

Topics *to be covered*

- 1 Complete Organic Chemistry ✓
- 2 JEE Mains PYQs ✓
- 3 NCERT Exemplar Questions ✓
- 4 Practice





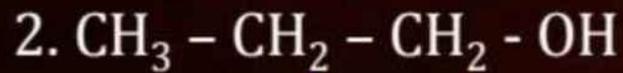
IUPAC NOMENCLATURE



Representation of Organic Compounds

Definition Bond Line Structure:

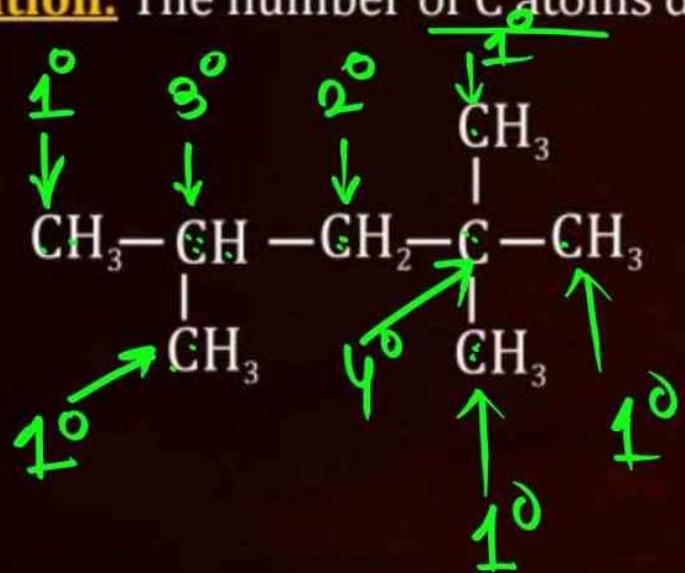
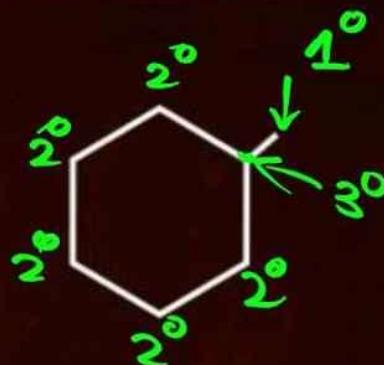
- One C - C bonds are represented ✓
- Heteroatoms are always represented ✓ N, O, S
- Longest C - C chain is represented in Zig-Zag pattern. ✓
- Double bonds are shown with two lines and triple bonds three lines.
- Example: 1. CH₃ - CH₂ - CH₂ - CH₂ - CH₃





Degree of Carbon

Definition: The number of C atoms directly attached with the carbon.

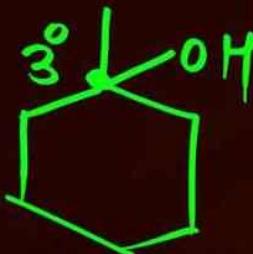
A**B**



Degree of Alcohols

Definition: The degree of carbon at which the -OH group is present.

A



B



OP Point: Degree of Phenol

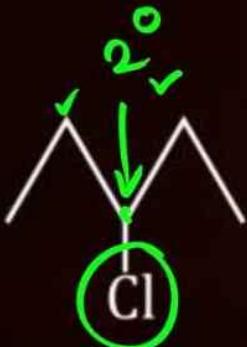


Nahi hoh



Degree of Halogens

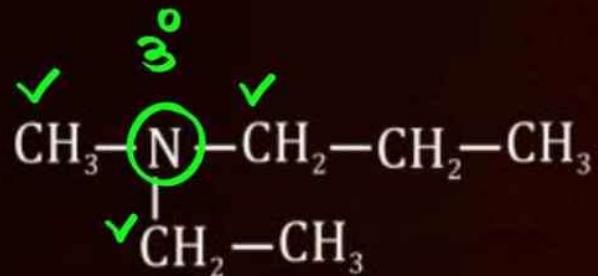
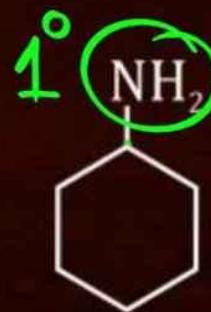
Definition: Degree of carbon at which X group is present.

A**B**

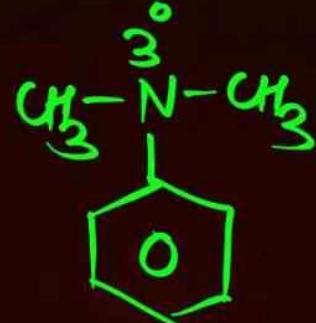
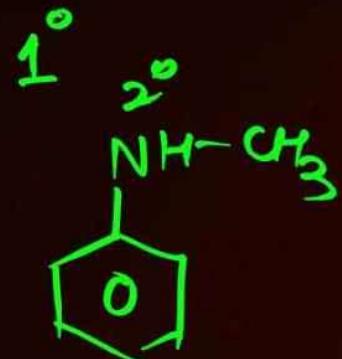


Degree of Amine

Definition: The number of carbon atoms directly connected with the N.

A**B****C****D**

OP Point: Degree of Aniline

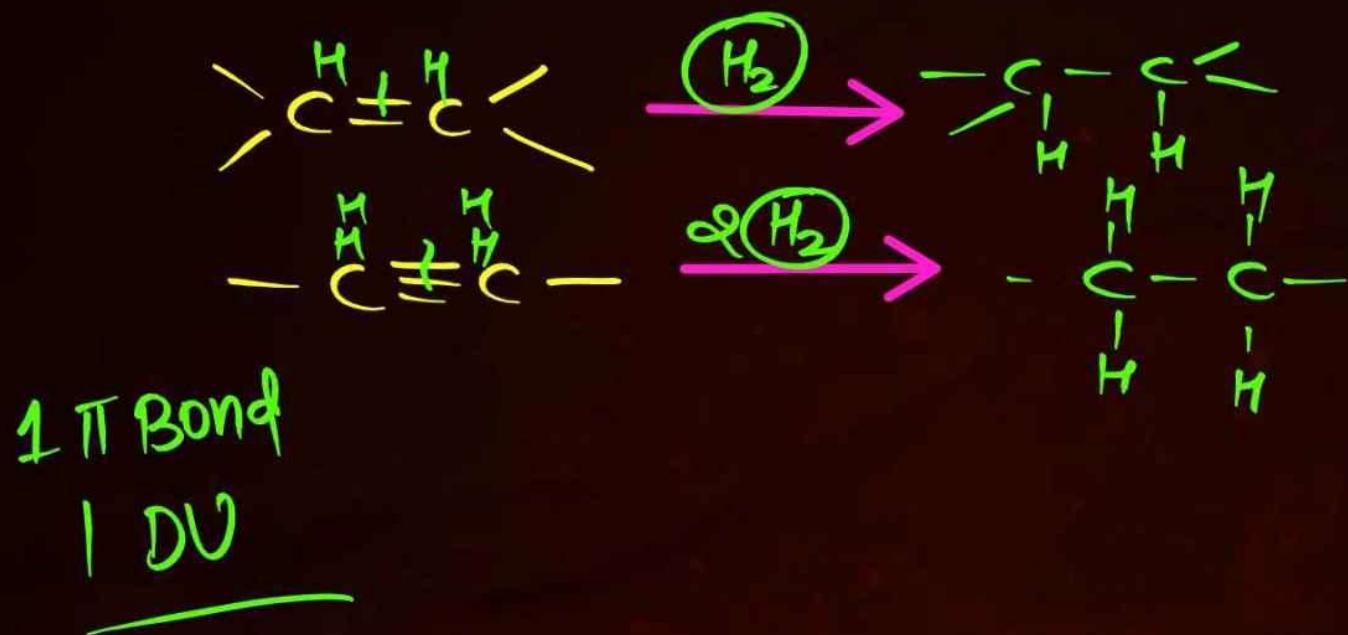




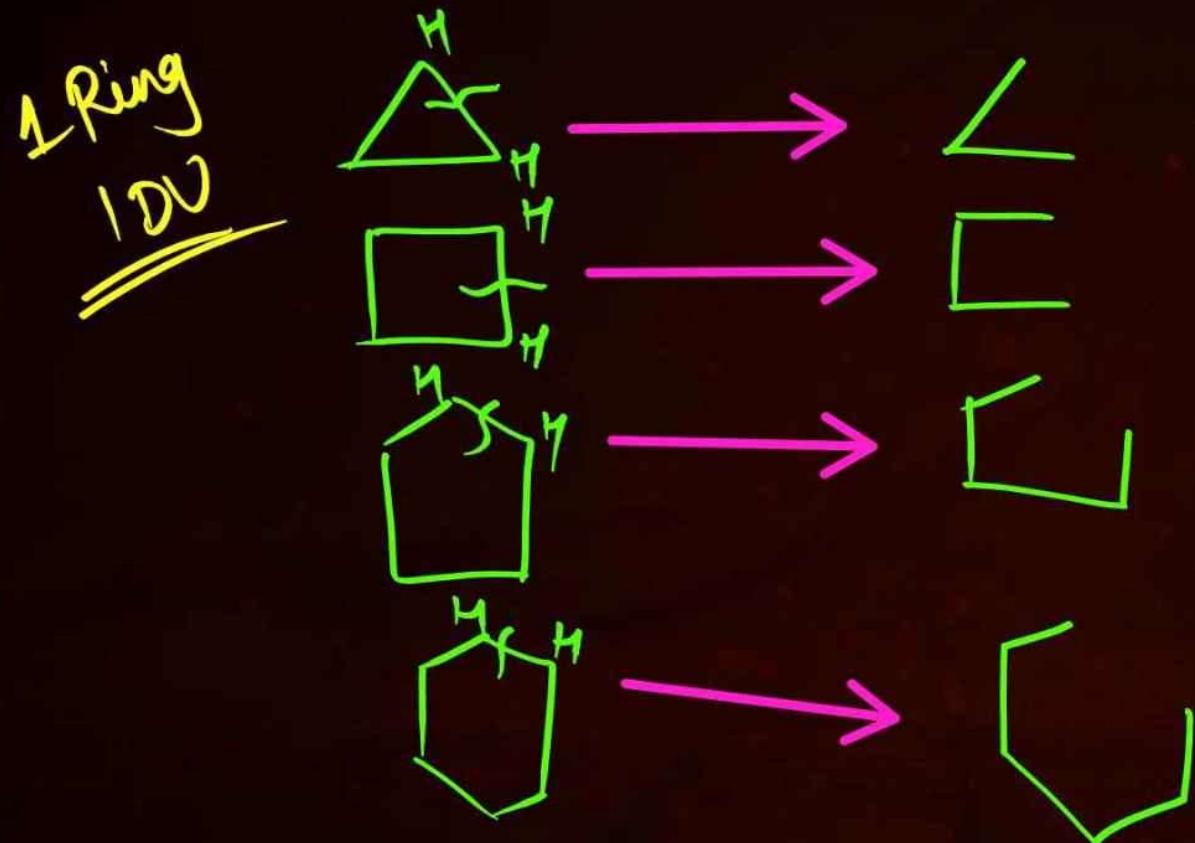
Degree of Unsaturation

- D.U. (Degree of Unsaturation)
OR
- I.H.D. (Index of Hydrogen deficiency)
- U.I. (Unsaturation Index)
OR
- D.B.E. (Double bond equivalent)

Case 01: Number of H_2 molecules are required to convert a molecule (multiple bond) into open chain saturated compound.



Case 02: How many bonds are cleaved to form an open chain saturated compounds.



If M.F is given

$$Dv = (C+I) - \left(\frac{H+X-N}{2} \right)$$

P.F.G

COOH	Carboxylic acid
SO_3H	Sulphonic acid
$\text{C}(\text{O})_2\text{O}$	Anhydride
$\text{C}(\text{O})\text{O}$	Ester
$\text{C}(\text{O})\text{Cl}$	acid chloride
$\text{C}(\text{O})\text{NH}_2$	acid amide
CN	cyanide
NC	isocyanide
CHO	aldehyde
$\text{C}(=\text{O})$	ketone
$\text{C}(\text{H})\text{OH}$	alcohol
SH	thiol
NH_2	amine

Suffix-2

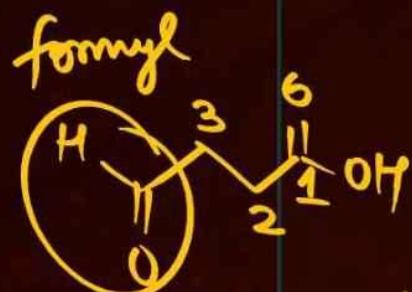
oic acid
Sulphonic acid
oic anhydride
oate
oyl chloride
amide
nitrile
isonitrile
al
one
ol
thiol
amine

Top to bottom
decreases



P.F.G

Carboxylic acid
Sulphonic acid
anhydride
Ester
acid chloride
acid amide
cyanide
isocyanide
aldehyde
ketone
alcohol
thiol
amine



3-Formyl propanoic acid

Prefix-2

carboxy

Sulpho

-

Alkoxycarbonyl

chlorocarbonyl

carbamoyl

cynano

isocyano

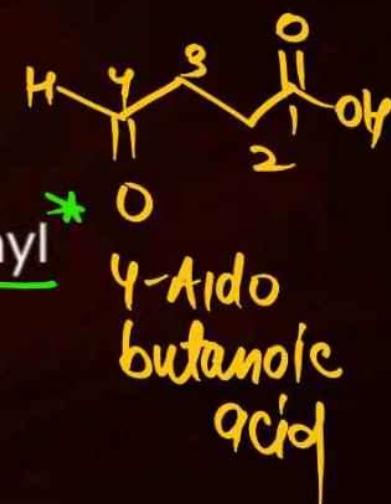
aldo and formyl

keto or oxo

hydroxy

mercapto

amino





IUPAC Naming of Cyclo Compounds

Rule: Prefix-2 + Cyclo + Word Root + Suffix-1 + Suffix-2



Priority:

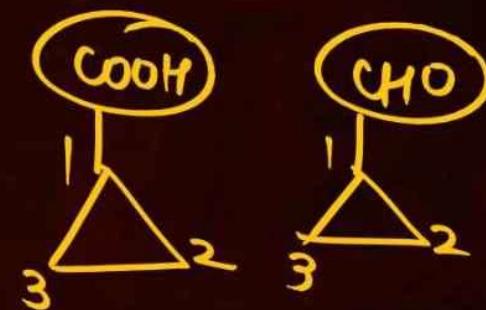
PFG > Multiple bonds > Number of C atoms

If no. of carbon atoms are same then

priority Ring > Chain



If carbon containing F.G is directly attached with the ring then they are taken as part of the ring. (Ring *k* numbering Kolengh)



F.G

Carboxylic acid
Ester
acid chloride
acid amide
cyanide
aldehyde

Special Suffix-2

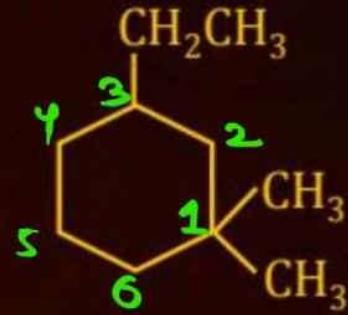
carboxylic acid ✓
carboxylate ✓
carbonyl chloride ✓
carboxamide ✓
carbonitrile ✓
carbaldehyde ✓

Question

Write IUPAC Name of the following Compounds.

