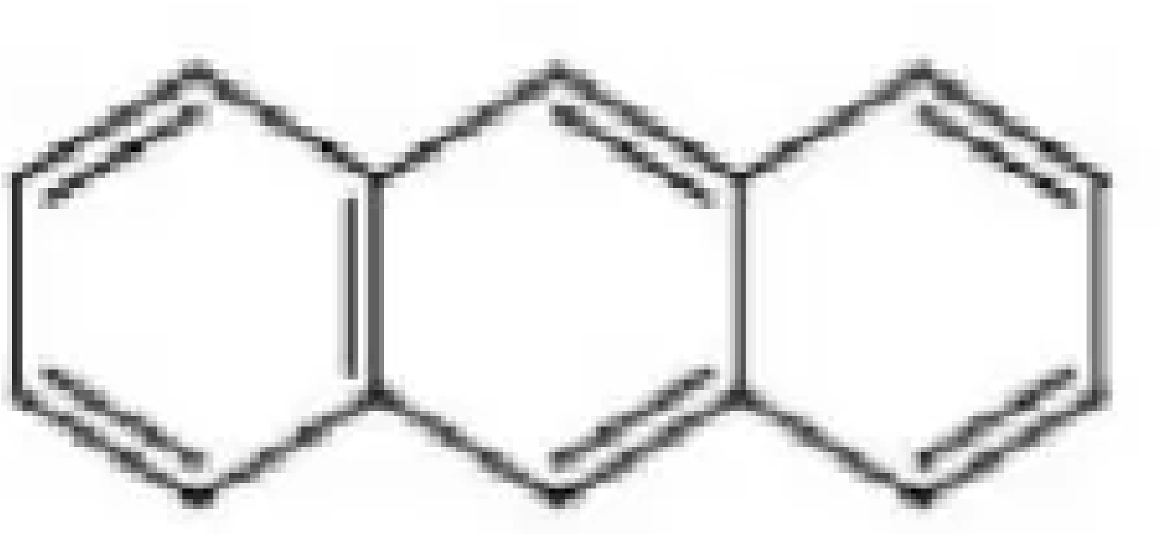

a. A

b. B

c. C

d. D

---

5. ________ grams of 3-Hydroxy propanal (MW = 74) must be dehydrated to produce 7.8 g of acrolein (MW = 56) if the percentage yield is 64. (Round off to the Nearest Integer). (+4, -1)

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

(a) Alcoholic potassium hydroxide
(b) $Pd/BaSO_4$
(c) BHC (Benzene hexachloride)
(d) Polyacetylene **List - II (Use/Preparation/Constituent)**
(i) electrodes in batteries
(ii) obtained by addition reaction
(iii) used for β-elimination reaction
(iv) Lindlar's Catalyst

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

---

7. Compound with molecular formula C_3H_6O can show : **(+4, -1)**

a. Positional isomerism

b. Functional group isomerism

c. Metamerism

d. Both positional isomerism and metamerism

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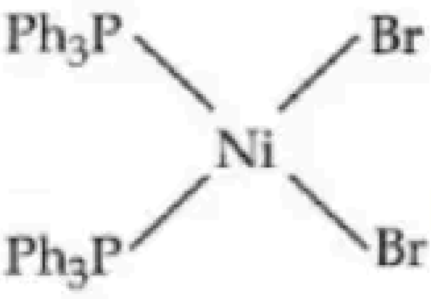
8. The correct structures of trans-$[NiBr_2(PPh_3)_2]$ and meridional-$[Co(NH_3)_3(NO_2)_3]$, respectively, are : **(+4, -1)**



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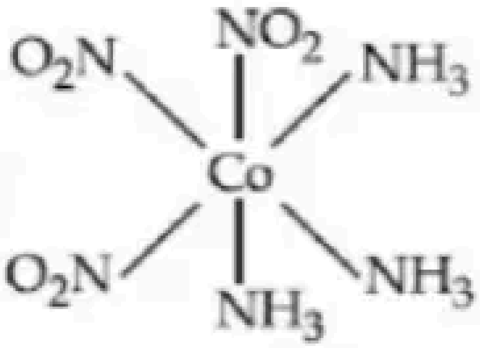

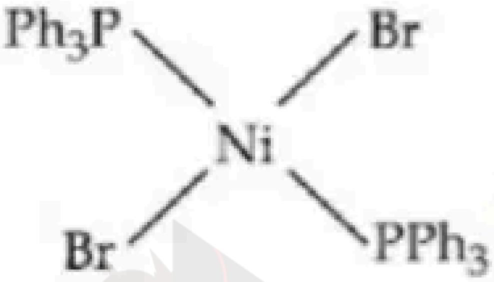

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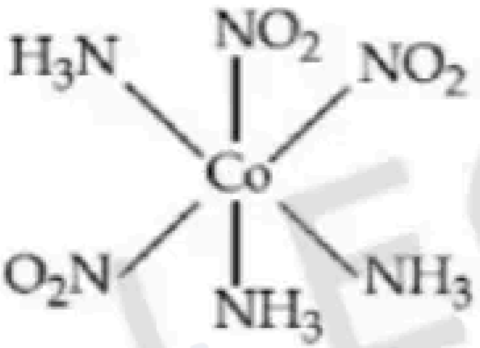

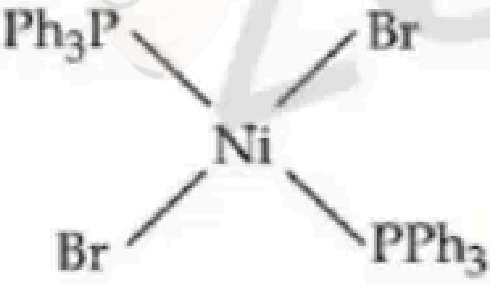

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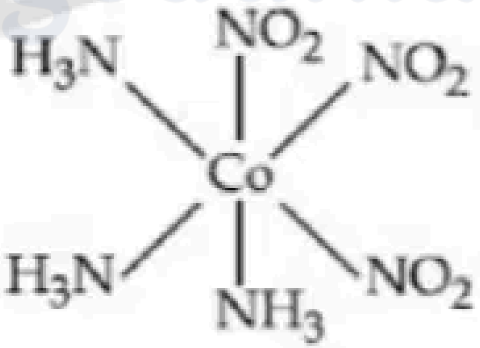

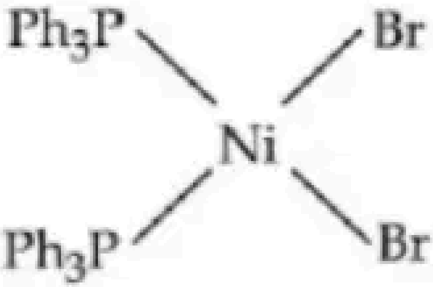

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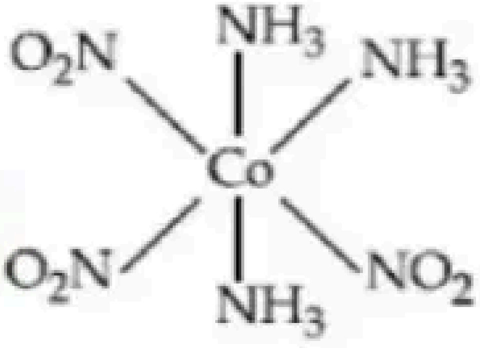

a. Trans Ni with Br opposite, mer Co with NO_2 adjacent

b. Trans Ni with P opposite, fac Co

c. Trans Ni, mer Co

d. Trans Ni, fac Co

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

(a) Chlorophyll
(b) Vitamin - B_{12}
(c) Anticancer drug
(d) Grubbs catalyst **List - II**
(i) Ruthenium
(ii) Platinum
(iii) Cobalt
(iv) Magnesium

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

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

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

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

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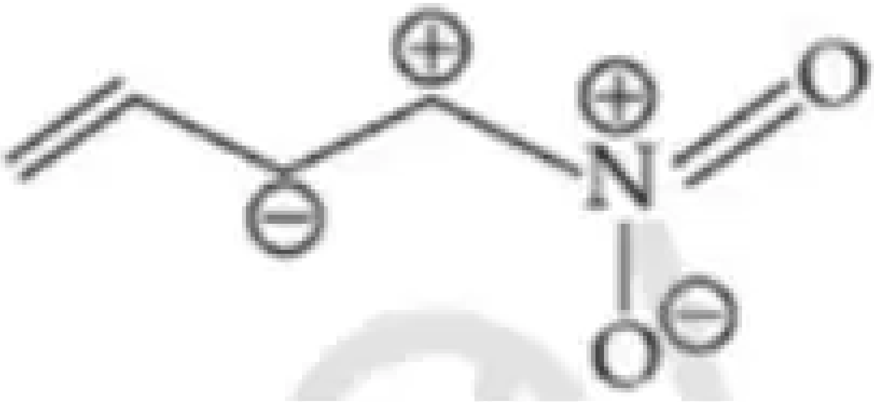
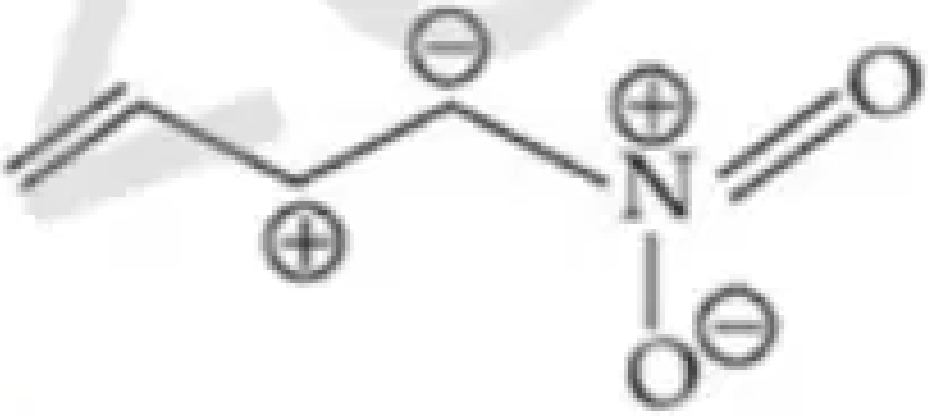
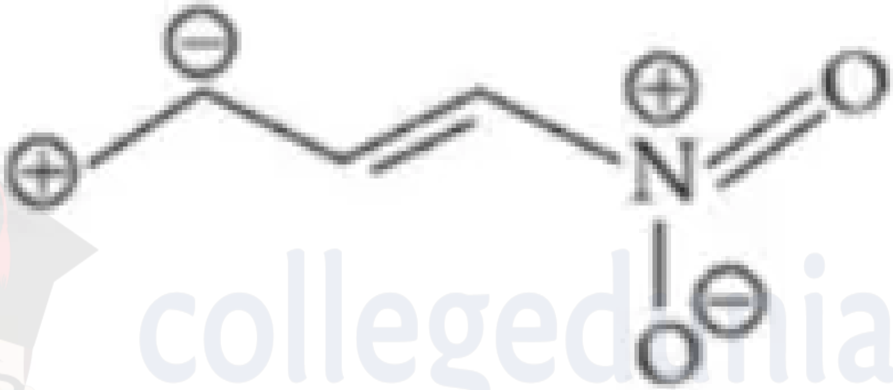
10. Which one among the following resonating structures is not correct ? **(+4, -1)**