A

*2-Ethyl -1,4-dimethyl
Cyclohexane*

B

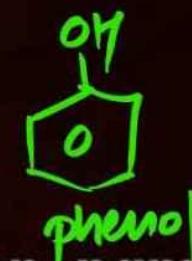
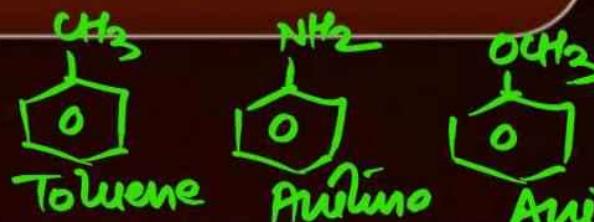
3-Ethyl-1,1-dimethylcyclohexane



IUPAC Naming of Benzene Derivatives

Rules

1. If organic Compound is having one F.G then common name is retained in IUPAC.



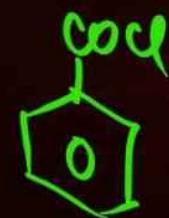
Benzoic acid



Benzene sulphonic acid



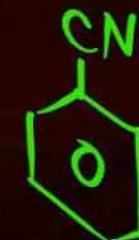
Benzoate



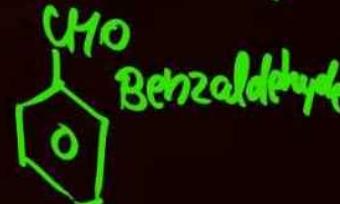
Benzoyl chloride



Benzamide

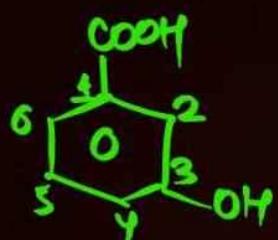


Benzonitrile



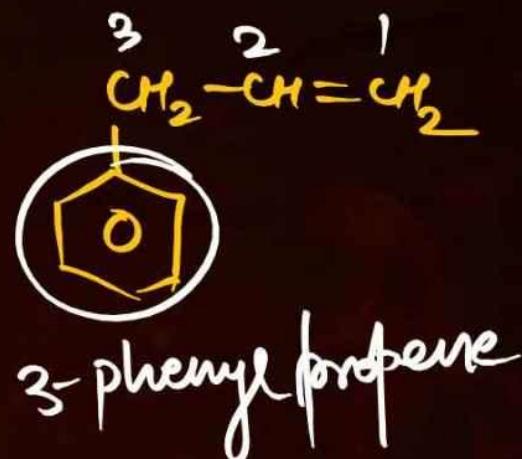
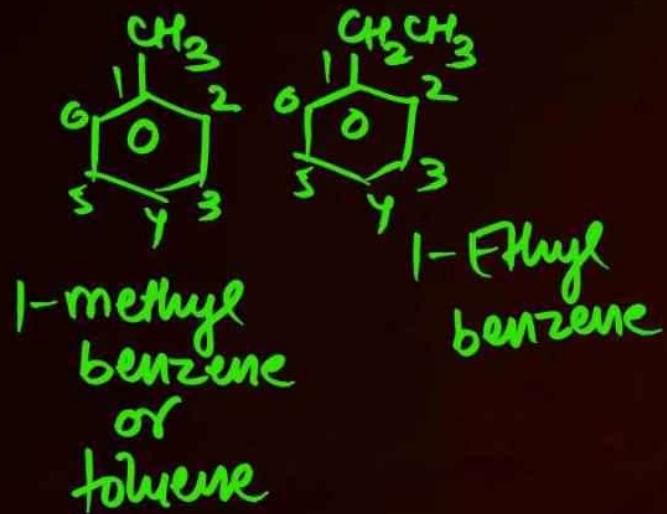
Benzaldehyde

2. If more than one F.G are present then numbering is done according to IUPAC.

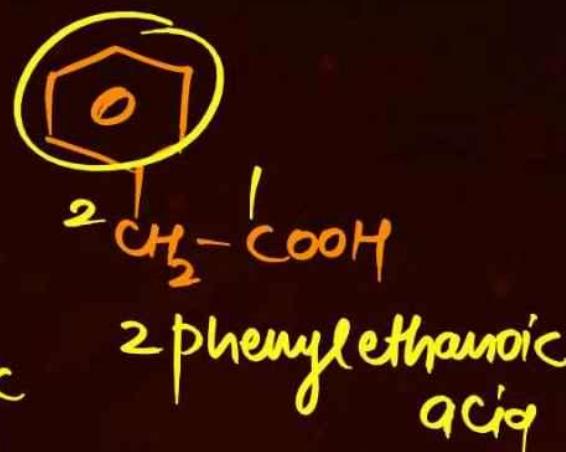
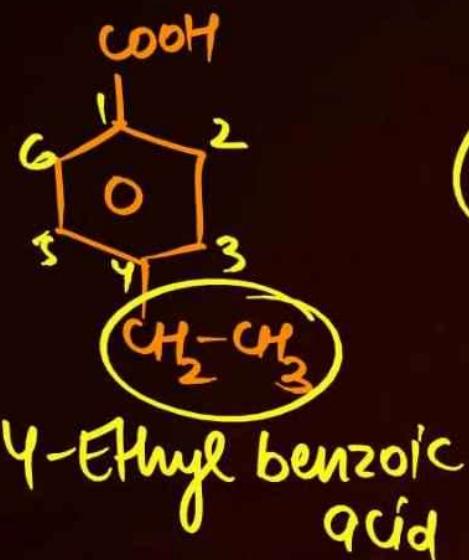


3-Hydroxybenzoic acid

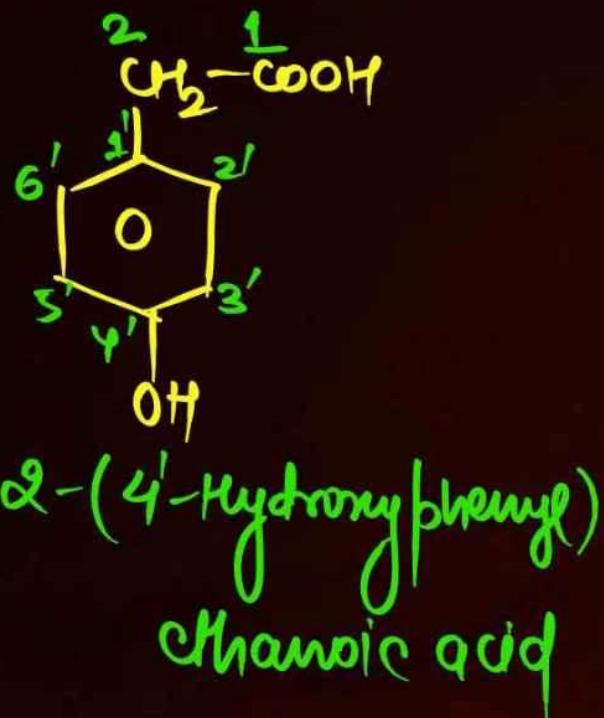
3. If Hydrocarbon is combination of both open and ring part then except Me and Et open part is taken as main part.



4. If organic compound is having F.G then part having F.G is taken as main part.



5. If both parts are having F.G then part having P.F.G is taken as main part.



6. If there is choice priority is given to open part.

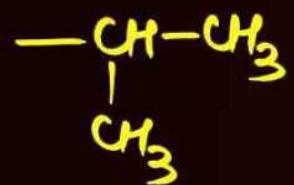


2-(4'-Carboxyphenyl)ethanoic acid

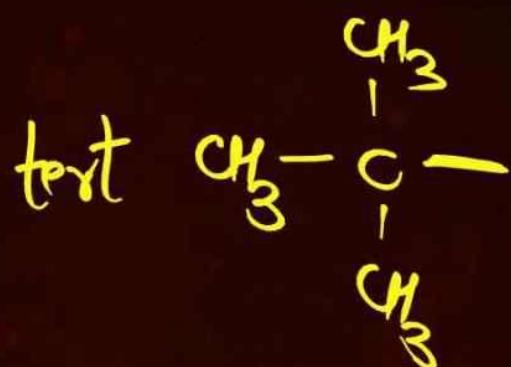
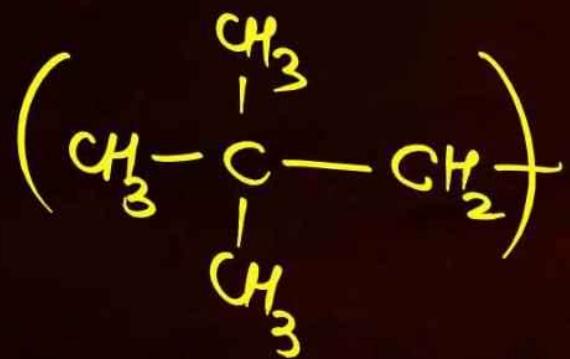


Common Names

Iso



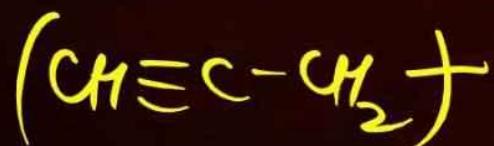
Neo



Vinyl



Allyl $(CH_2=CH-CH_3)$



Propargyl

n
normal
straight
chain



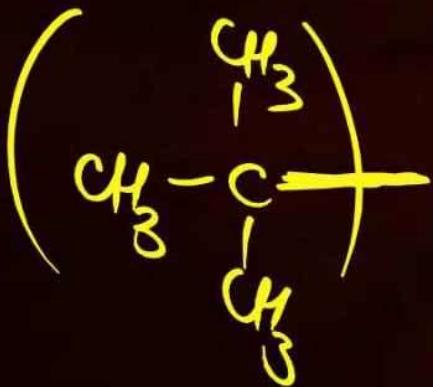
npr

sec



sec butyl

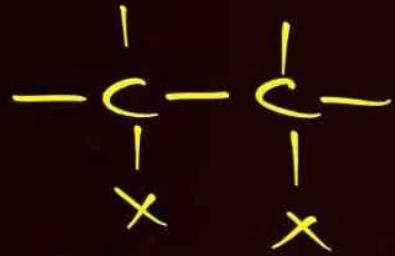
tert



gem



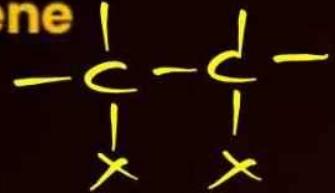
vic



Alkylidene



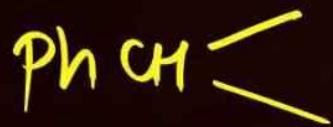
Alkylene



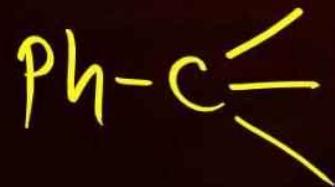
Benzyl



Benzal



Benzo



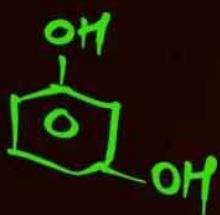
QUESTION (JEE Mains 4th April 2024, Evening Shift)

Common name of Benzene-1, 2-diol is:

A quinol

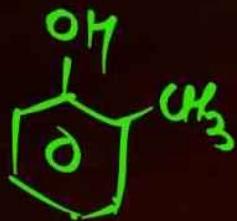


B resorcinol



C catechol

D o-cresol



QUESTION (JEE Mains 4th April 2024, Evening Shift)



The total number of 'sigma' and 'Pi' bonds in 2-oxohex-4-yneoic acid is ____.



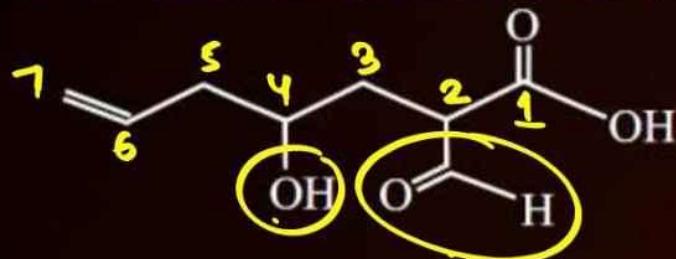
$$14\sigma + 4\pi$$

18

QUESTION (JEE Mains 5th April 2024, Evening Shift)



The correct nomenclature for the following compound is:



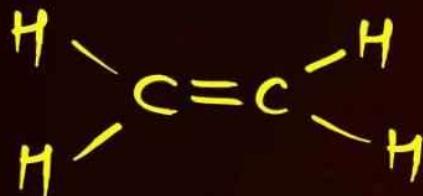
- A 2-carboxy-4-hydroxy hept-6-enal
- B 2-carboxy-4-hydroxy hept-7-enal
- C 2-formyl-4-hydroxy hept-6-enoic acid
- D 2-formyl-4-hydroxy hept-7-enoic acid

QUESTION (JEE Mains 5th April 2024, Morning Shift)



Number of σ and π bonds present in ethylene molecule is respectively:

- A** 3 and 1
- C** 4 and 1



- B** 5 and 2
- D** 5 and 1

QUESTION (JEE Mains 6th April 2024, Morning Shift)

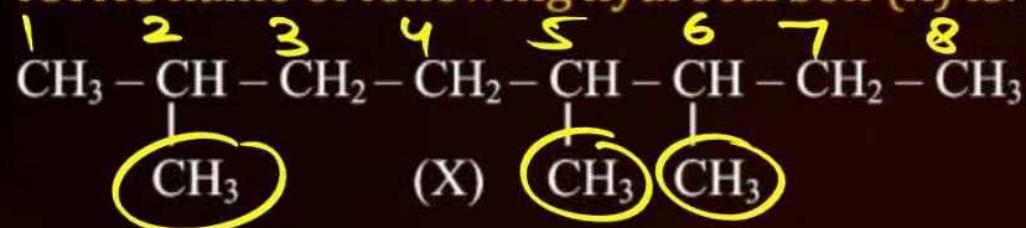


Functional group present in Sulphonic acid is:



QUESTION (JEE Mains 8th April 2024, Evening Shift)

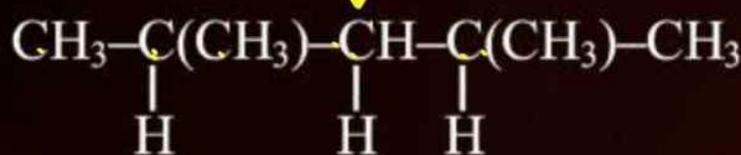
IUPAC name of following hydrocarbon (X) is:



- A 2-Ethyl-3, 6-dimethylheptane
- B 2-Ethyl-2, 6-diethylheptane
- C 2, 5, 6-Trimethyloctane
- D 3, 4, 7-Trimethyloctane

QUESTION (JEE Mains 8th April 2024, Morning Shift)

In the given compound, the number of 2° carbon atom/s is ____.



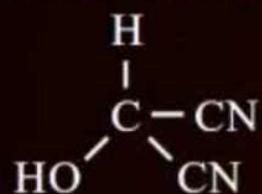
- A Three
- B One
- C Two
- D Four

QUESTION (JEE Mains 27th January 2024, Evening Shift)

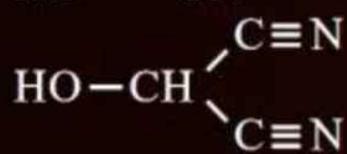


Bond line formula of $\text{HOCH}(\text{CN})_2$ is:

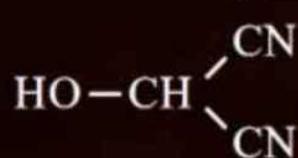
A



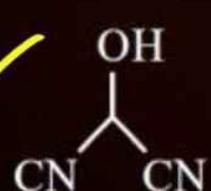
B



C



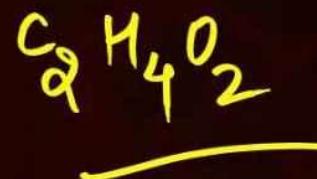
D



QUESTION (JEE Mains 27th January 2024, Evening Shift)

The molecular formula of second homologue in the homologous series of mono carboxylic acids is _____. $\text{H}-\overset{\overset{\text{O}}{\parallel}}{\underset{\underset{\text{CH}_2}{|}}{\text{C}}-\text{OH}$

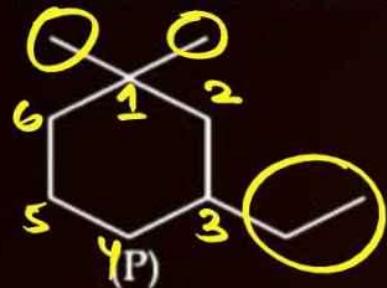
- A** $\text{C}_3\text{H}_6\text{O}_2$
- B** $\text{C}_2\text{H}_4\text{O}_2$
- C** CH_2O
- D** $\text{C}_2\text{H}_2\text{O}_2$



QUESTION (JEE Mains 27th January 2024, Morning Shift)



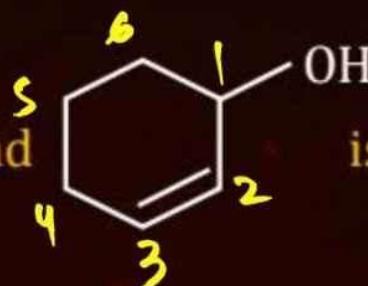
IUPAC name of following compound (P) is:



- A 1-Ethyl-5, 5-dimethylcyclohexane
- B 3-Ethyl-1,1-dimethylcyclohexane
- C 1-Ethyl-3, 3-dimethylcyclohexane
- D 1, 1-Dimethyl-3-ethylcyclohexane

QUESTION (JEE Mains 29 January 2024, Evening Shift)

According to IUPAC system, the compound



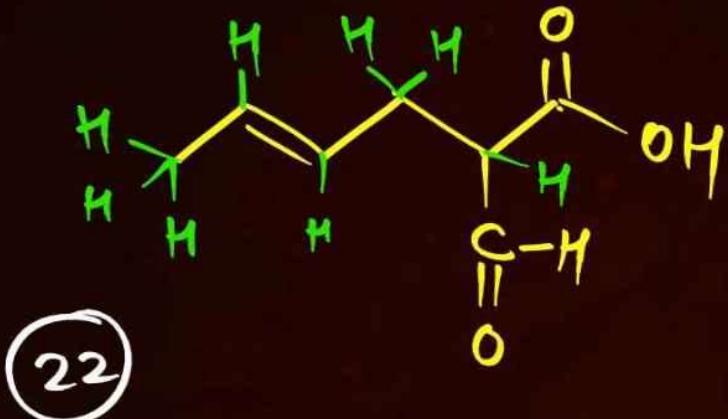
is named as

- A** Cyclohex-1-en-2-ol
- B** 1-Hydroxyhex-2-ene
- C** Cyclohex-1-en-3-ol
- D** Cyclohex-2-en-1-ol

QUESTION (JEE Mains 29 January 2024, Evening Shift)

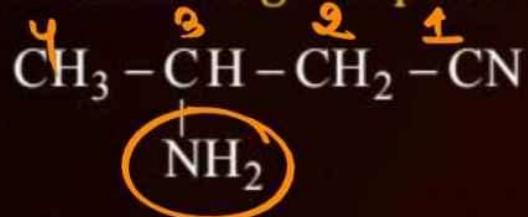


The total number of 'Sigma' and Pi bonds in 2-formylhex-4-enoic acid is ____.



QUESTION (JEE Mains 30 January 2024, Evening Shift)

IUPAC name of following compound is:

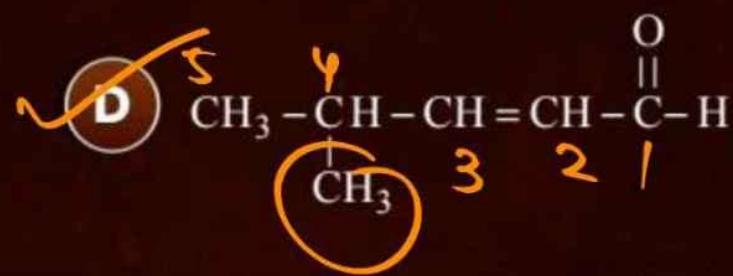
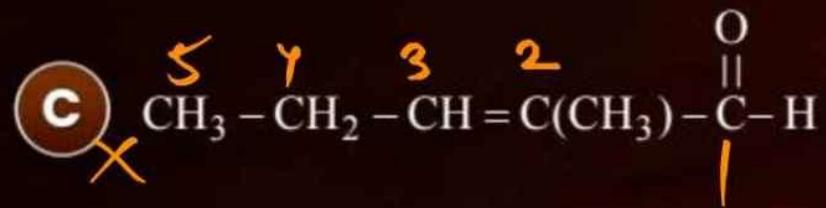
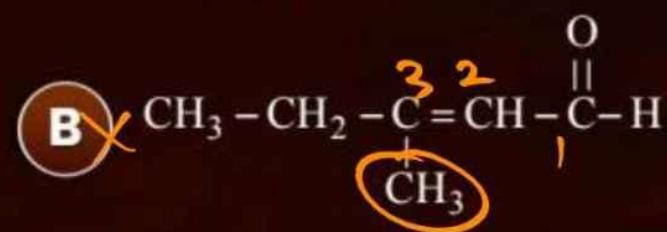
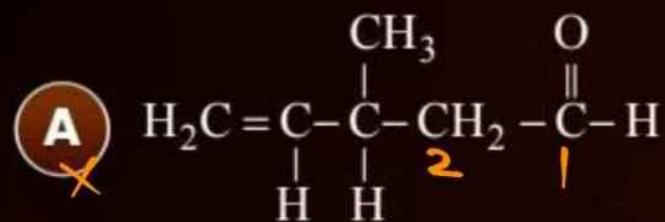


- A** 2-Aminopentanenitrile
- B** 2-Aminobutanenitrile
- C** 3-Aminobutanenitrile
- D** 3-Aminopropanenitrile

QUESTION (JEE Mains 30 January 2024, Morning Shift)



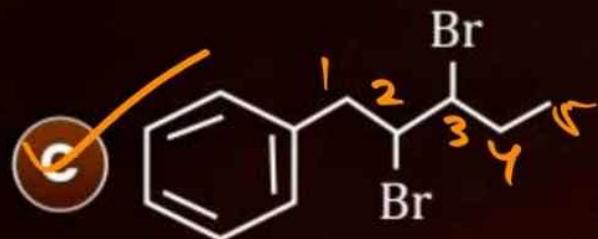
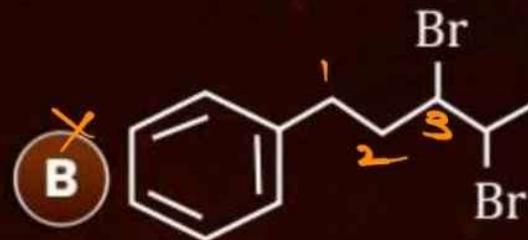
Structure of 4-Methylpent-2-enal is:



QUESTION (JEE Mains 31 January 2024, Evening Shift)



Identify structure of 2, 3-dibromo-1-phenylpentane.



QUESTION (JEE Mains 31 January 2024, Morning Shift)

Given below are two statements:

~~Statement I:~~ IUPAC name of $\underline{\text{HO}-\text{CH}_2-\text{(CH}_2)_3-\text{CH}_2-\text{COCH}_3}$ is 7-hydroxyheptan-2-one.

~~Statement II:~~ 2-oxoheptan-7-ol is the correct IUPAC name for above compound.

In the light of the above statements, choose the most appropriate answer from the options given below:

- A Statement I is correct but Statement II is incorrect.
- B Both Statement I and Statement II are incorrect.
- C Both Statement I and Statement II are correct.
- D Statement I is incorrect but Statement II is correct.

QUESTION (NCERT Exemplar)

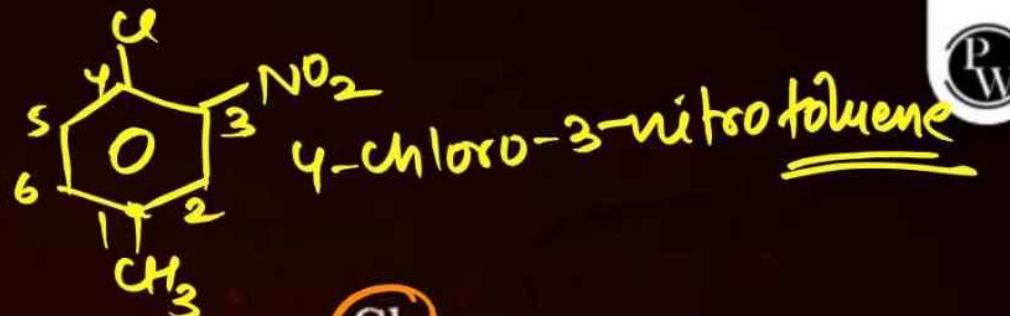
The IUPAC name for $\text{CH}_3 - \overset{\text{O}}{\underset{||}{\text{C}}} - \text{CH}_2 - \text{CH}_2 - \overset{\text{O}}{\underset{||}{\text{C}}} - \text{OH}$ is:

- A** 1-hydroxypentane-1,4-dione
- B** 1,4-dioxopentanol
- C** 1-carboxybutan-3-one
- D** 4-oxopentanoic acid

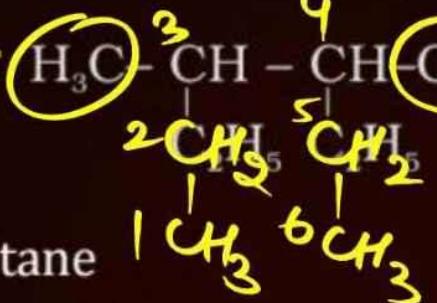
QUESTION (NCERT Exemplar)

The IUPAC name for

- A 1-Chloro-2-nitro-4-methylbenzene
- B 1-Chloro-4-methyl-2-nitrobenzene
- C 2-Chloro-1-nitro-5-methylbenzene
- D m-Nitro-p-chlorotoluene



QUESTION (NCERT Exemplar)

Correct IUPAC name for  is _____.

- A** 2-ethyl-3-methylpentane
- B** 3,4-dimethylhexane
- C** 2-sec-butylbutane
- D** 2, 3-dimethylbutane

QUESTION (NCERT Exemplar)

Which of the following compounds contain all the carbon atoms in the same hybridization state?

- A $\text{H}-\overset{\text{sp}}{\text{C}} \equiv \overset{\text{sp}}{\text{C}}-\overset{\text{sp}}{\text{C}} \equiv \overset{\text{sp}}{\text{C}}-\text{H}$
- B $\text{CH}_3-\overset{\text{sp}^3}{\text{C}} \equiv \overset{\text{sp}}{\text{C}}-\overset{\text{sp}^3}{\text{C}}-\text{CH}_3$
- C $\text{CH}_2=\overset{\text{sp}^2}{\text{C}}=\overset{\text{sp}^2}{\text{C}}=\text{CH}_2$
- D None of these

QUESTION (NCERT Exemplar)

Assertion (A): All the carbon atoms in $\text{H}_2\text{C} = \text{C} = \text{CH}_2$ are sp^2 hybridized.

Reason (R): In this molecule all the carbon atoms are attached to each other by double bonds.

- A** Both A and R are correct and R is the correct explanation of A.
- B** Both A and R are correct but R is not the correct explanation of A.
- C** Both A and R are not correct.
- D** A is not correct but R is correct.



ISOMERISM



ISOMERISM

M.F Same



1. Isomers have same molecular formula but different physical and chemical properties.
2. Compounds having same molecular formula, but different connectivity, different bonding pattern (structural isomerism) or different 3-D relative arrangement (stereoisomerism) is known as isomers.
IUPAC name diff
3. This phenomenon is known as isomerism.
IUPAC name same
4. Isomers are those which can be separated at room temperature.
5. Isomers always have same Degree of Unsaturation (DU).



ISOMERISM Example

ISOMERISM



Same Molecular formula but Different Properties



Types of Isomerism

1. Structural Isomerism ✓
2. Stereoisomerism ✓
3. Conformers ✓



Types of Structural Isomerism

1. Chain Isomerism ✓
2. Position Isomerism ✓
3. Metamerism ✓
4. Functional Isomerism ✓
5. Ring-Chain Isomerism ✗
6. Tautomerism ✓



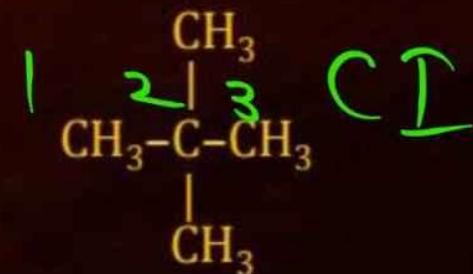
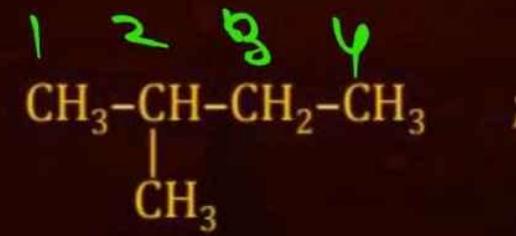
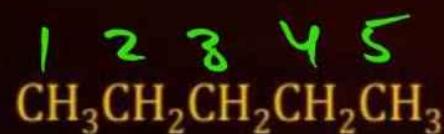
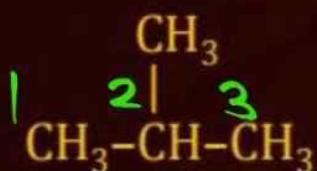
1. Chain Isomerism

Definition: Compounds which have same molecular formula but have different parent chain.