(A)

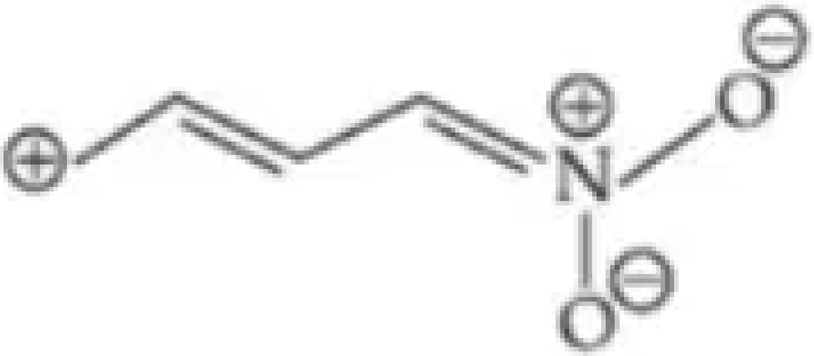




(B)



(C)



(D)

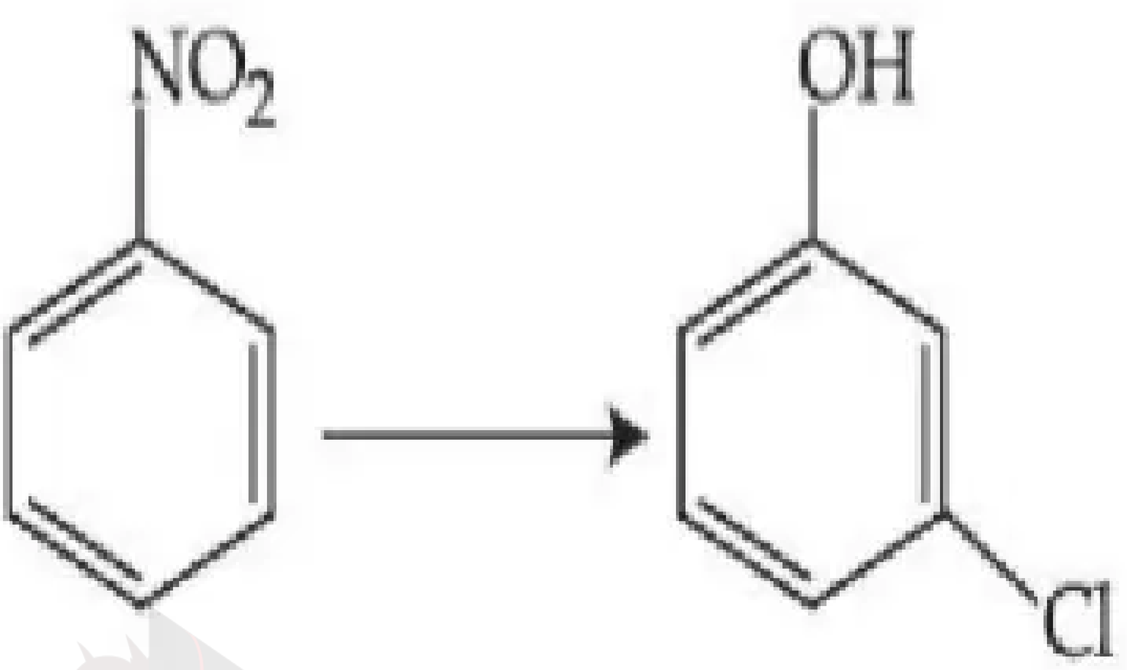
a. A

b. B

c. C

d. D

11. The correct sequence of correct reagents for the following transformation is : (+4, -1)



a. (i) $Cl_2, FeCl_3$ (ii) Fe, HCl (iii) $NaNO_2$, HCl, 0°C (iv) H_2O/H^+

b. (i) Fe, HCl (ii) $NaNO_2$, HCl, 0°C (iii) H_2O/H^+ (iv) $Cl_2, FeCl_3$

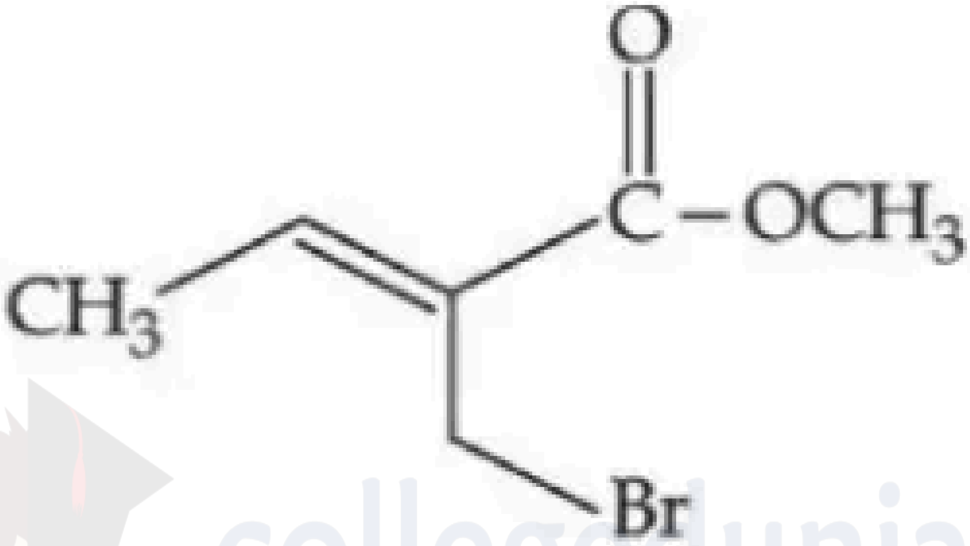
c. (i) Fe, HCl (ii) Cl_2, HCl (iii) $NaNO_2$, HCl, 0°C (iv) H_2O/H^+

d. (i) $Cl_2, FeCl_3$ (ii) $NaNO_2$, HCl, 0°C (iii) Fe, HCl (iv) H_2O/H^+

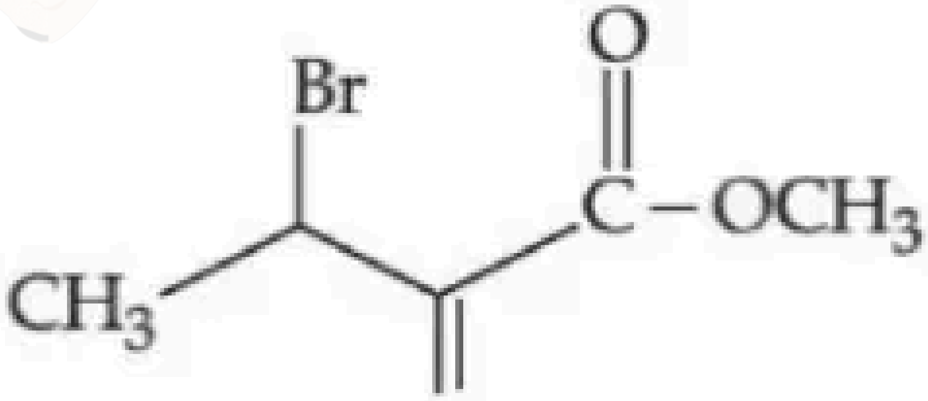
---

12. Consider the above reaction, the major product "P" formed is : (+4, -1)

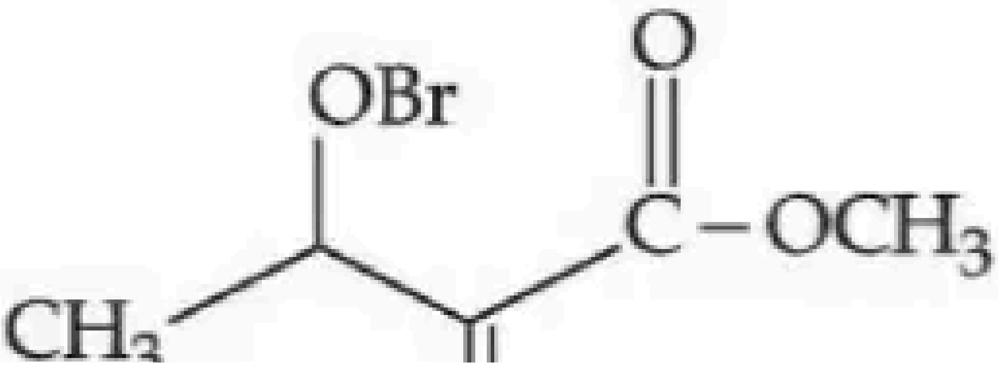

OH
O
H_3C
C–OCH$_3$
Conc. HBr
"P"
(Major Product)


O
CH$_3$
C–OCH$_3$
Br

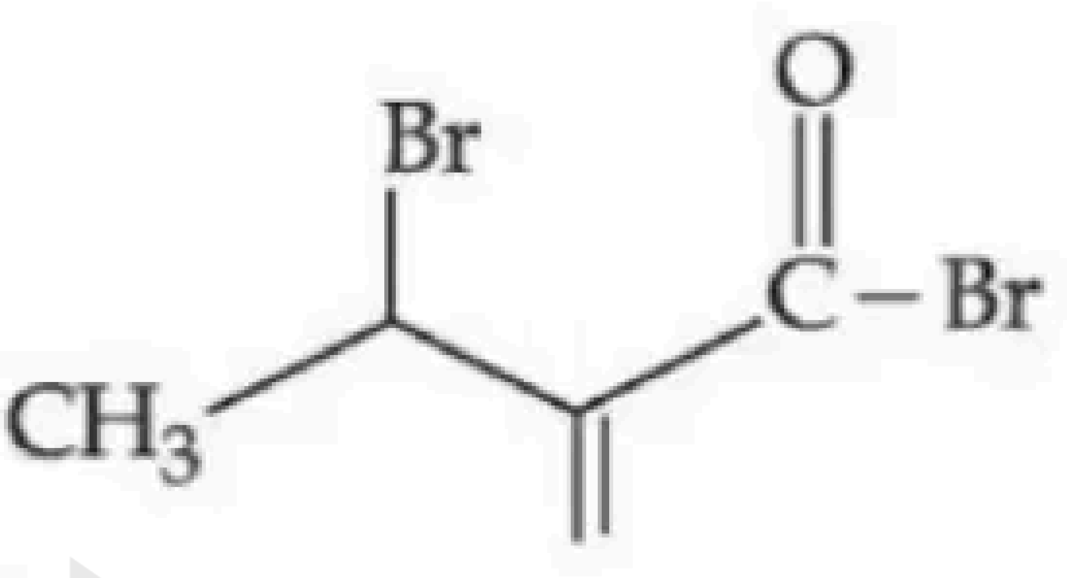
(A)


Br
O
CH$_3$
C–OCH$_3$

(B)


OBr
O
C–OCH$_3$
CH$_3$

(C)



(D)

a. A

b. B

c. C

d. D

---

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

Statement I : Hyperconjugation is a permanent effect.

Statement II : Hyperconjugation in ethyl cation $(CH_3 - CH_2^+)$ involves the overlapping of $C_{sp^2} - H_{1s}$ bond with empty $2p$ orbital of the other carbon.

Choose the correct option :

a. Both statement I and statement II are true

b. Both statement I and statement II are false

c. Statement I is correct but statement II is false

d. Statement I is incorrect but statement II is true

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14. Which one of the following set of elements can be detected using sodium fusion extract ? **(+4, -1)**

a. Nitrogen, Phosphorous, Carbon, Sulfur

b. Sulfur, Nitrogen, Phosphorous, Halogens

c. Phosphorous, Oxygen, Nitrogen, Halogens

d. Halogens, Nitrogen, Oxygen, Sulfur

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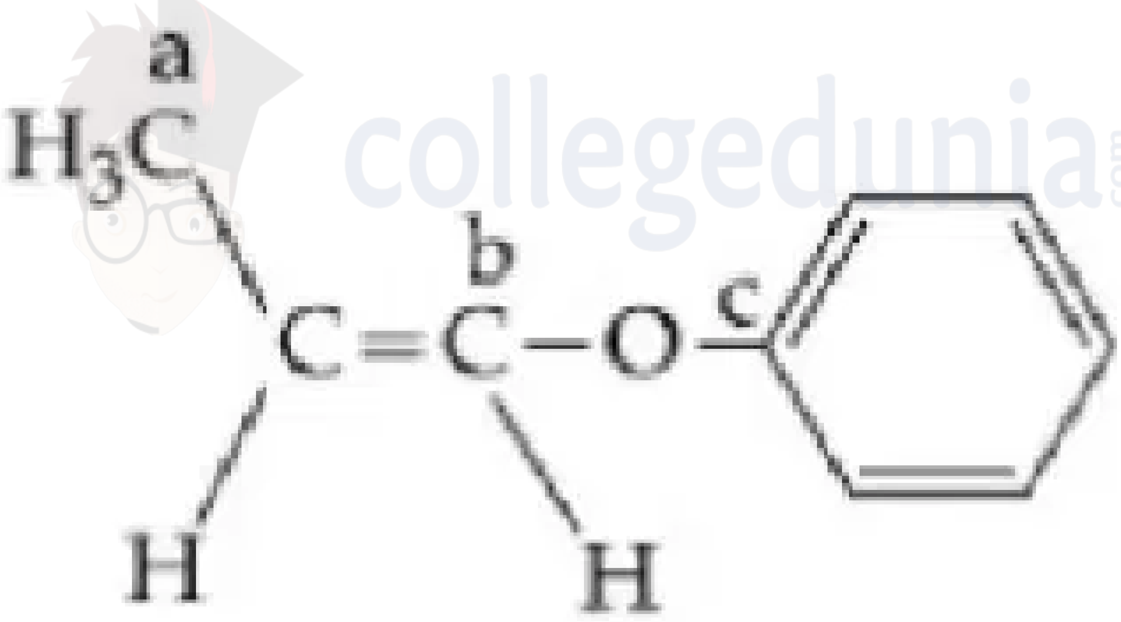
15. In the following molecule, **(+4, -1)**



Hybridisation of Carbon a, b and c respectively are :