Example.



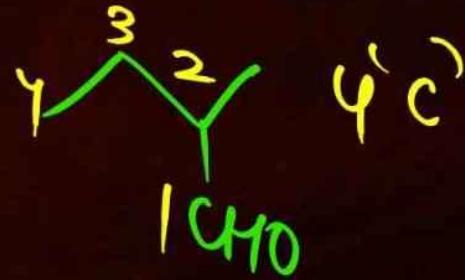
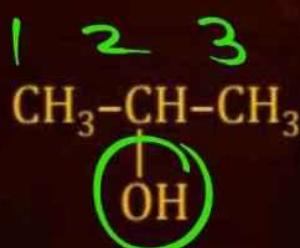
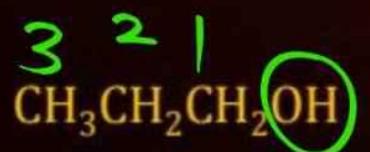
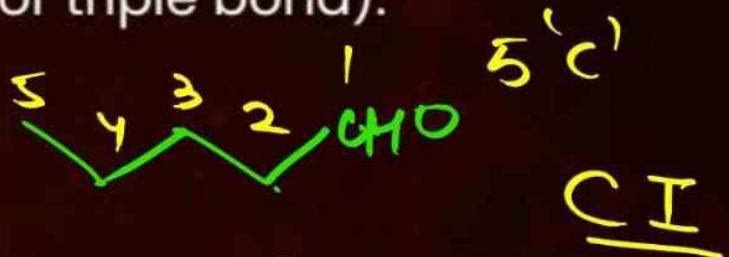
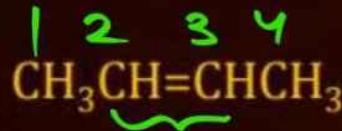
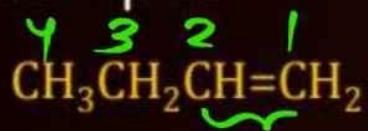
CI



2. Position Isomerism

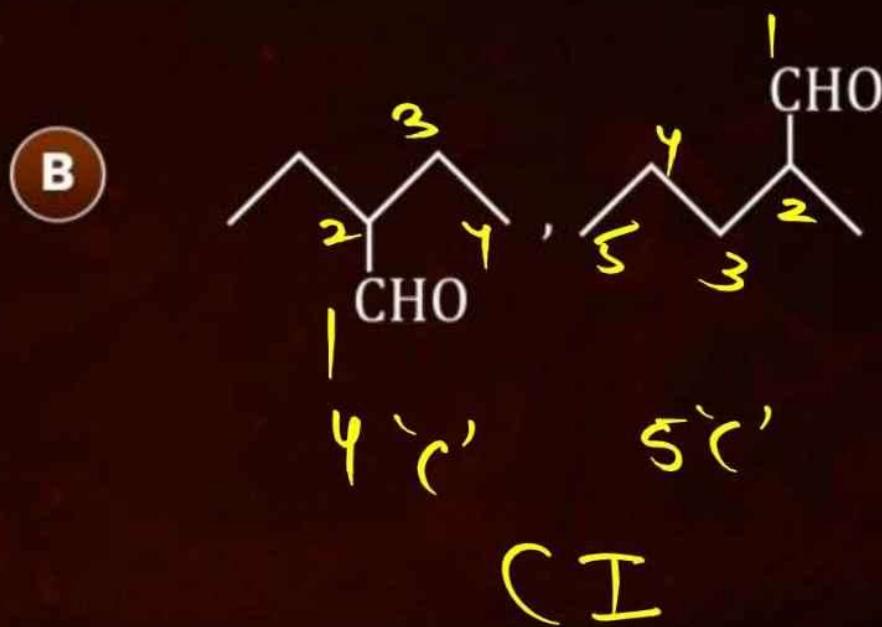
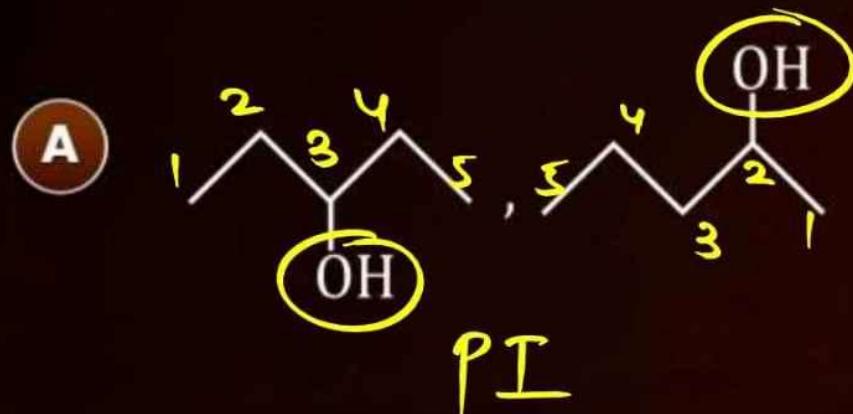
Definition: Compounds which have same molecular formula but have different position of branch or F.G (double or triple bond).

Example.



Question

Identify whether chain or position isomers.





3. Metamerism

Definition: Compounds which have same molecular formula but have different arrangement of atoms or groups from either side of bridging function group.

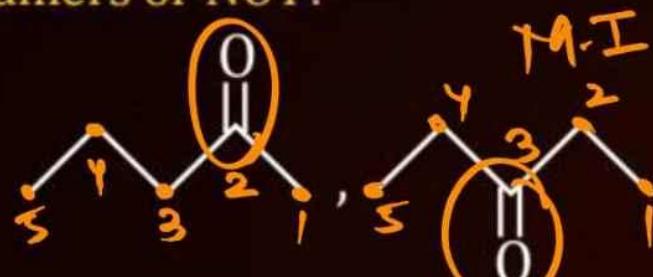


Question

Priority : M > C > P
For M.I, F.G must be same

Metamers or NOT?

A



B

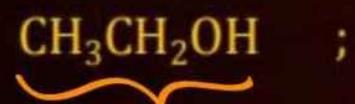




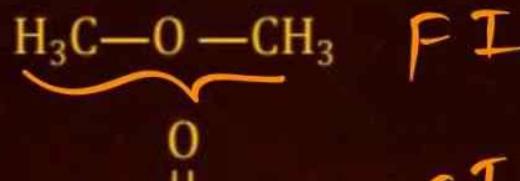
4. Functional Isomerism

Definition: Compounds which have same molecular formula but have different functional groups.

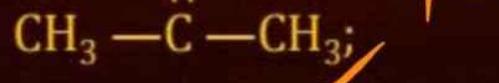
Example.



;



FI



FI



;



FI

Some Important Functional Isomers:

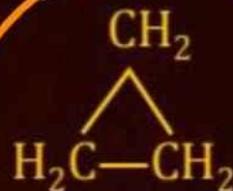
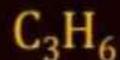
- A Alcohols and ethers ✓
- B Aldehydes and ketones ✓
- C Cyanides and isocyanides ✓
- D Primary, secondary and tertiary amines ✓
- E Acids and esters ✓
- F Diene and yne ✓



5. Ring – Chain Isomerism

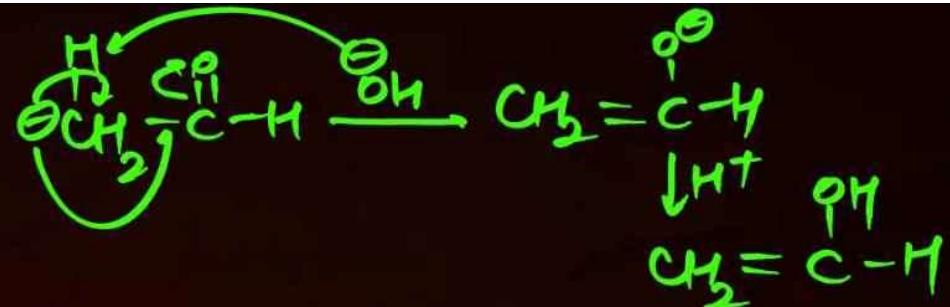
Definition: Compounds which have same molecular formula but one compound is chain & other is cyclic.

Example.

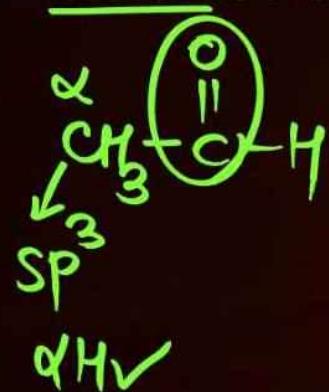




6. Tautomerism

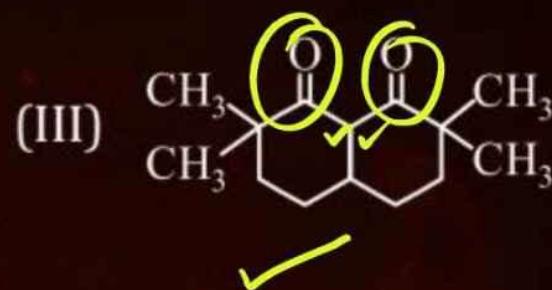
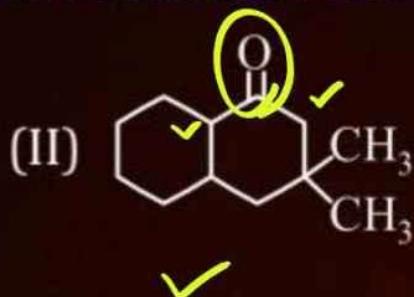
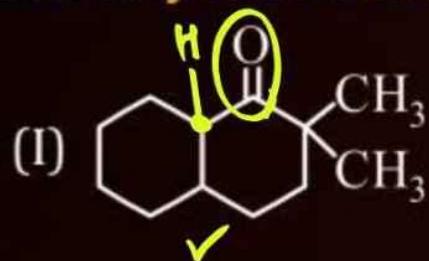


Definition: Intramolecular proton (H^+) transfer.



Question

Identify which can exhibit tautomerism?



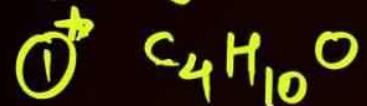
- A** (i) only
- B** (ii) only
- C** (iii) only
- D** All of these



[R > T > F > M > C > P]

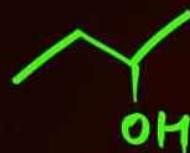
Calculation of no. of Structural Isomers

MF given

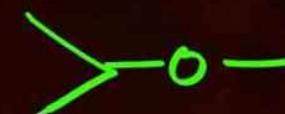
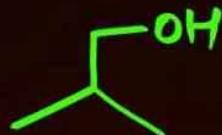


$$\text{DV} = (4+1) - \left(\frac{10+0}{2} \right)$$

$$\text{DV} = 0$$



4 Alcohol



3 Ether

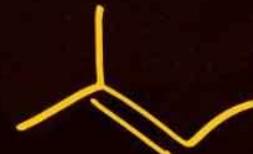
Total 7

Alkane

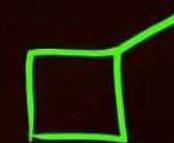
C_4H_{10}	2
C_5H_{12}	3
C_6H_{14}	5
C_7H_{16}	9
C_8H_{18}	18
C_9H_{20}	35
$C_{10}H_{22}$	75

C_5H_{10}

DU = 1



Aus 10





Geometrical Isomerism

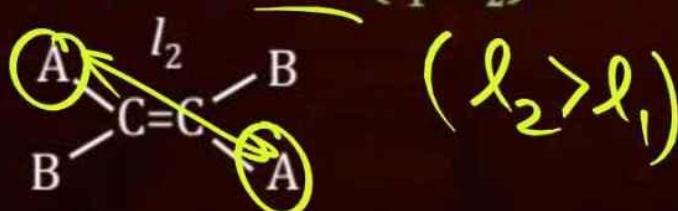
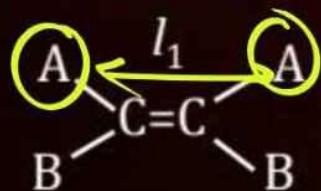
1. Arises due to Restricted rotation around

C=C, C=N, N=N, Cycloalkanes etc..

G.I. are not interconvertible at room temperature because of π -bond dissociation energy (62 Kcal).

2. G.I are also known as diastereomers (Not mirror image).

3. Areal Distance must be different ($l_1 \neq l_2$).

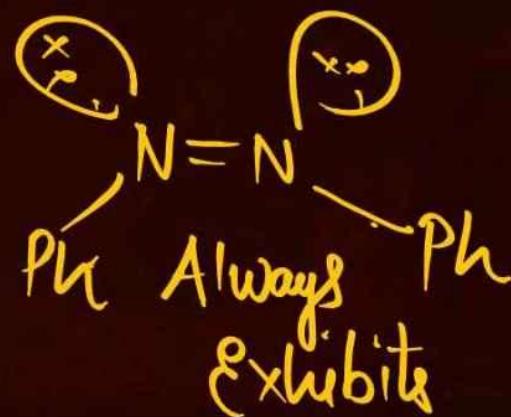
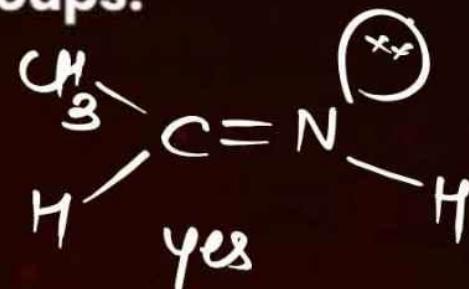
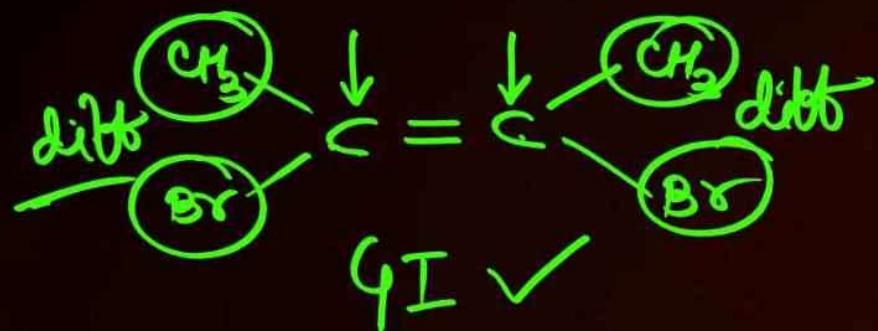


$$(l_2 > l_1)$$

4. Can be separated.

Condition for exhibition of Geometrical Isomerism

Restricted site must have different groups.



Types of G.I.

1. Cis-Trans ✓



/cyclo

2. E/Z isomers ✓



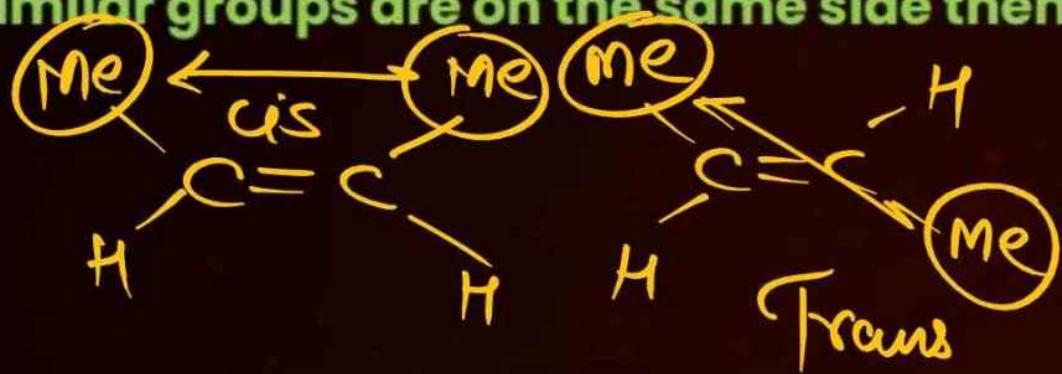
3. Syn-anti ✓



Case 01 Cis-Trans System

C=C

If similar groups are on the same side then cis otherwise trans.



Case- 2 Z-E System

C.I.P. Rules

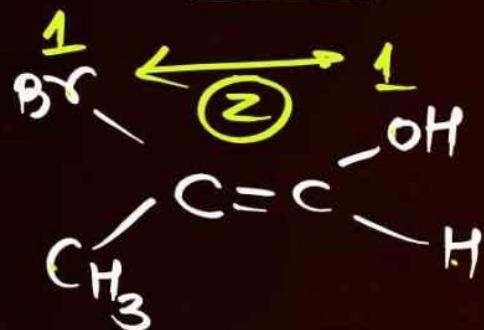
zusammen
Same Side

entgegen
Opposite Side

$\text{Br} \quad \text{OH}$
 $\backslash \quad /$
 $\text{C} = \text{C}$
 $/ \quad \backslash$
 $\text{CH}_3 \quad \text{H}$

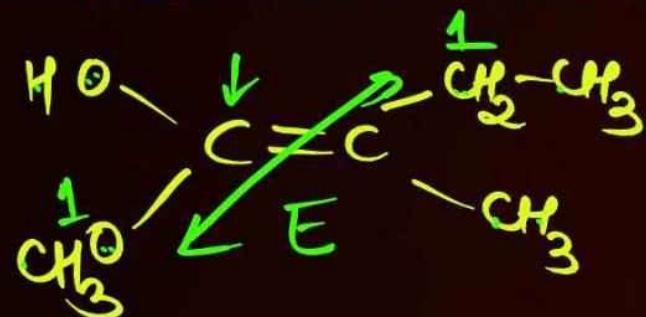
cis | trans fail
ZIE

Rule 01. Greater the atomic number, higher will be the priority.



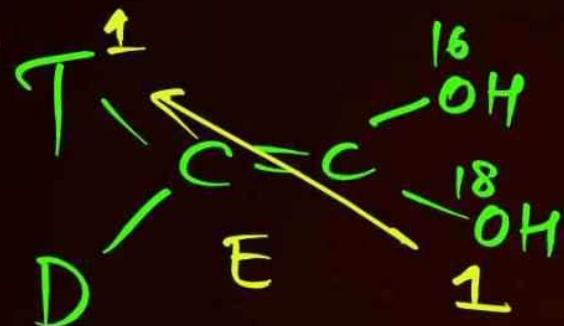
C.I.P. Rules

Rule 02. If the atomic number of first atom is same then go for the next atom and apply the rule number 01.



C.I.P. Rules

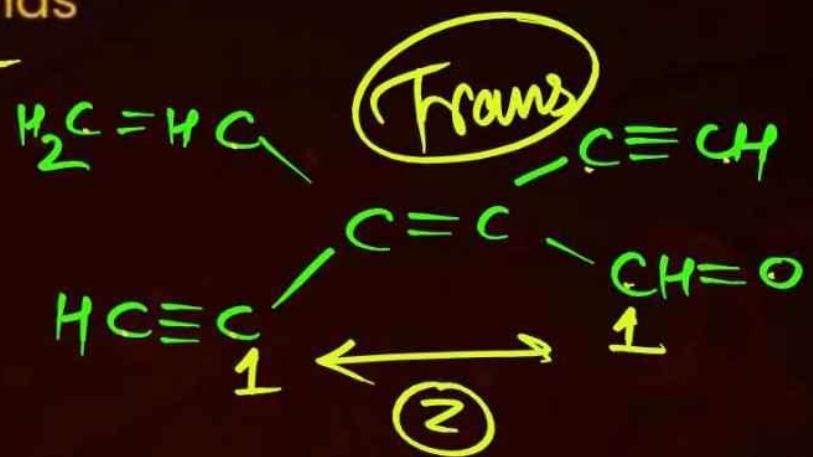
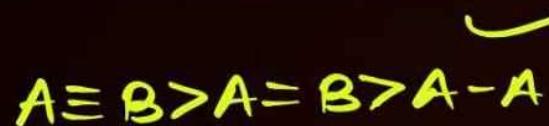
Rule 03. In the case of isotopes higher mass number will be the higher priority.



C.I.P. Rules



Rule 04. In the case of multiple bonds



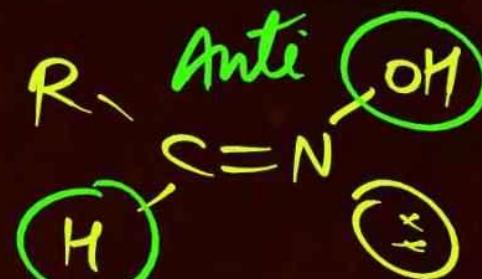
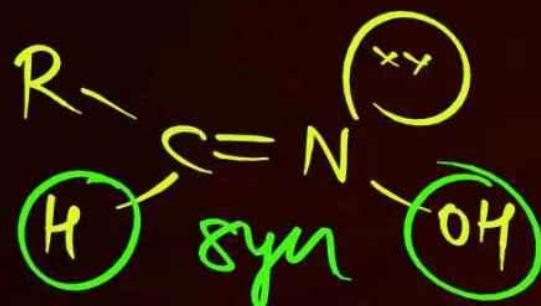
Case-3 Syn anti System

C=N

Case 01. Aldoxime



If OH and H are on the same side then syn otherwise anti.



Case 02. Ketoxime

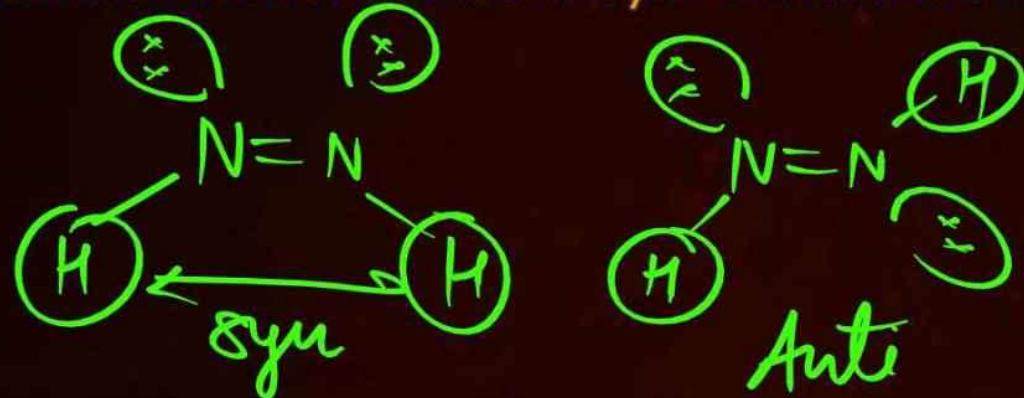
Sym methyl ethyl oxime
or

Anti ethyl methyl oxime

Case-3 N=N

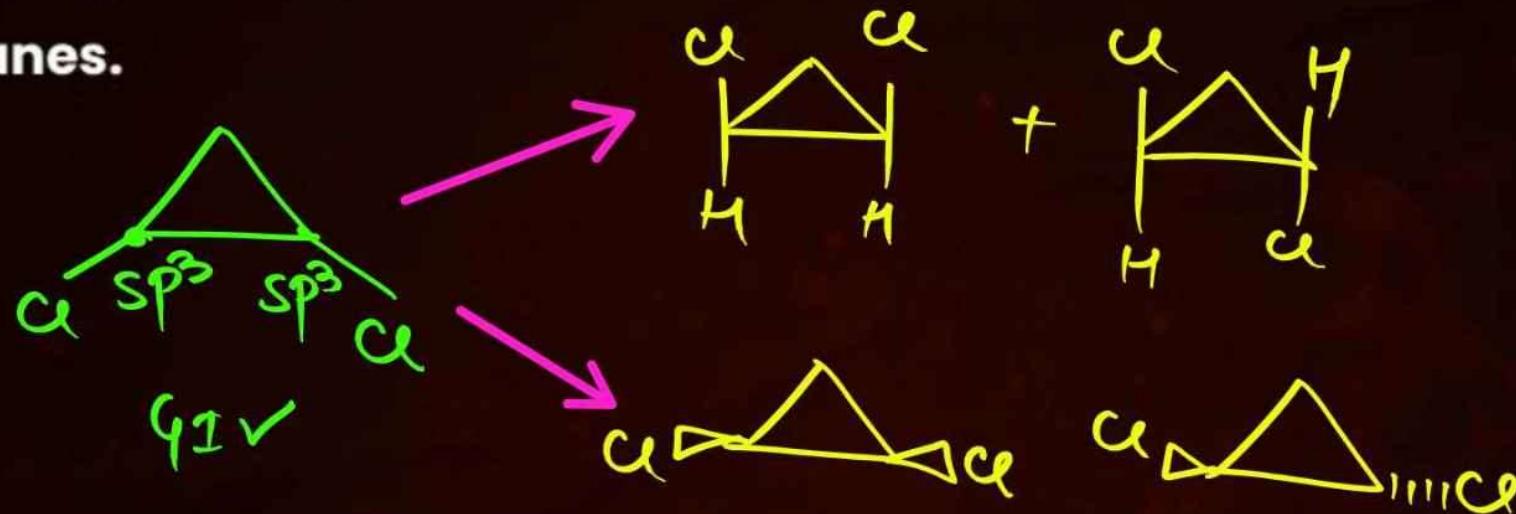
1. Syn anti

If group are on the same side then syn otherwise anti.



Case-4 Cycloalkanes

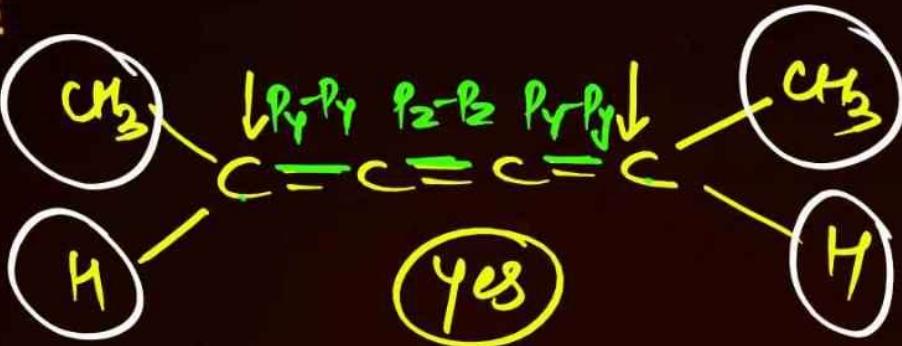
Minimum 2 sp^3 carbon must be attached at different site to show G.I in cycloalkanes.



Special Cases

1. Cummulenes

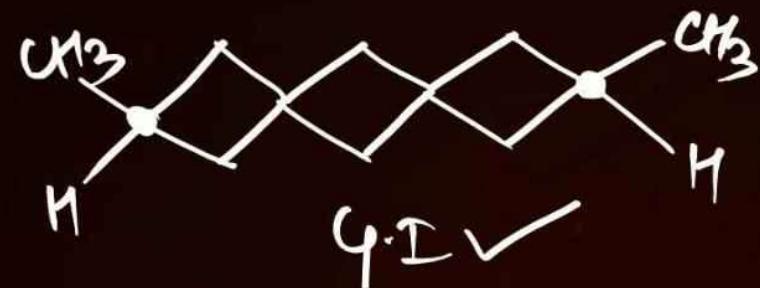
Lagataar
= bond
odd NO



yes

2. Spiranes

odd no of
sing



q.i ✓

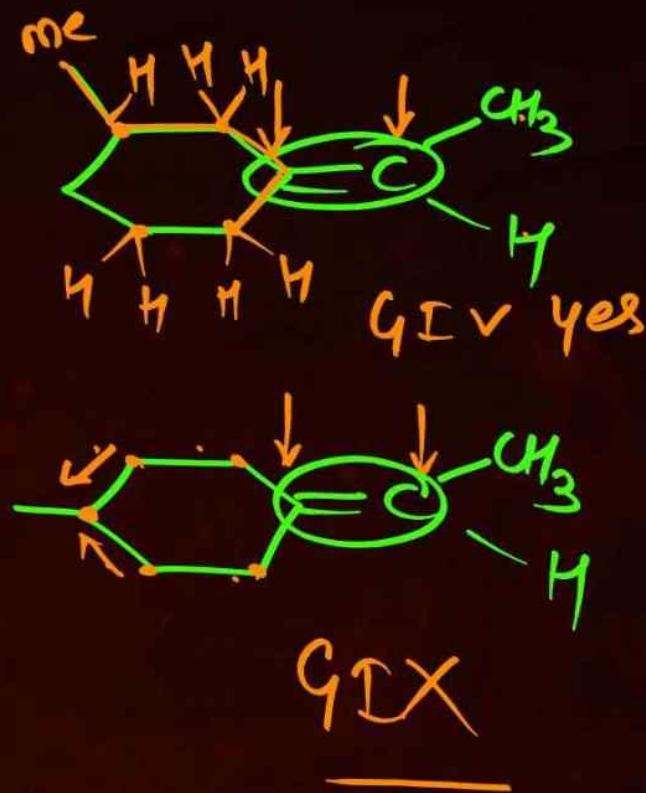
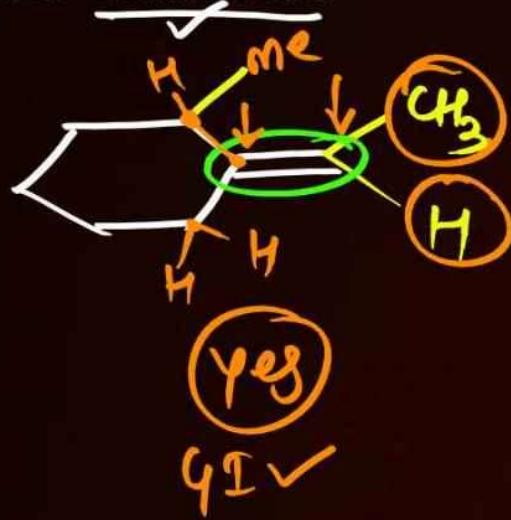
3. Spiranes + Cummulenes