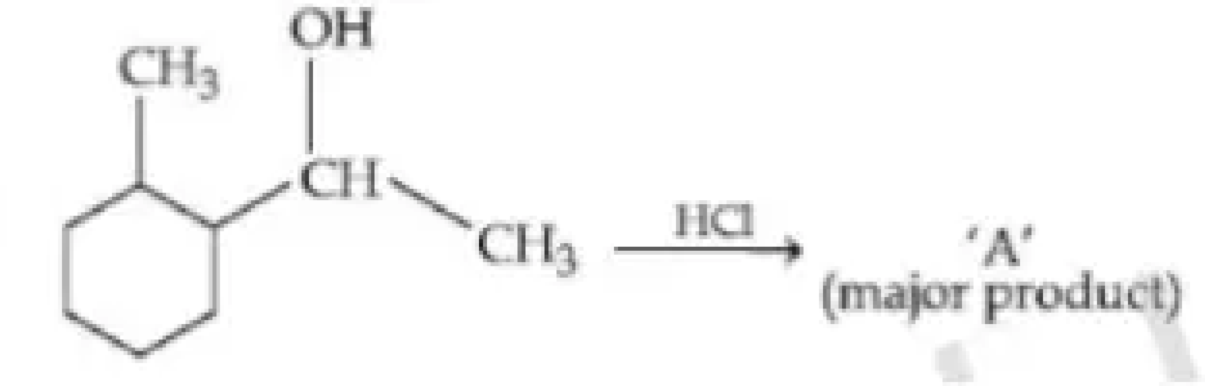
a. sp^3, sp^2, sp^2

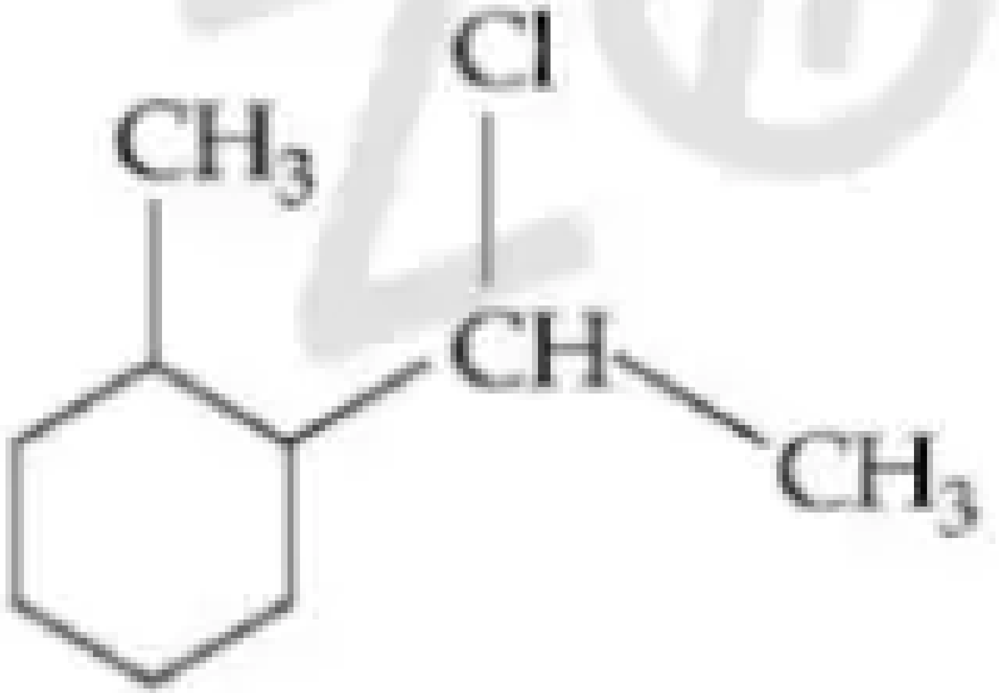
b. sp^3, sp, sp

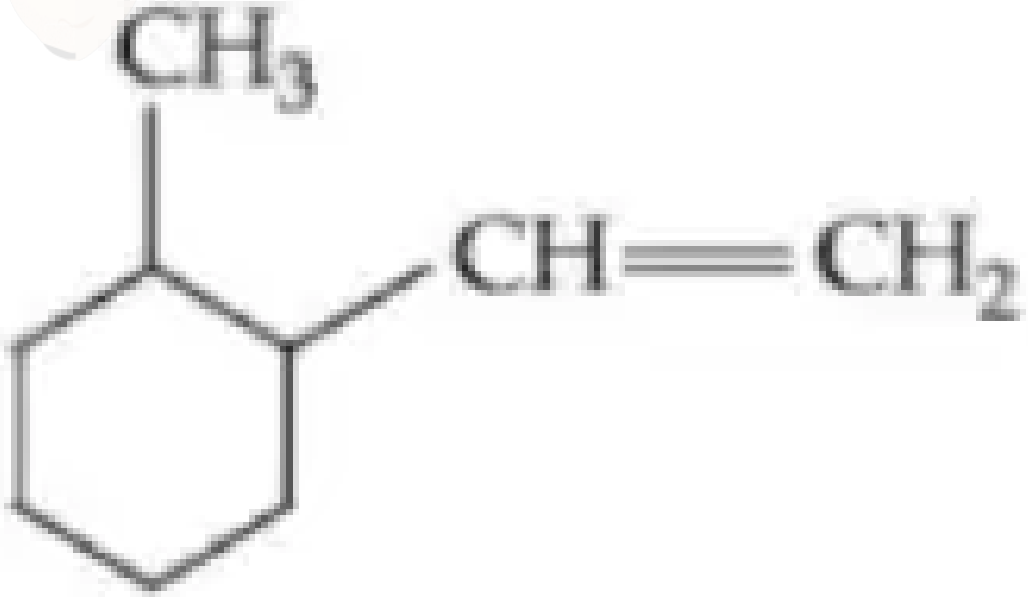
c. sp^2, sp, sp^2

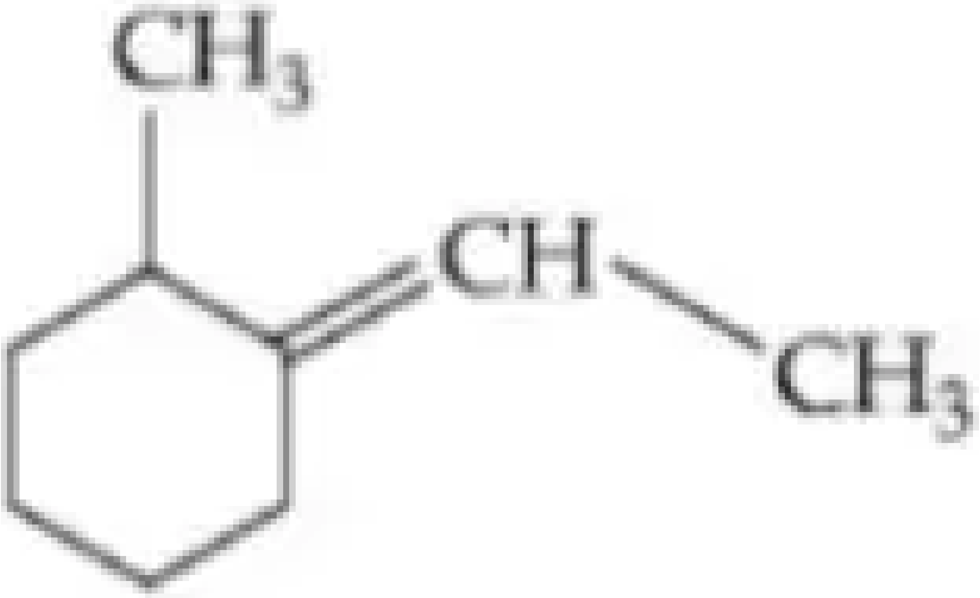
d. sp^3, sp, sp

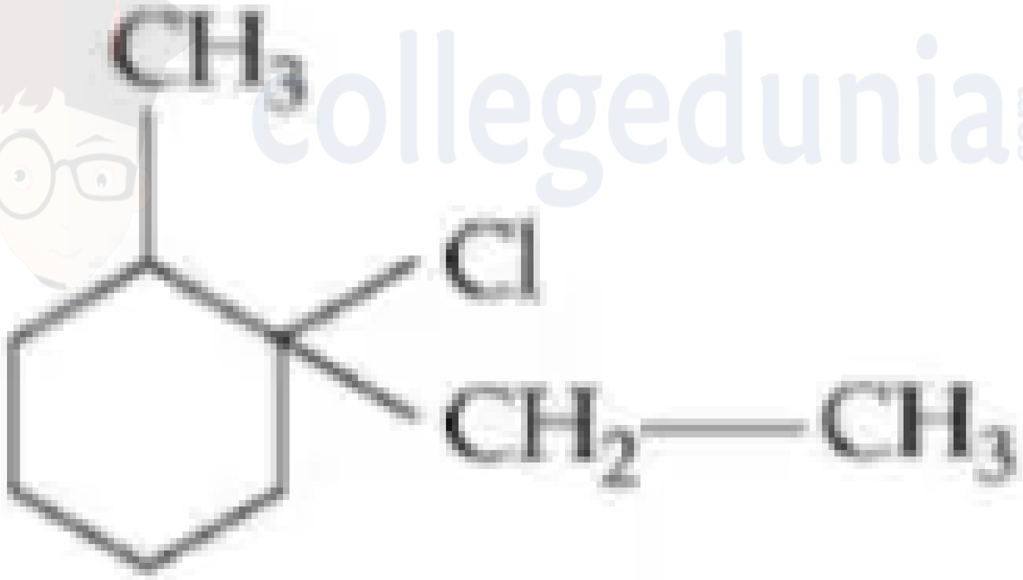
16. What is the final product (major) 'A' in the given reaction ? $CH_3 - CH = CH - CH_3 \xrightarrow{HCl} A$ (+4, -1)




Cl
CH$_3$
CH
CH$_3$


CH$_3$
CH
CH$_2$





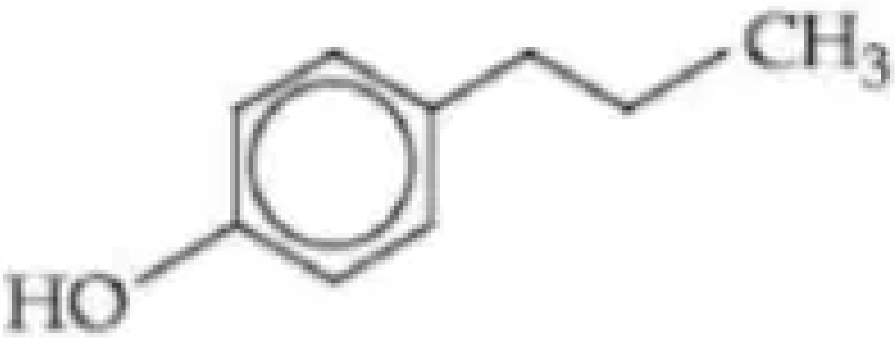
a. A

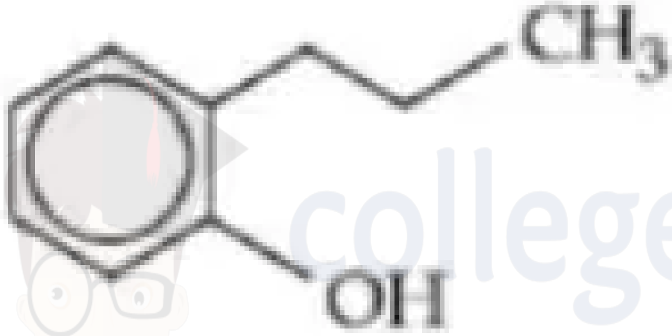
b. B

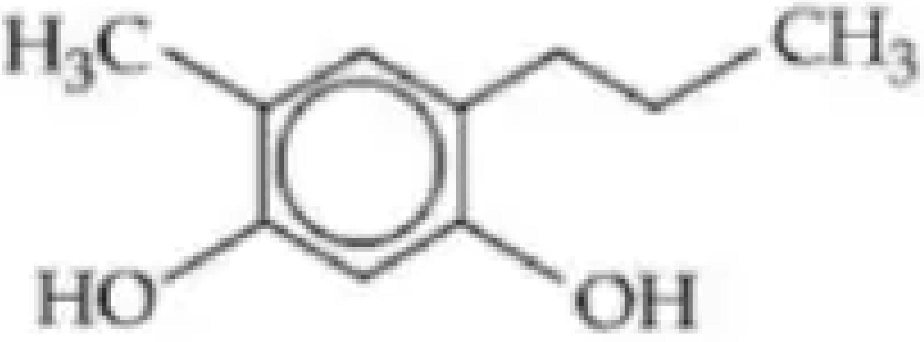
c. C

d. D

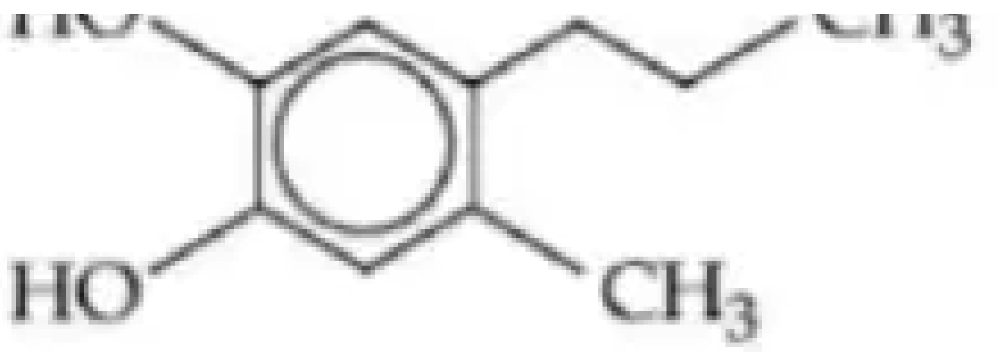
17. Which of the following compound gives pink colour on reaction with phthalic anhydride in conc. H_2SO_4 followed by treatment with $NaOH$? (+4, -1)


CH3
HO


CH3
OH


H3C
CH3
HO
OH


HO
CH3



a. A

b. B

c. C

d. D

---

18. Consider the reaction: CH≡CH $\xrightarrow{\text{Red hot Fe}}$ (1) $\xrightarrow{CO,HCl,AlCl_3}$ (2). The number of sp^2 hybridized carbon atom(s) in the product is ___________. (+4, -1)

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19. Which one of the following reactions will not form acetaldehyde ? (+4, -1)

a. $CH_2{=}CH_2 + O_2 \xrightarrow{Pd(II)/Cu(II)} H_2O$

b. $CH_3CH_2OH \xrightarrow{CrO_3-H_2SO_4}$

c. $CH_3CN \xrightarrow{(i)DIBAL-H(ii)H_2O}$

d. $CH_3CH_2OH \xrightarrow{Cu,573K}$

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20. An organic compound is subjected to chlorination to get compound A using 5.0 g of chlorine. When 0.5 g of compound A is reacted with $AgNO_3$ [Carius Method], the percentage of chlorine in compound A is __________ when it forms 0.3849 g of AgCl. (Round off to the Nearest Integer)
(Atomic masses of Ag and Cl are 107.87 and 35.5 respectively) (+4, -1)

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21. Given below are two statements: (+4, -1)
Statement I : Aniline is less basic than acetamide.
Statement II : In aniline, the lone pair of electrons on nitrogen atom is

delocalised over benzene ring due to resonance and hence less available to a proton.

Choose the most appropriate option :

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.

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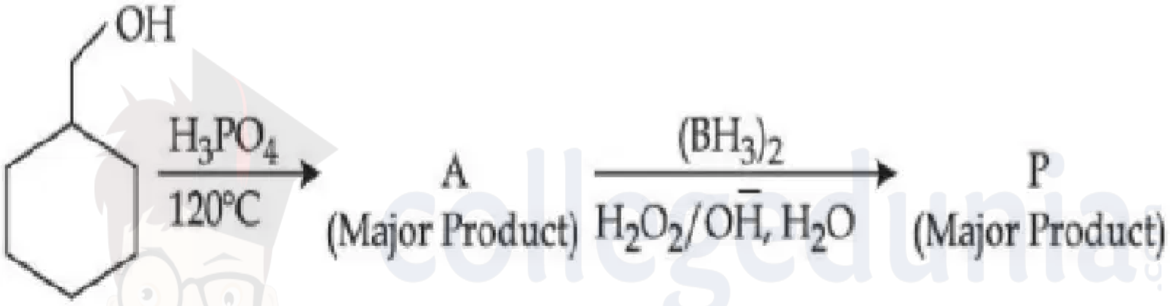
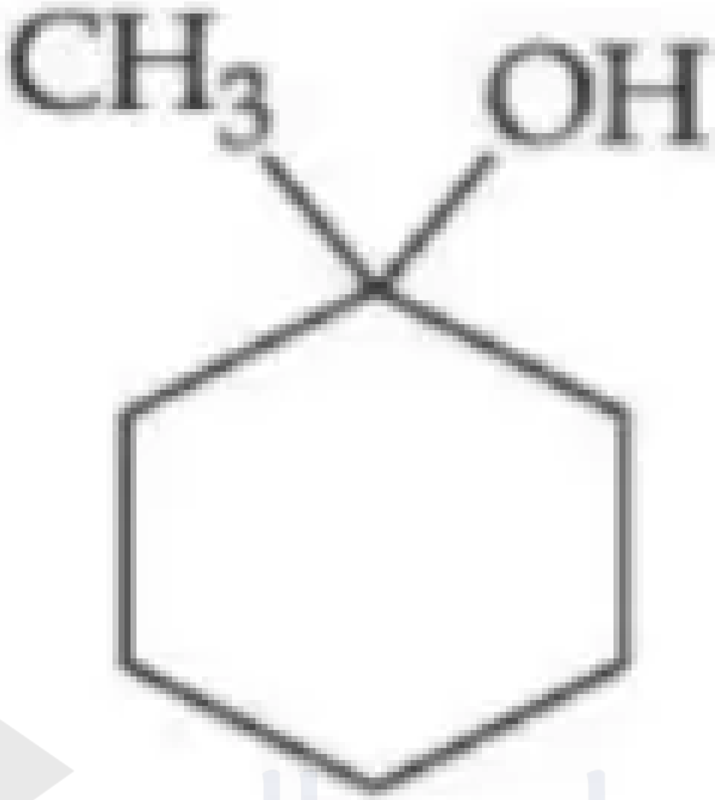
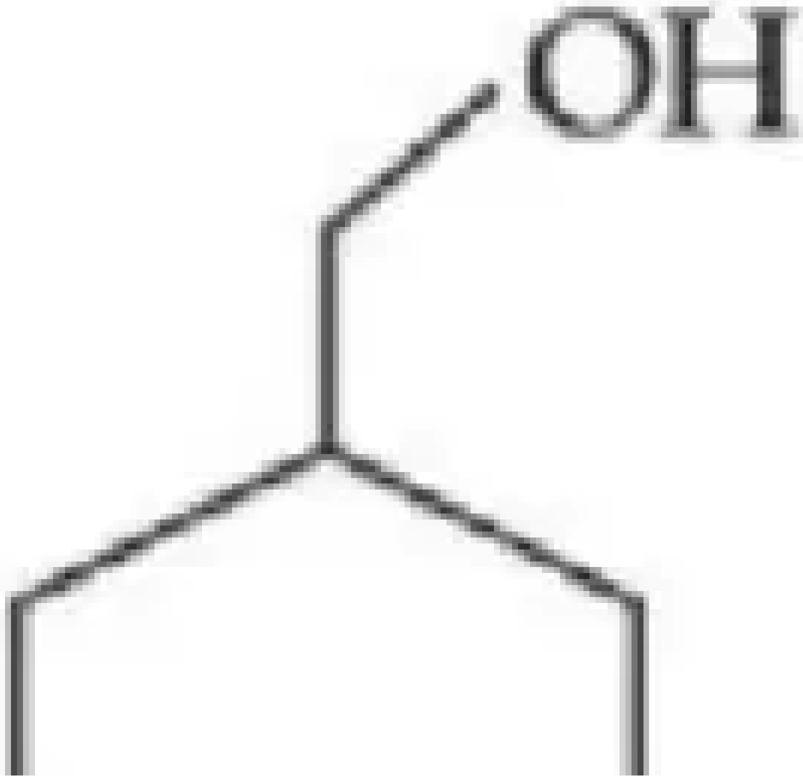
22. Consider the above reaction and identify the Product P : **(+4, -1)**