odd NO

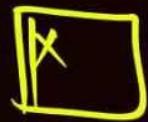
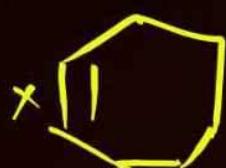


yes 4D ✓

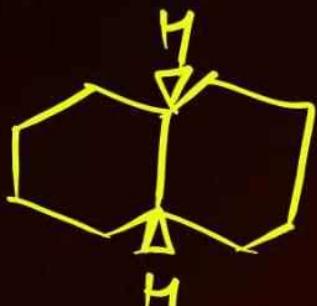
4. Cycloalkanes + Alkenes



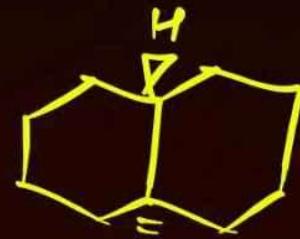
5. Cycloalkenes



6. Bicyclo compounds

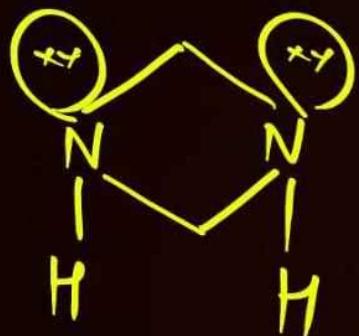


cis-decalin



trans-decalin

7. Heterocyclic compounds

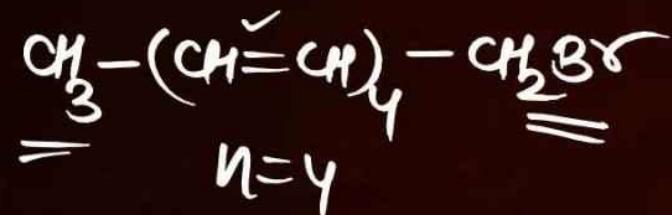


Calculation of no. of G.I.

Case 1. If End groups are different. (Unsymmetrical)

$n = \text{Stereogenic area (double bond that exhibit GI)}$

$$\text{Total GI} = 2^n$$



$$\text{Total GI} = 2^4 = 16$$

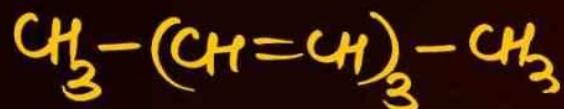
Calculation of no. of G.I.

Case 2. If End groups are same. (Symmetrical)

$$\text{Total G.I} = 2^{\frac{n-1}{2}} + 2^{\frac{p-1}{2}}$$

$$p = \frac{n}{2} \quad n = \text{even}$$

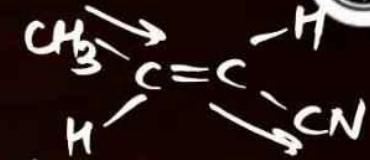
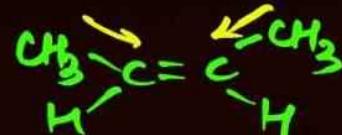
$$p = \frac{n+1}{2} \quad n = \text{odd}$$



$$n=3 \quad p = \frac{3+1}{2} = 2$$

$$\begin{aligned}\text{Total GI} &= 2^{\frac{3-1}{2}} + 2^{\frac{2-1}{2}} \\ &= 2^2 + 2^1 \\ &= 6\end{aligned}$$

Properties of Cis-Trans



1. Dipole moment

$C > T$

$C < T$

2. Boiling Point

$C > T$

$C < T$

DM Trans $>$ cis

3. Crystal Lattice Energy

$C < T$

4. Melting Point

$C < T$

5. Stability

$C < T$

6. Solubility

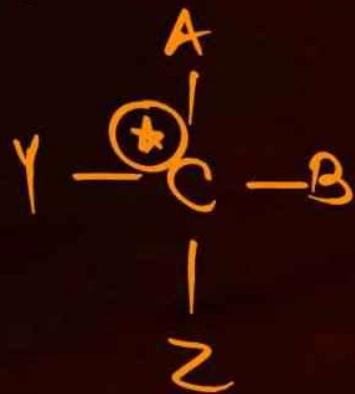
$C > T$



Optical Isomerism

Basic Terms:

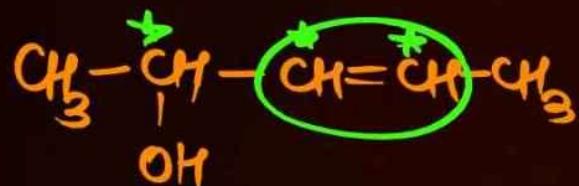
Chiral Centers: sp³ tetrahedral atom attached with four different groups.



Stereocenters

The atoms where by changing two groups a new stereo isomer is formed.

$$S\text{C} = \text{Geom center} + \underset{\text{Cent}}{\text{chiral}} = 2 + 1 = 3$$

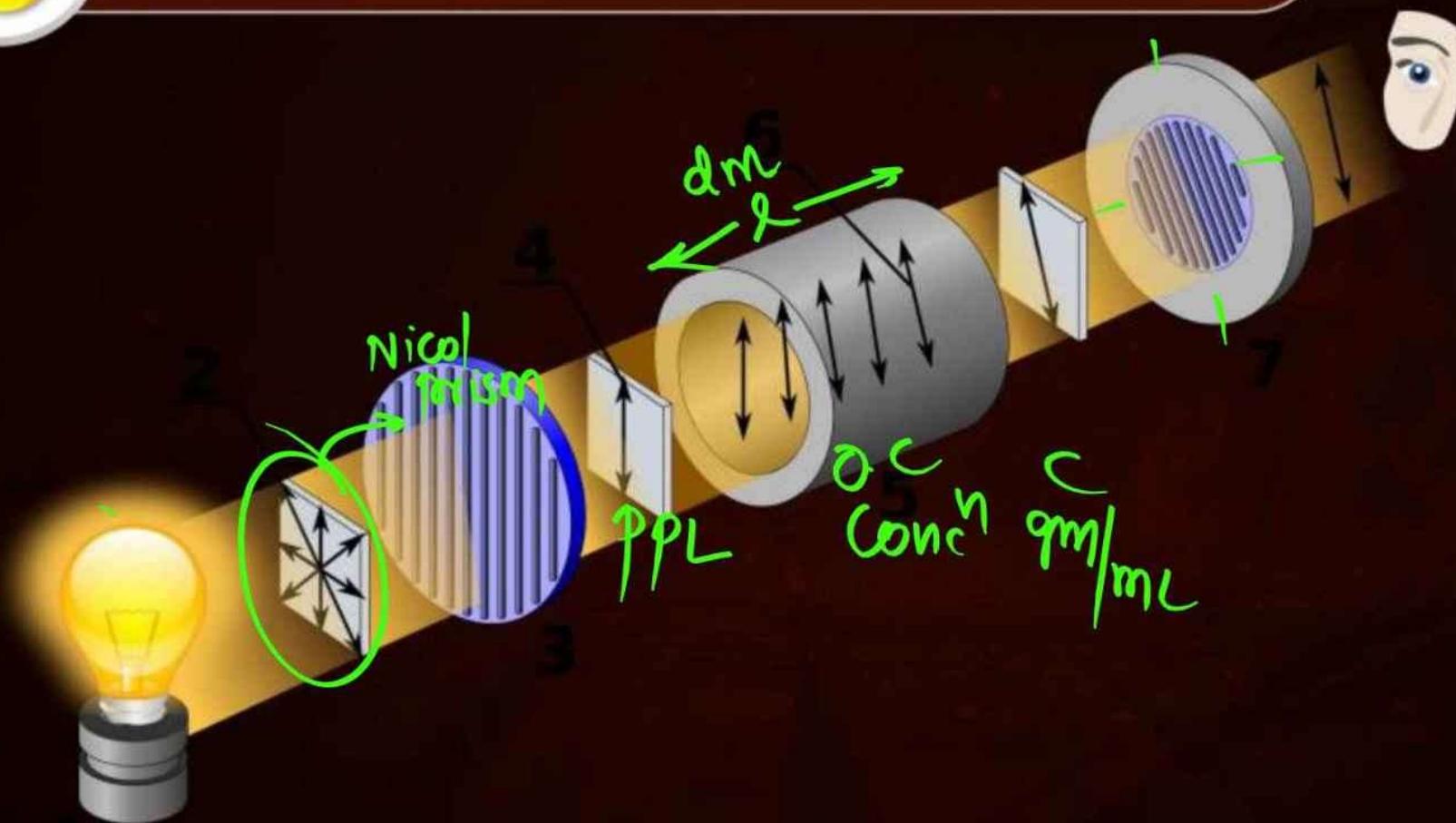


OP Points:

1. All stereocenters are chiral centers (T/F).
2. All chiral centers are stereocenters (T/F).

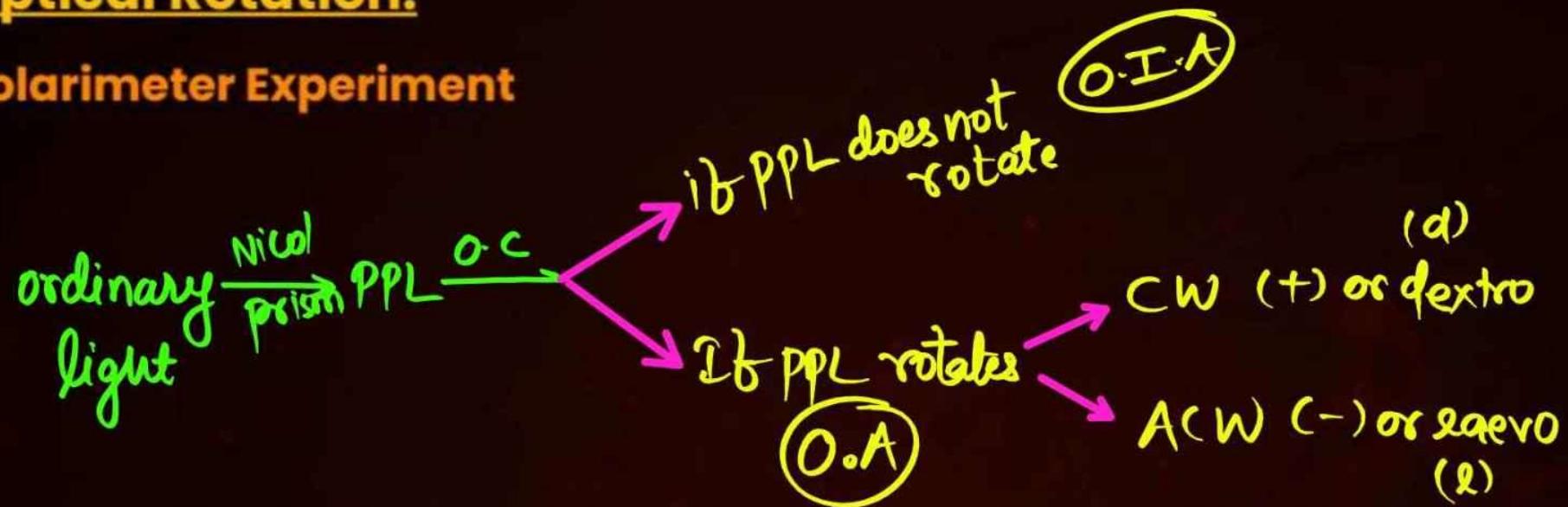


Optical Isomerism Polarimeter Experiment



Optical Rotation:

Polarimeter Experiment



POS (Plane of Symmetry)



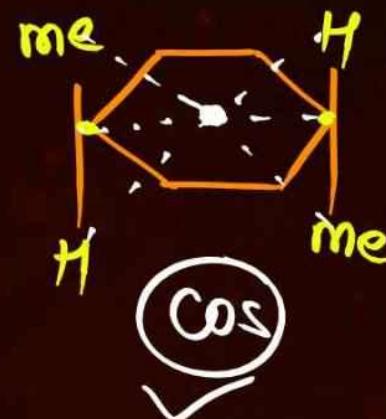
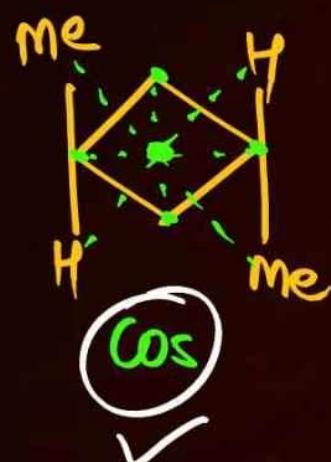
An Imaginary plane which can divide a molecule into two equal parts. These two parts must be mirror images



cos (Center of Symmetry)

An Imaginary point from which opposite lines are drawn same group will meet.

(4, 6 cyclic comp)



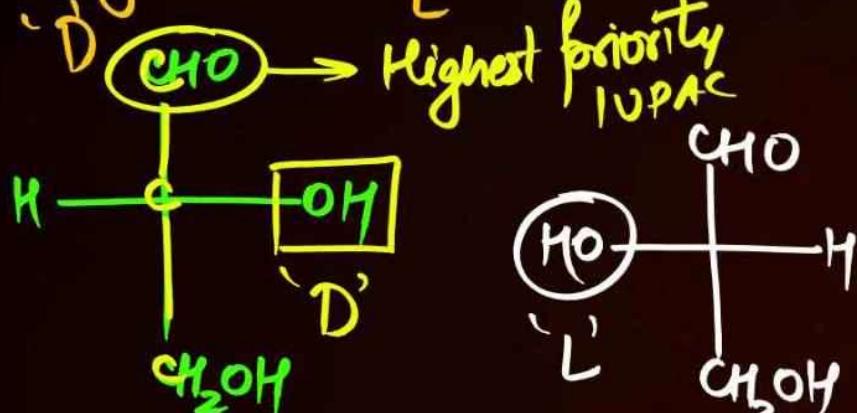
OP Points

1. Chiral Molecule —————> Optically Active
2. Chiral Molecule have chiral centers (T/F) ✓

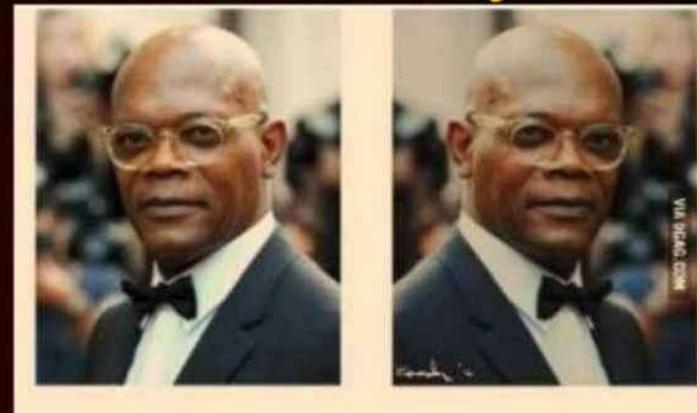
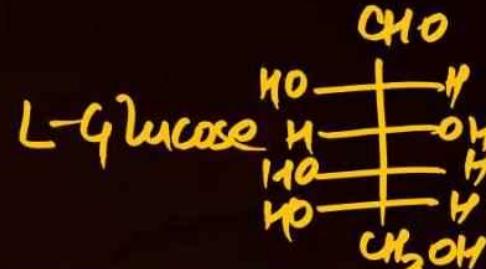
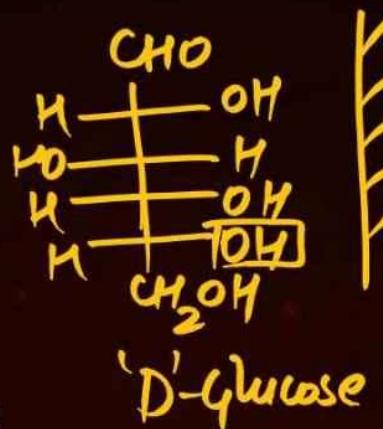
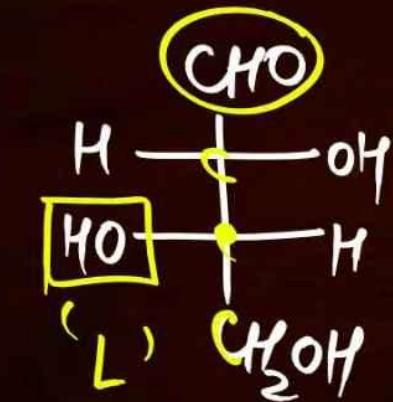
O·A
≡

D/L Configuration:

Carbohydrate & Amino acid



'D' Glyceraldehyde

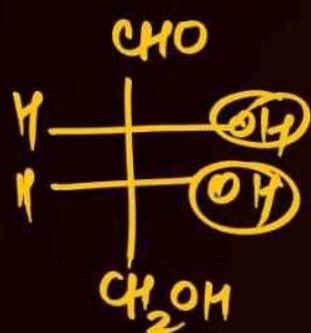


Samuel-L-Jackson

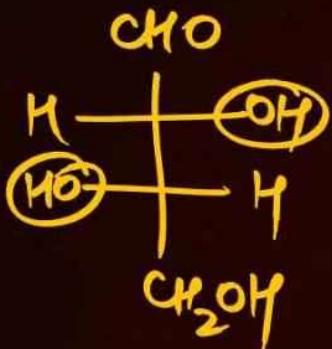
Samuel-D-Jackson

Erythro/Threo:

Similar group same side Erythro
otherwise Threo



E



T

R/S Configuration

CIP

Case 01: In Fischer Projection Formula

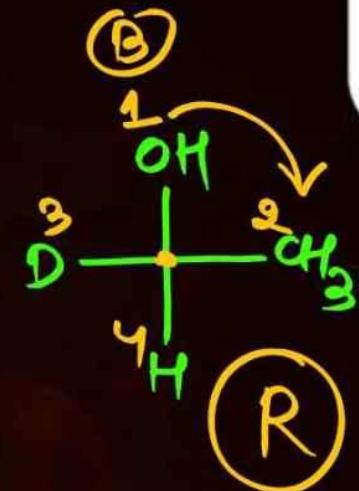
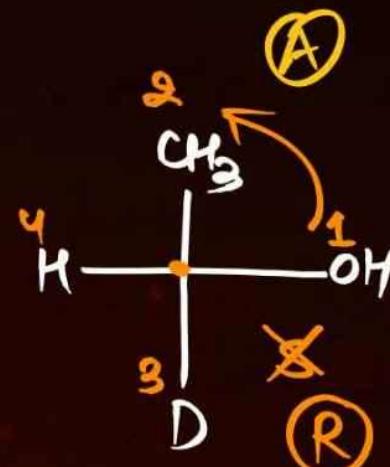
if ④ is on Horizon

Answer change
Kai dwej



1 → 2 shortest path

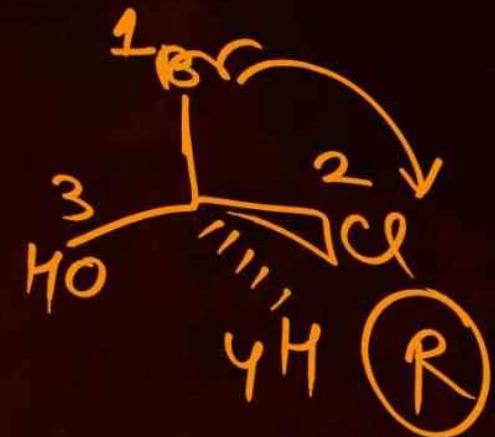
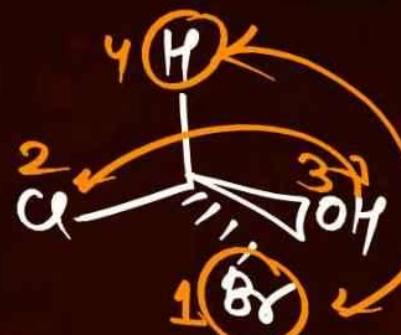
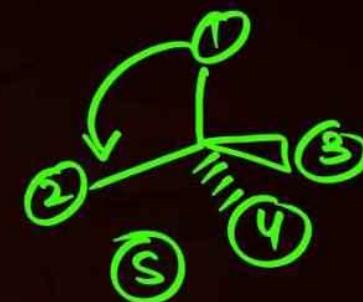
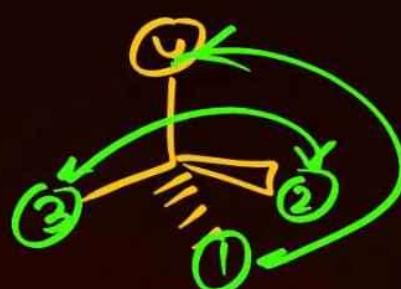
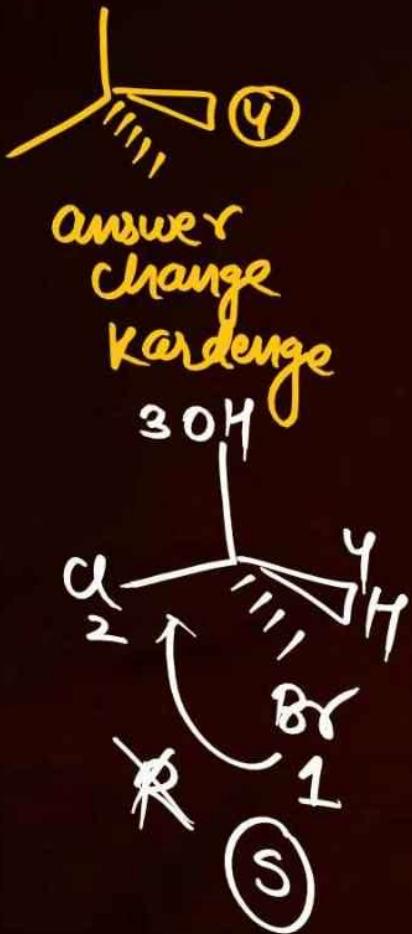
2 → 3 shortest



A & B are iden

$R \rightarrow R$ iden $R \rightarrow S$ Enantiomeric
 $S \rightarrow S$ $S \rightarrow R$

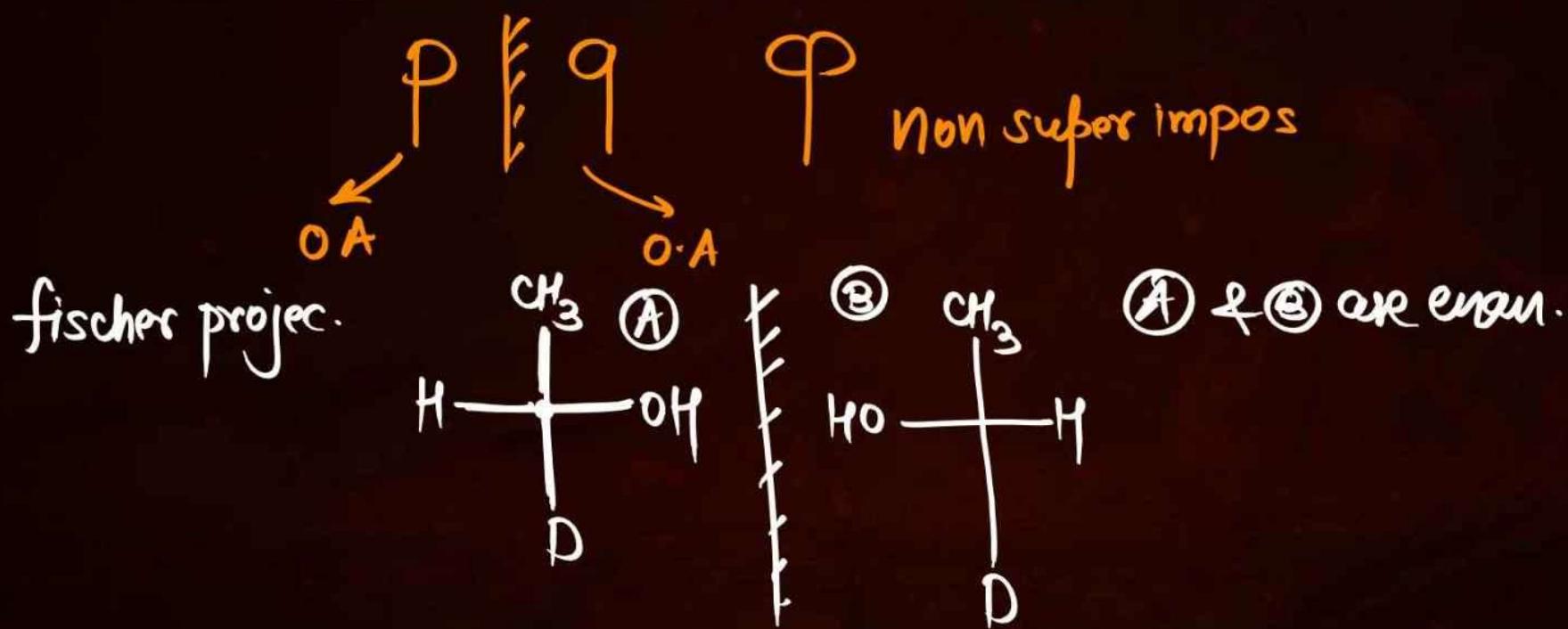
Case 02: In Solid dash wedge



Relation b/w compounds when only one chiral carbon is present

Answer: Either Enantiomers or Identical

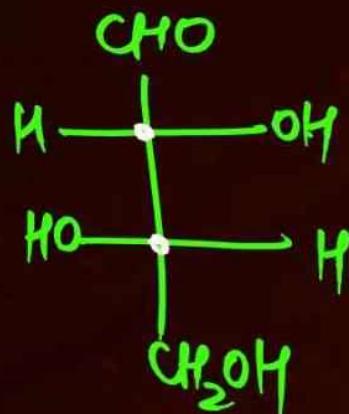
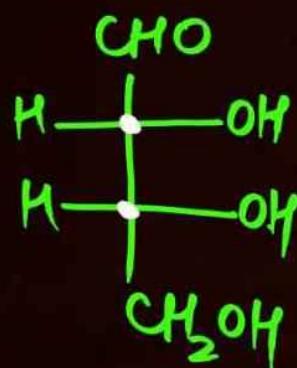
Enantiomers: Non superimposable mirror image.



Relation b/w compounds when only two or more chiral carbons are present

Answer: Enantiomers or Identical or Diastereomers

Diastereomers: Non superimposable & not mirror image.



Dias

1 chiral ka same config & doosre ka change ho Jaye

Enantiomers:

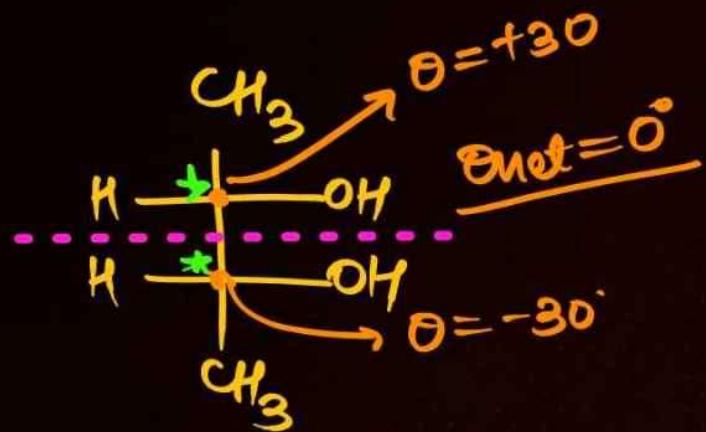
1. Non superimposable mirror image of each other.
2. Same physical properties like M.P, B.P, Solubility, Refractive Index, Dissociation constant & etc
3. Cannot be separated by fractional distillation.
4. Rotate PPL in same magnitude but in opposite direction.
5. React with same rate whenever treated with optically inactive compound.
6. React with different rate whenever treated with optically active compounds.

Diastereomers:

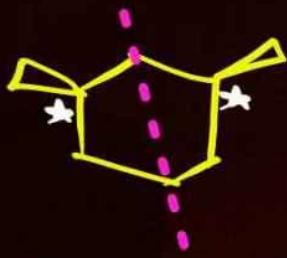
1. Stereoisomers of each other ✓
2. Not mirror image of each other ✓
3. Different physical properties like M.P, B.P, Solubility, Refractive Index, Dissociation constant & etc.
4. Can be separated by fractional distillation. ✓

Meso Compounds:

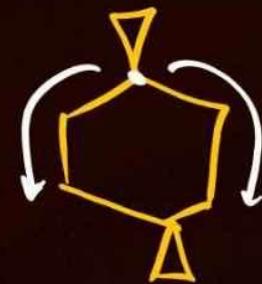
1. Optical isomers having chiral center more than one with Pos/cos.
2. Meso compounds are optically inactive due to internal compensation or intra-molecular neutralization or molecular symmetry.
3. Mirror image of meso compounds represent its identical molecule.
4. Meso compounds cannot have enantiomers.