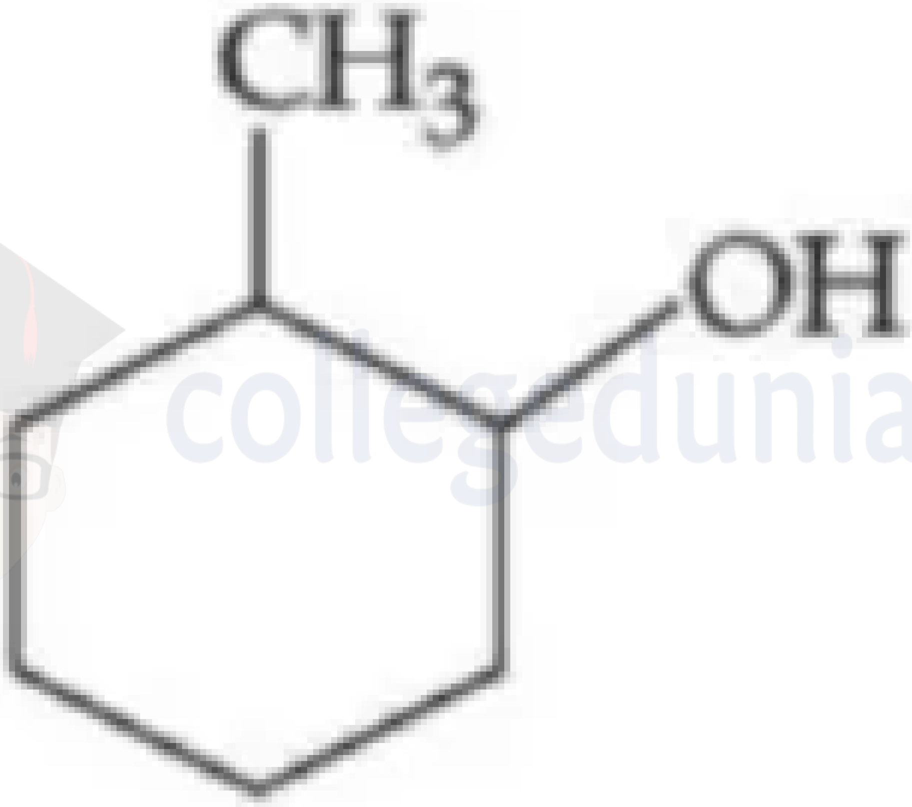




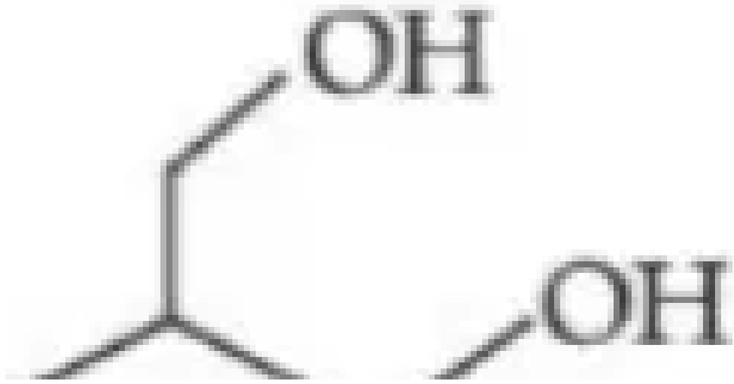
(A)



(B)



(C)



(D) 1.

a. A

b. B

c. C

d. D

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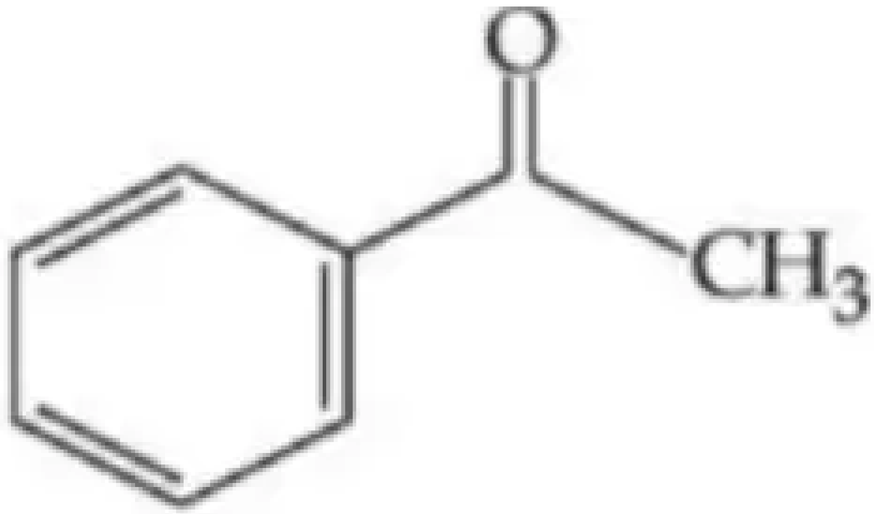
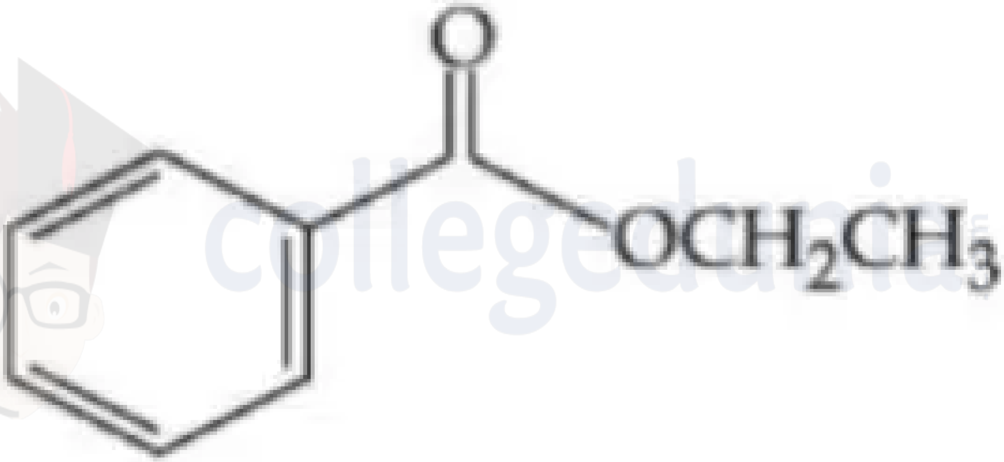
23. Which one of the following compounds will give orange precipitate when treated with 2,4-dinitrophenyl hydrazine ? (+4, -1)

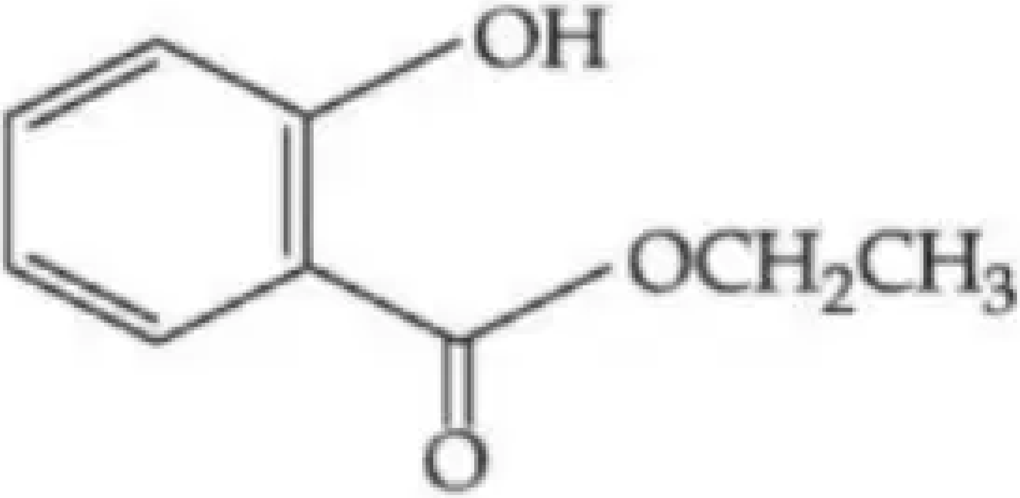


(A) ·

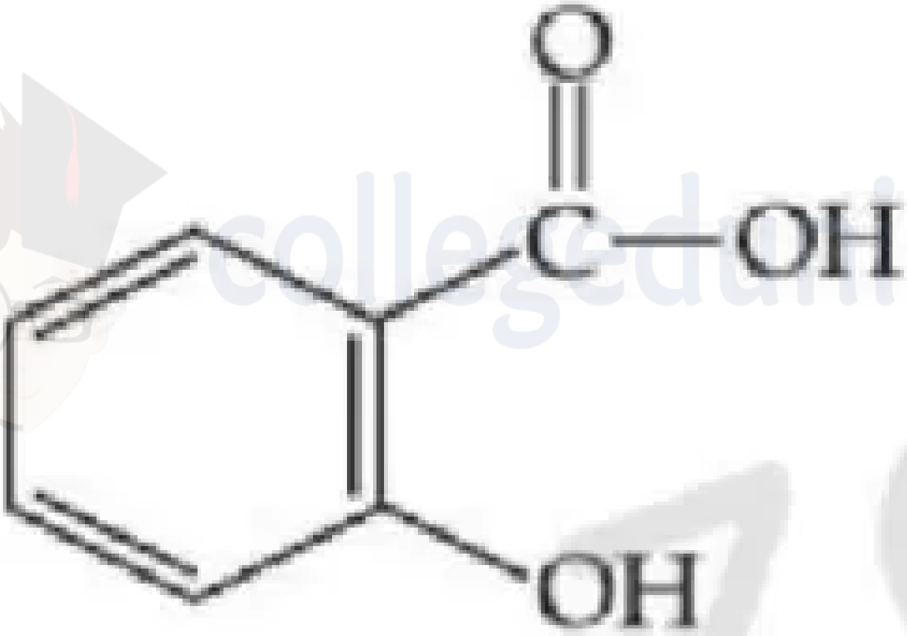


2.

(B)



(C)



(D)

a. A

b. B

c. C

d. D

24. **Presence of which reagent will affect the reversibility of the following reaction, and change it to a irreversible reaction:** **(+4, -1)**

$CH_4 + I_2 \rightleftharpoons CH_3 - I + HI$

a. Concentrated HIO_3

b. HOCl

c. Liquid NH_3

d. dilute HNO_2

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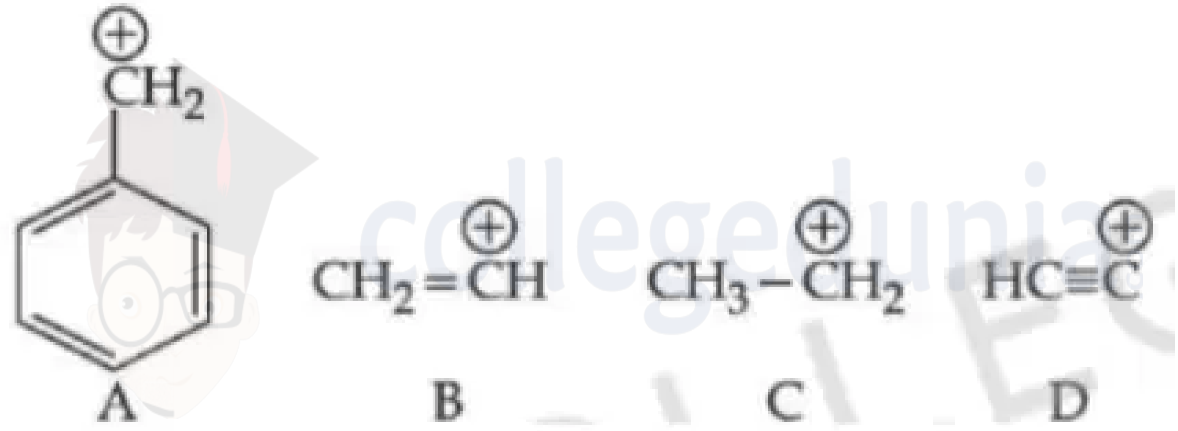
25. **The correct order of stability of given carbocations is :** **(+4, -1)**



a. D>B>C>A

b. A>C>B>D

c. C>A>D>B

d. D>B>A>C

---

26. **Staggered and eclipsed conformers of ethane are :** **(+4, -1)**

a. Rotamers

b. Mirror images

c. Enantiomers

d. Polymers

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27. **The number of compound/s given below which contain/s —COOH group is _________ . (Integer answer)** **(+4, -1)**
(A) Sulphanilic acid (B) Picric acid (C) Aspirin (D) Ascorbic acid

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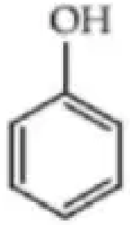
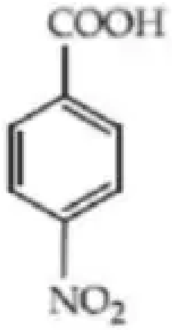
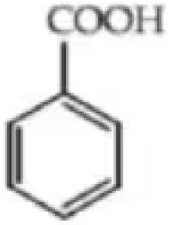
28. **The correct order of acid character of the following compounds is :** **(+4, -1)**
I: Phenol, II: p-Nitrobenzoic acid, III: Benzoic acid, IV: p-Toluic acid



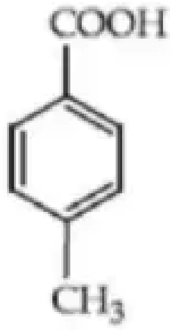
I



II



III



IV

a. I>II>III>IV

b. III>II>I>IV

c. II>III>IV>I

d. IV>III>II>I

---

29. **The correct sequence of reagents used in the preparation of 4-bromo-2-nitroethylbenzene from benzene is:** **(+4, -1)**

a. $CH_3COCl/AlCl_3$, $Br_2/AlBr_3$, HNO_3/H_2SO_4, Zn/HCl

b. $CH_3COCl/AlCl_3$, Zn-Hg/HCl, $Br_2/AlBr_3$, HNO_3/H_2SO_4

c. $Br_2/AlBr_3$, $CH_3COCl/AlCl_3$, HNO_3/H_2SO_4, Zn/HCl

d. HNO_3/H_2SO_4, $Br_2/AlCl_3$, $CH_3COCl/AlCl_3$, Zn-Hg/HCl

30. The transformation occurring in Duma's method is given below: (+4, -1)

$C_2H_7N + (2x + y/2)CuO \rightarrow xCO_2 + y/2H_2O + z/2N_2 + (2x + y/2)Cu.$

The value of y is _________. (Integer answer)

Answers

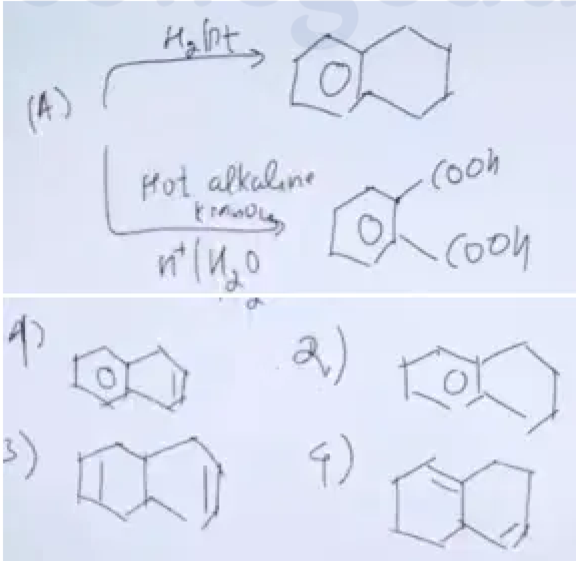
1. Answer: a

Explanation:

To identify the organic compound (A), we need to consider the reactions it undergoes:

1. **Catalytic Hydrogenation:** Compound (A) reacts with $\mathrm{H_2/Pt}$ to give tetralin. Tetralin is also known as tetrahydronaphthalene, which has a fully saturated cyclohexane ring fused to a benzene ring.
2. **Oxidation Reaction:** Compound (A) on oxidation with hot alkaline $\mathrm{KMnO_4}$ followed by acidification yields phthalic acid, which is a benzene ring with two adjacent carboxylic acid groups.

From the information given, compound (A) needs to have a naphthalene structure with a partial unsaturation that hydrogenates to form tetralin and oxidizes to form phthalic acid. This corresponds to 1,2-dihydronaphthalene.



Hence, option a is correct. Compound (A) is 1,2-dihydronaphthalene.

---

2. Answer: d

Explanation:

Step 1: (a) R-COCl → R-CHO: This is the **Rosenmund Reduction**. The reagent used is Hydrogen in the presence of Palladium supported on Barium Sulphate ($H_2/Pd\text{-}BaSO_4$). The $BaSO_4$ "poisons" the catalyst to stop the reduction at the aldehyde stage. So, **(a)-(ii)**.
Step 2: (b) R-CH$_2$-COOH → R-CH-Cl-COOH: This is the **Hell-Volhard-Zelinsky (HVZ) Reaction**. Carboxylic acids with α-hydrogens react with Cl_2 or Br_2 in the presence of red phosphorus to form α-halo carboxylic acids. So, **(b)-(iv)**.
Step 3: (c) R-CONH$_2$ → R-NH$_2$: This is the **Hoffmann Bromamide Degradation**. It converts an amide into a primary amine with one less carbon atom using Br_2 and $NaOH$. So, **(c)-(i)**.
Step 4: (d) R-COCH$_3$ → R-CH$_2$-CH$_3$: This is the **Clemmensen Reduction**. It reduces the carbonyl group ($> C = O$) of aldehydes or ketones to a methylene group ($> CH_2$) using Zinc amalgam and concentrated HCl. So, **(d)-(iii)**.

---

3. Answer: d

Explanation:

Step 1: Nitrobenzene has an $-NO_2$ group which is **meta-directing**. So, first brominate with Br_2/Fe to get **m-bromonitrobenzene**.
Step 2: Reduce the $-NO_2$ to $-NH_2$ using Sn/HCl to get **m-bromoaniline**.
Step 3: Convert the $-NH_2$ to a diazonium salt using $NaNO_2/HCl$.
Step 4: Replace the diazonium group with Br using the **Sandmeyer Reaction** ($CuBr/HBr$) to get m-dibromobenzene.

---

4. Answer: c

Explanation:

Step 1: Apply Hückel's Rule $(4n + 2)$ π electrons for aromaticity.
Step 2: Furan and **Thiophene** have 6 π electrons (4 from double bonds + 2 from lone pair), so they are aromatic.
Step 3: Cyclopropenyl cation has 2 π electrons ($n = 0$ in $4n + 2$), so it is aromatic.
Step 4: Cyclobutadiene has 4 π electrons. It follows the $4n$ rule, making it **anti-aromatic**, which falls under the broad category of "non-aromatic" in many MCQ contexts.

---

5. Answer: 16 - 16

Explanation:

Step 1: Reaction: $HO - CH_2 - CH_2 - CHO \xrightarrow{-H_2O} CH_2 = CH - CHO$ (Acrolein).
Step 2: Stoichiometry is 1:1.
Step 3: Theoretical moles of acrolein needed $= \frac{\text{Actual moles}}{\text{Yield}} = \frac{7.8/56}{0.64} \approx 0.2176$ mol.
Step 4: Mass of 3-Hydroxy propanal $= 0.2176 \times 74 \approx 16.1$ g. The nearest integer is 16.

---

6. Answer: d

Explanation:

Step 1: **Alc. KOH** is a strong base used for dehydrohalogenation (**β-elimination**).
Step 2: **Pd/BaSO$_4$** (poisoned with sulfur or quinoline) is **Lindlar's Catalyst**.
Step 3: **BHC** (Gammaxene) is produced by the **photo-addition** of Cl_2 to benzene.
Step 4: **Polyacetylene** is a conducting polymer used in specialized **electrodes**.

---

7. Answer: b

Explanation:

Step 1: Calculate Degree of Unsaturation: $DU = \frac{2(3)+2-6}{2} = 1.$
Step 2: Possible structures include **Propanal** (CH_3CH_2CHO) and **Propanone** (CH_3COCH_3).
Step 3: Since propanal (aldehyde) and propanone (ketone) have different functional groups, they exhibit **Functional group isomerism**.
Step 4: Metamerism is not possible as it requires at least 4 carbons for ethers/ketones to have different alkyl groups around the functional group.

---

8. Answer: c

Explanation:

Step 1: In **trans** geometry, identical ligands are at 180° (opposite). $[NiBr_2(PPh_3)_2]$ is square planar; "trans" means Br-Ni-Br is a straight line.
Step 2: In octahedral $[MA_3B_3]$ complexes, **meridional (mer)** means the three identical ligands occupy the vertices of a triangle that passes through the metal center (a meridian).
Step 3: In **facial (fac)**, the three ligands are on one triangular face of the octahedron.

---

9. Answer: b

Explanation:

Step 1: **Chlorophyll** contains a **Magnesium** ion at its center.
Step 2: **Vitamin B_{12}** (Cyanocobalamin) is a coordination complex of **Cobalt**.
Step 3: The famous **Anticancer drug** is Cis-platin, which contains **Platinum**.
Step 4: **Grubbs catalyst** used in olefin metathesis contains **Ruthenium**.

---

10. Answer: b

Explanation:

Step 1: Understanding the Concept:
Resonance structures must follow Lewis structure rules. Second-period elements like Nitrogen cannot exceed an octet (8 electrons).
Step 2: Detailed Explanation:
Nitrogen is in the second period of the periodic table. It only has s and p valence orbitals.
Consequently, it can form a maximum of 4 bonds (e.g., in NH_4^+ or NO_3^-).
Any resonance structure that depicts Nitrogen with 5 covalent bonds would imply that it has 10 valence electrons, which is impossible due to the absence of d-orbitals.
The structure in option (B) shows 5 bonds on Nitrogen, making it incorrect.
Step 3: Final Answer:
The structure in option (B) is not correct.

---

11. Answer: b

Explanation:

We need to convert nitrobenzene to 2-chlorophenol. This is a multi-step synthesis. Let's analyze the sequence of reactions. The target molecule has an -OH group and a -Cl group ortho to each other. Both are ortho, para-directing groups. The starting material has a -NO_2 group, which is a meta-directing deactivator.
Let's evaluate the sequence in option (B):
(i) Fe, HCl: This reagent is used for the reduction of the nitro group (-NO_2) to an amino group (-NH_2).
Nitrobenzene $\xrightarrow{\text{Fe, HCl}}$ Aniline.
This is a correct and standard first step. Aniline's -NH_2 group is an ortho, para-director.
(ii) $NaNO_2$, HCl, 0°C: This is the reagent for diazotization of a primary aromatic amine.
Aniline $\xrightarrow{\text{NaNO}_2\text{, HCl, }0^\circ\text{C}}$ Benzenediazonium chloride ($C_6H_5N_2^+Cl^-$).
This step is also correct.
(iii) H_2O/H^+ (warming): This step is the hydrolysis of the diazonium salt to form a phenol.
Benzenediazonium chloride $\xrightarrow{\text{H}_2\text{O, warm}}$ Phenol.
This is a standard method for preparing phenols.
(iv) Cl_2, $FeCl_3$: This is for the electrophilic aromatic substitution (chlorination) of phenol. The -OH group in phenol is a strongly activating ortho, para-director. The reaction will produce a mixture of the ortho-product (2-chlorophenol) and the para-product (4-chlorophenol).
Phenol $\xrightarrow{\text{Cl}_2\text{, FeCl}_3}$ 2-chlorophenol + 4-chlorophenol.
Since 2-chlorophenol is one of the products, this sequence is a valid pathway to synthesize the target molecule. The other options lead to different isomers (like meta) or involve incorrect reaction sequences.

---

12. Answer: a

Explanation:

The given reaction involves treatment of an α, β-unsaturated carbonyl compound with concentrated HBr.
In acidic conditions, HBr adds to the double bond via **Markovnikov electrophilic addition**.
Step 1: Protonation occurs at the carbon atom which leads to the **more stable**

carbocation intermediate.
Step 2: The bromide ion (Br^-) attacks the carbocation, forming the **more substituted bromo-carbonyl compound**.
Addition occurs in such a way that the bromine attaches to the more substituted carbon of the double bond, giving the thermodynamically stable product.
Among the given options, structure (A) corresponds to this Markovnikov addition product and is therefore the **major product**.

---

13. Answer: c

Explanation:

Let's evaluate each statement.
Statement I: Hyperconjugation is a permanent effect. This is true. Like the inductive effect and resonance, hyperconjugation involves a permanent delocalization of sigma (σ) electrons, which influences the properties of the molecule at all times. It is not a temporary effect that only occurs in the presence of a reagent.
Statement II: Hyperconjugation in ethyl cation ($\mathrm{CH_3 - CH_2^+}$) involves the overlapping of $\mathrm{C_{sp^2} - H_{1s}}$ bond with empty $2p$ orbital of other carbon.
Let's analyze the structure of the ethyl cation: $\mathrm{H_3C^\beta - C^\alpha H_2^+}$.
The positively charged carbon ($\mathrm{C^\alpha}$) is sp^2-hybridized and has an empty $2p$ orbital.
The adjacent carbon ($\mathrm{C^\beta}$) is sp^3-hybridized.
Hyperconjugation occurs by the overlap of the $\mathrm{C^\beta - H}$ sigma bond (which is a $\mathrm{C_{sp^3} - H_{1s}}$ bond) with the adjacent empty $2p$ orbital of the $\mathrm{C^\alpha}$ carbocation.
The statement incorrectly says the overlap is with a $\mathrm{C_{sp^2} - H_{1s}}$ bond. Therefore, Statement II is false.
Since Statement I is correct and Statement II is false, the correct option is (C).

---

14. Answer: b

Explanation:

The sodium fusion test, also known as Lassaigne's test, is a method used in qualitative analysis to detect the presence of foreign elements (heteroatoms) in an organic compound.
In this test, the organic compound is fused with metallic sodium, which converts the

heteroatoms into water-soluble ionic sodium salts.
- Nitrogen is converted to sodium cyanide (NaCN).
- Sulfur is converted to sodium sulfide (Na_2S).
- Halogens (Cl, Br, I) are converted to sodium halides (NaX).
- Phosphorus is converted to sodium phosphate (Na_3PO_4).

These ionic salts can then be detected by specific chemical tests on the aqueous extract.
The test is not used for Carbon and Hydrogen as they are the basic constituents of organic compounds.
Oxygen is not detected by this test.
Therefore, the set of elements that can be detected using the sodium fusion extract is Sulfur, Nitrogen, Phosphorous, and Halogens.

---

15. Answer: b

Explanation:

Step 1: Carbon 'a' (CH_3) is bonded to 4 other atoms via single sigma bonds. Total σ bonds = 4, so it is **sp³** hybridized.
Step 2: Carbon 'b' is part of a triple bond ($C \equiv C$). It has 2 σ bonds (one to Carbon 'a', one to Carbon 'c'). Total σ bonds = 2, so it is **sp** hybridized.
Step 3: Carbon 'c' is also part of the triple bond and has 2 σ bonds (one to Carbon 'b', one to Hydrogen). Total σ bonds = 2, so it is **sp** hybridized.

---

16. Answer: a

Explanation:

Step 1: But-2-ene is a symmetrical alkene.
Step 2: Electrophilic addition of HCl will add H to one carbon and Cl to the other.
Step 3: Regardless of which carbon gets the Cl, the product is $CH_3-CH_2-CHCl-CH_3$, which is 2-chlorobutane.

---

17. Answer: a

Explanation:

Step 1: This is the Phthalein dye test.
Step 2: Phenol reacts with phthalic anhydride in the presence of H_2SO_4 to form Phenolphthalein.
Step 3: Phenolphthalein is a colorless indicator that turns deep pink/magenta in the presence of an alkali like $NaOH$.

---

18. Answer: 7 - 7

Explanation:

Step 1: $3\,CH \equiv CH \xrightarrow{\text{Red hot Fe tube}}$ **Benzene** (C_6H_6).
Step 2: Benzene $\xrightarrow{CO,HCl,AlCl_3}$ **Benzaldehyde** (C_6H_5CHO) via **Gattermann-Koch reaction**.
Step 3: In Benzaldehyde, there are 6 carbons in the ring (all sp^2) and 1 carbon in the aldehyde group (sp^2).
Step 4: Total sp^2 carbons $= 6 + 1 = 7$.

---

19. Answer: b

Explanation:

Step 1: (A) is the **Wacker Process**, which converts ethene to acetaldehyde.
Step 2: (B) Uses Jones Reagent (CrO_3/H_2SO_4), which is a strong oxidizing agent. It will oxidize ethanol past the aldehyde stage directly to **Acetic Acid**.
Step 3: (C) DIBAL-H reduces nitriles selectively to aldehydes.
Step 4: (D) Catalytic dehydrogenation of primary alcohols over hot Copper gives aldehydes.

---

20. Answer: 19 - 19

Explanation:

The estimation of chlorine is carried out using the **Carius method**, in which chlorine present in the organic compound is converted completely into silver chloride

(AgCl).

Step 1: Calculate the mass of chlorine from AgCl Molar mass of AgCl:

$$M_{\text{AgCl}} = 107.87 + 35.5 = 143.37 \text{ g mol}^{-1}$$

Fraction of chlorine in AgCl:

$$\frac{35.5}{143.37}$$

Given mass of AgCl formed:

$$= 0.3849 \text{ g}$$

Mass of chlorine in the sample:

$$= 0.3849 \times \frac{35.5}{143.37} \approx 0.0952 \text{ g}$$

Step 2: Calculate percentage of chlorine in compound A Mass of compound A taken:

$$= 0.5 \text{ g}$$

$$= 19.04$$

Step 3: Round off

$$\boxed{19}$$

---

21. Answer: d

Explanation:

Statement II: In aniline, the lone pair of electrons on the nitrogen atom is delocalised into the benzene ring through resonance. As a result, the availability of the lone pair for protonation decreases. Hence, aniline is a weak base. Therefore, **Statement II is true**. **Statement I:** In acetamide (CH_3CONH_2), the lone pair on nitrogen is involved in strong resonance with the adjacent carbonyl group. The resonance structure places negative charge on the oxygen atom, which is highly electronegative, making the lone pair on nitrogen much less available for protonation. Thus, acetamide is **far less basic** than aniline. Numerically,

$$\text{p}K_b(\text{aniline}) \approx 9.4, \qquad \text{p}K_b(\text{acetamide}) \approx 14.5$$

Since higher pK_b implies weaker basicity, acetamide is weaker than aniline. Hence, the statement **“aniline is less basic than acetamide”** is false. **Conclusion:**

$$\boxed{\text{Statement I is false but Statement II is true}}$$

$$\boxed{\text{Option (D)}}$$

---

22. Answer: c

Explanation:

Step 1: Acid-catalysed dehydration Cyclohexylmethanol is a primary alcohol. In the presence of hot H_3PO_4 (120°C), dehydration occurs via protonation of the –OH group followed by loss of water. A primary carbocation formed initially is unstable and undergoes a **1,2-hydride shift** from the cyclohexyl ring, producing a more stable **tertiary carbocation**. Elimination of a proton from this carbocation gives the more substituted alkene (Zaitsev product):

$$\text{A} = \text{1-methylcyclohex-1-ene}$$

Step 2: Hydroboration–oxidation The alkene undergoes hydroboration–oxidation

$$(BH_3)_2 \longrightarrow H_2O_2/\,OH^-$$

This reaction proceeds via:
anti-Markovnikov addition
syn addition (stereochemistry not required here)
Hence, the –OH group attaches to the **less substituted carbon** of the double bond (C-2). **Final Product:**

$$\text{2-methylcyclohexanol}$$

$$\boxed{\text{Option (C)}}$$

---

23. Answer: a

Explanation:

2,4-Dinitrophenylhydrazine (2,4-DNP), also called Brady's reagent, is used to detect the presence of **aldehydes and ketones**.

These compounds react with 2,4-DNP to form brightly coloured 2,4-dinitrophenylhydrazones (orange or yellow precipitate).

Analysis of given compounds:

Acetophenone: It is a **ketone** and contains a reactive carbonyl (>C=O) group. Hence, it gives an orange precipitate with 2,4-DNP.

Ethyl benzoate: It is an **ester**. Due to resonance stabilisation of the carbonyl group, esters do not undergo nucleophilic addition with 2,4-DNP.

Ethyl salicylate: Also an **ester**, so it does not give the 2,4-DNP test.

Salicylic acid: A **carboxylic acid**. Carboxylic acids do not react with 2,4-DNP.

Hence, only acetophenone gives a positive 2,4-DNP test.

$$\boxed{\text{Acetophenone}}$$

---

24. Answer: a

Explanation:

The iodination of methane is a reversible reaction.

$CH_4 + I_2 \overset{h\nu}{\rightleftharpoons} CH_3I + HI$

The hydrogen iodide (HI) formed as a product is a strong reducing agent and can reduce methyl iodide (CH_3I) back to methane (CH_4), shifting the equilibrium to the left.

To make the reaction proceed in the forward direction (irreversible), the HI product must be removed from the reaction mixture as it is formed. This can be achieved by adding a strong oxidizing agent that reacts with HI.

Let's examine the options:

(A) Concentrated HIO_3 (Iodic acid) is a strong oxidizing agent. It readily oxidizes HI to I_2.

$5HI + HIO_3 \rightarrow 3I_2 + 3H_2O$

By consuming HI, this reagent shifts the equilibrium of the main reaction to the right, making it effectively irreversible. This is the standard reagent used for this purpose.

The other options are either not strong enough or not typically used for this specific purpose.

---

25. Answer: b

Explanation:

The stability of carbocations is determined by factors like resonance, hyperconjugation, and the electronegativity of the carbon atom holding the positive charge.
(A) Benzyl carbocation ($C_6H_5\overset{+}{C}H_2$): The positive charge is on an sp^2 hybridized carbon, and it is extensively stabilized by resonance, delocalizing the charge over the entire benzene ring. This makes it very stable.
(C) Ethyl carbocation ($CH_3 - \overset{+}{C}H_2$): This is a primary (1°) sp^2 hybridized carbocation. It is stabilized by the inductive effect (+I) and hyperconjugation from the three α-hydrogens of the methyl group.
(B) Vinyl carbocation ($CH_2 = \overset{+}{C}H$): The positive charge is on an sp hybridized carbon which is part of a double bond. An sp hybridized carbon is more electronegative than an sp^2 carbon, making it less capable of holding a positive charge. There is no resonance or hyperconjugation. This is very unstable.
(D) Ethynyl carbocation ($HC \equiv \overset{+}{C}$): The positive charge is on an sp hybridized carbon which is part of a triple bond. An sp carbon has 50% s-character and is highly electronegative, making it extremely unwilling to bear a positive charge. This is the least stable carbocation among the given options.
Comparing the stability effects: Resonance (A) is much stronger than hyperconjugation (C). The instability due to high s-character is most severe in (D) followed by (B).
Therefore, the correct order of stability is: Benzyl>Ethyl>Vinyl>Ethynyl.
A>C>B>D.

26. Answer: a

Explanation:

Conformational isomers, or conformers, are stereoisomers that can be converted into one another by rotation about a single bond.
The term "rotamers" is a specific name for these conformational isomers.
In ethane ($CH_3 - CH_3$), rotation around the central carbon-carbon single bond leads to different spatial arrangements of the hydrogen atoms.

The two extreme arrangements are the staggered conformation (where hydrogens on the front carbon are positioned between the hydrogens on the back carbon, most stable) and the eclipsed conformation (where hydrogens on the front carbon are directly in front of the hydrogens on the back carbon, least stable).
These staggered and eclipsed forms are interconvertible by rotation and are therefore called rotamers.
Options (B) and (C) are incorrect because they are not mirror images of each other.
Option (D) is incorrect as polymers are large molecules made of repeating monomer units.

27. **Answer: 1 - 1**

Explanation:

Check presence of –COOH group:
Sulphanilic acid: $-SO_3H$ (No –COOH)
Picric acid: Phenolic –OH (No –COOH)
Aspirin: Contains –COOH
Ascorbic acid: Enediol lactone (No –COOH)
Total compounds containing –COOH

$$\boxed{1}$$

28. **Answer: c**

Explanation:

The acidity of these compounds depends on the stability of the conjugate base formed after donating a proton.
First, compare carboxylic acids (II, III, IV) with phenol (I). Carboxylic acids are significantly more acidic than phenols because the carboxylate anion is stabilized by resonance involving two electronegative oxygen atoms, delocalizing the negative charge more effectively than in the phenoxide ion. So, (II, III, IV)>I.
Next, compare the substituted benzoic acids. The acidity of benzoic acid is affected by the substituent on the benzene ring.
Compound II (p-Nitrobenzoic acid): The nitro group ($-NO_2$) is a strong electron-

withdrawing group (-I and -R effect). It stabilizes the carboxylate anion by withdrawing electron density, thereby increasing the acidity.
Compound III (Benzoic acid): This is the reference compound with no substituent.
Compound IV (p-Toluic acid): The methyl group (-CH_3) is an electron-donating group (+I and hyperconjugation effect). It destabilizes the carboxylate anion by pushing electron density towards it, thereby decreasing the acidity.
Therefore, the order of acidity for the carboxylic acids is: p-Nitrobenzoic acid>Benzoic acid>p-Toluic acid. (II>III>IV).
Combining all the compounds, the final order of decreasing acid strength is: II>III>IV>I.

---

29. Answer: b

Explanation:

Step 1: Understanding the target molecule The final compound is **4-bromo-2-nitroethylbenzene**. Thus, the benzene ring contains:
an **ethyl group** ($-C_2H_5$),
a **bromo group** at the **para position** to ethyl,
a **nitro group** at the **ortho position** to ethyl.
Hence, the ethyl group must be introduced **before** nitration so that it can control orientation. **Step 2: Introduction of ethyl group (indirect method)** Direct Friedel–Crafts alkylation can lead to rearrangement, so the ethyl group is introduced via an acylation–reduction sequence.

$$\text{Benzene} \xrightarrow{\text{CH}_3\text{COCl}/\text{AlCl}_3} \text{Acetophenone}$$

This is Friedel–Crafts acylation. The acyl group is meta-directing but will be removed later. **Step 3: Reduction of acyl group**

$$\text{Acetophenone} \xrightarrow{\text{Zn–Hg}/\text{HCl}} \text{Ethylbenzene}$$

Clemmensen reduction converts the $-COCH_3$ group into an ethyl group ($-CH_2CH_3$). Ethyl group is:
activating,
ortho/para-directing.
Step 4: Bromination

$$\text{Ethylbenzene} \xrightarrow{\text{Br}_2/\text{AlBr}_3} \text{4-bromoethylbenzene (major)}$$

Bromination occurs mainly at the **para position** due to:
ortho/para-directing effect of ethyl group,
less steric hindrance at para position.
Step 5: Nitration

$$\text{4-bromoethylbenzene} \xrightarrow{HNO_3/H_2SO_4} \text{4-bromo-2-nitroethylbenzene}$$

Now two directing groups are present:
Ethyl group: strong activator, ortho/para-directing
Bromine: weak deactivator, ortho/para-directing
The **ethyl group dominates orientation**. The para position is already occupied by Br, so nitration occurs at the **ortho position** to ethyl (position 2). **Step 6: Why other options are incorrect**
Options (A) and (C): Bromination or nitration occurs on acetophenone, which is meta-directing → wrong substitution pattern.
Option (D): Nitration first strongly deactivates benzene, preventing Friedel–Crafts reactions.
Conclusion The correct reagent sequence is:

$$\boxed{CH_3COCl/AlCl_3 \rightarrow Zn\text{–}Hg/HCl \rightarrow Br_2/AlBr_3 \rightarrow HNO_3/H_2SO_4}$$

Hence, the correct answer is **Option (B)**.

---

30. Answer: 7 - 7

Explanation:

Step 1: Understanding the Concept:
Duma's method is used for the quantitative estimation of nitrogen in organic compounds. The compound is heated with copper oxide (CuO), which oxidizes carbon to CO_2, hydrogen to H_2O, and nitrogen is released as N_2 gas.
Step 2: Detailed Explanation:
1. The general formula for an organic compound in this context is $C_xH_yN_z$.
2. In the provided example, the specific compound is Ethylamine (or a related isomer) with the formula C_2H_7N.
3. By directly comparing the general subscripts (x, y, z) with the given formula:
- x (Number of Carbon atoms) = 2
- y (Number of Hydrogen atoms) = 7

- z (Number of Nitrogen atoms) = 1

4. The question specifically asks for the value of y.

Step 3: Final Answer:

The value of y is 7.