$C \cdot Cor = \alpha, pos(v)$
Meso



$C \cdot Cor(2) pos(v)$
 meso(v)



$C \cdot Cor(0)$
 meso(x)

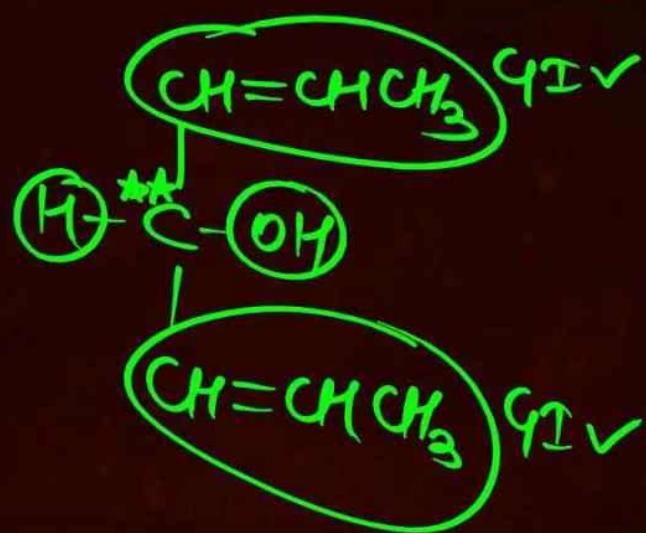
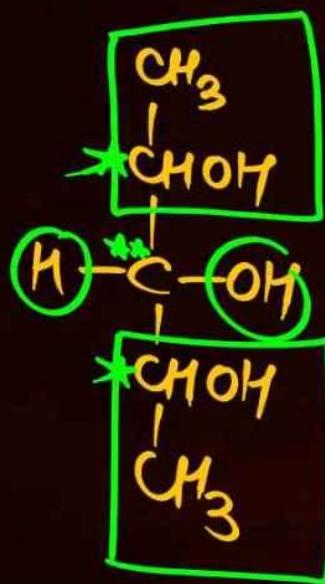
pos(v)
 $O \sqcap A$



pos	cos	comment
✓	✓	OIA
✗	✓	OIA
✓	✗	OIA
✗	✗	OA

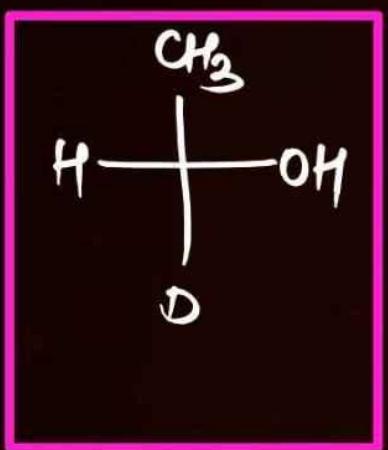
Pseudo Chiral Centers:

1. sp^3 atom attached with two different groups.
2. Other two groups are same but exhibit G.I or have chiral carbons.



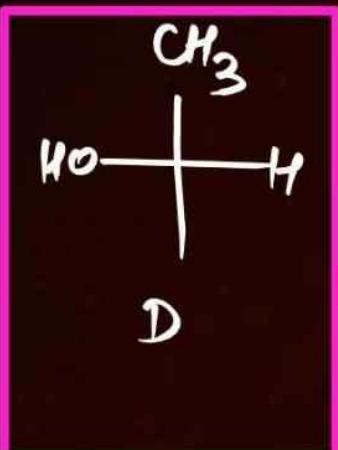
Racemic mixture:

Equimolar mixture of two enantiomers



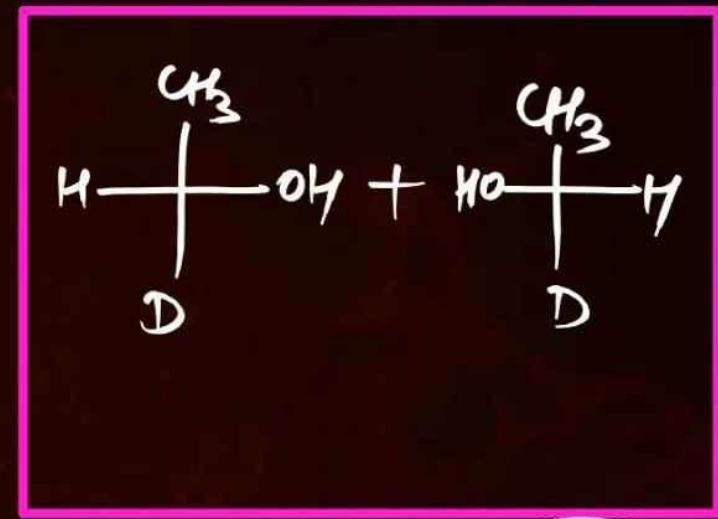
A

$$\theta = +30$$



B

$$\theta = -30$$



$$A+B = RM$$

O.I.A

due
 $D_{net} = 0^\circ$ to external
Compensator

Resolution:

Separation of Enantiomers from RM is called resolution.



Resolvable comp
O·A

Calculation of Optical Isomerism:

Case 1. If molecule is unsymmetrical.

$$\text{Total O.I.} = 2^n \quad n = \text{no. of chiral cent}$$

$$OA = 2^n$$

$$meso = 0$$

$$RM = \frac{OA}{2}$$



$$n=2$$

$$\text{Total OI} = 2^2 = 4$$

$$OA = 4$$

$$meso = 0$$

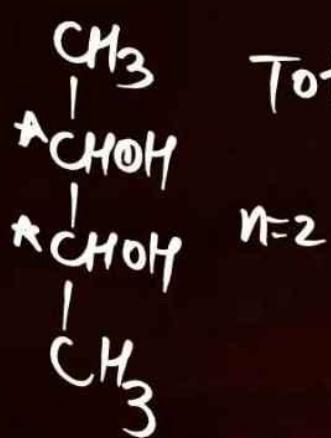
$$RM = 2$$

Calculation of Optical Isomerism:

Case 2. If molecule is symmetrical ($n = \text{even}$)

$$\text{Total O.I.} = 2^{n-1} + 2^{\frac{n}{2}-1}$$

↓ ↓
 OA meso



$$\begin{aligned}
 \text{Total O.I.} &= 2^{2-1} + 2^{\frac{2}{2}-1} \\
 &= 2 + 1 \\
 &\quad \downarrow \\
 &\quad \text{meso}
 \end{aligned}$$

$$R.M. = 2^{\frac{n}{2}-1}$$

Calculation of Optical Isomerism:

Case 3. If molecule is symmetrical ($n = \text{odd}$)

$$\text{Total OI} = 2^{\frac{n-1}{2}}$$

$$\text{meso} = 2^{\frac{n-1}{2}}$$

$$OA = \text{Total} - \text{meso}$$



$$n = 3$$

$$\text{Total OI} = 2^{\frac{3-1}{2}} = 4$$

$$\text{meso} = 2^{\frac{3-1}{2}} = 2$$

$$OA = 2$$

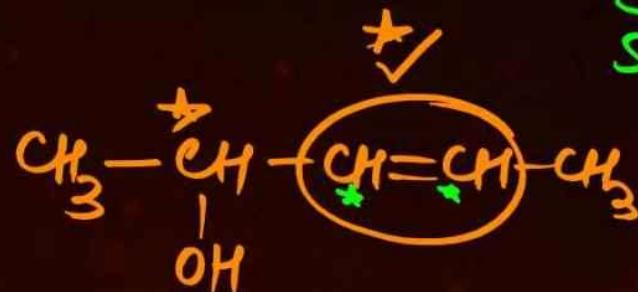
$$RM = \frac{2}{2} = 1$$

Calculation of Stereoisomers:

Case 1. If molecule is unsymmetrical.

$$\text{Total S.I.} = 2^n$$

$n = \text{no. of chiral centers}$
 $+ \text{Stereogenic area}$



$$S.C = 1 + 2 = 3$$

Stereocent

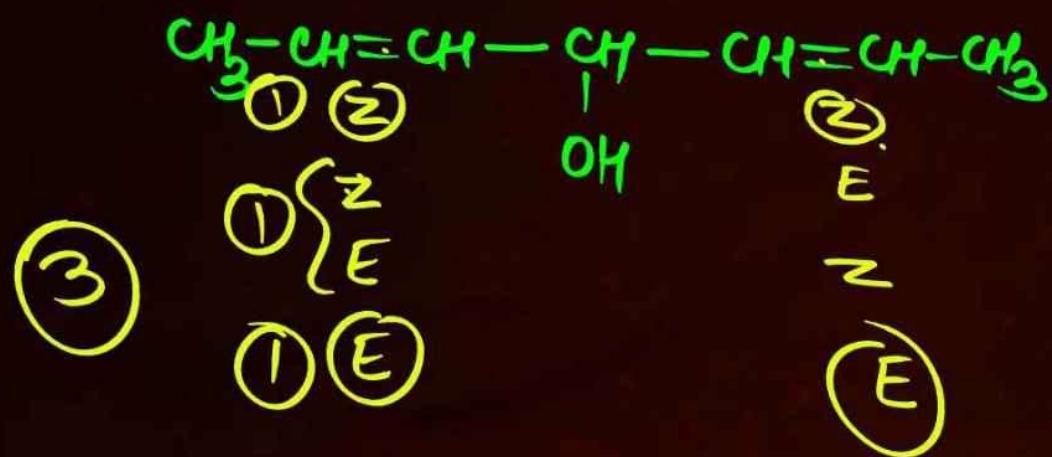
$$n=2 \quad \text{Total S.I.} = 2^2 = 4$$

PW

Calculation of Stereoisomers:

Case 2. If molecule is symmetrical.

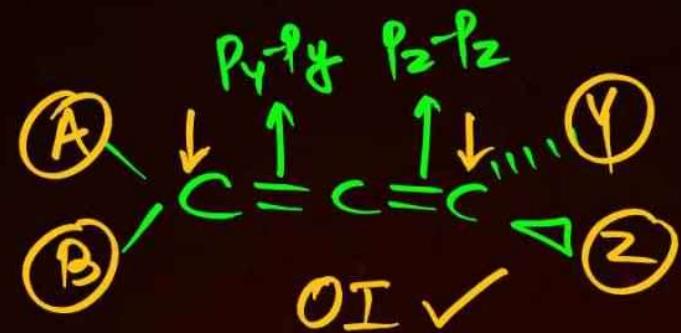
Note: In this case we will not use formula.



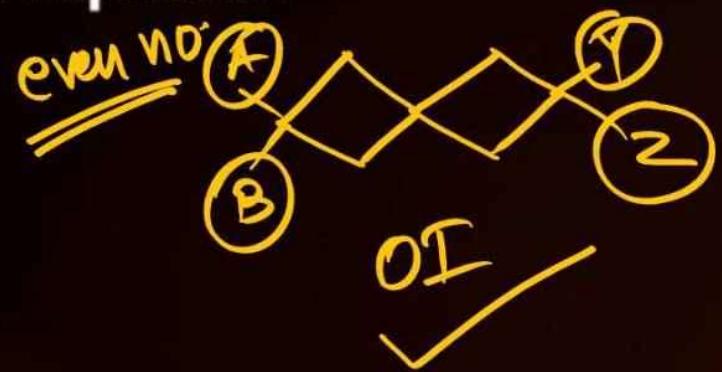
Special Cases

1. Cummulenes

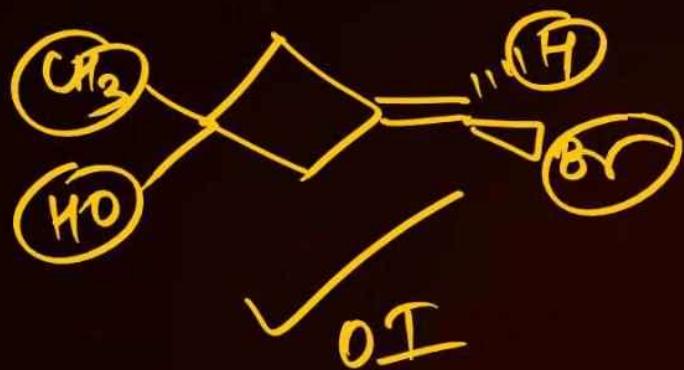
even no



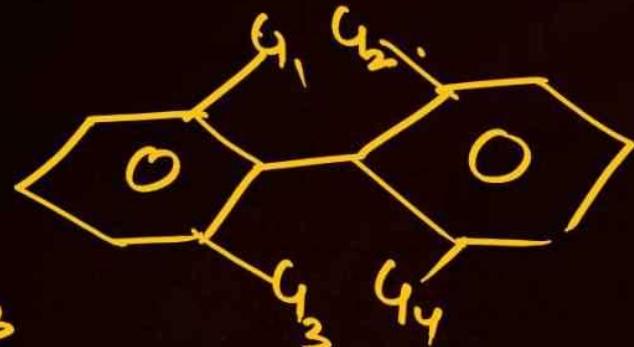
2. Spiranes



3. Spiranes + Cummulenes



④ Biphenyl



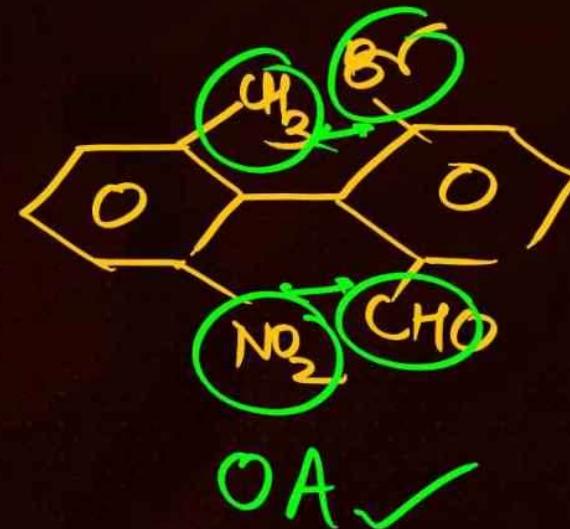
$Q_1 \neq Q_3$

$Q_2 \neq Q_4$

Q_1, Q_2, Q_3, Q_4 Bulky group

NO_2 , COOH , R , Cl , Br , I

SO_3H





Conformational Isomerism

1. Arises due to free rotation around C-C sigma bond.
2. There are infinite conformers.
3. The energy for rotation (Rotational Energy) around sigma bond is available at room temperature.
4. Total conformer of methane is zero.
5. Also known as Rotamers.
6. Conformers are not true isomers.
7. Interconvertible.

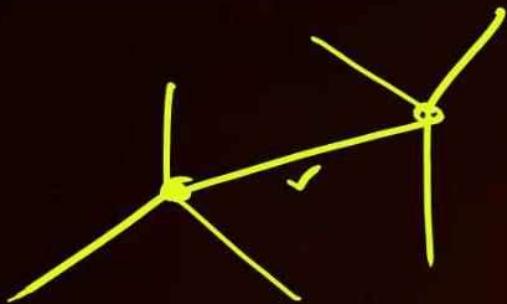
General Form

Newman
form

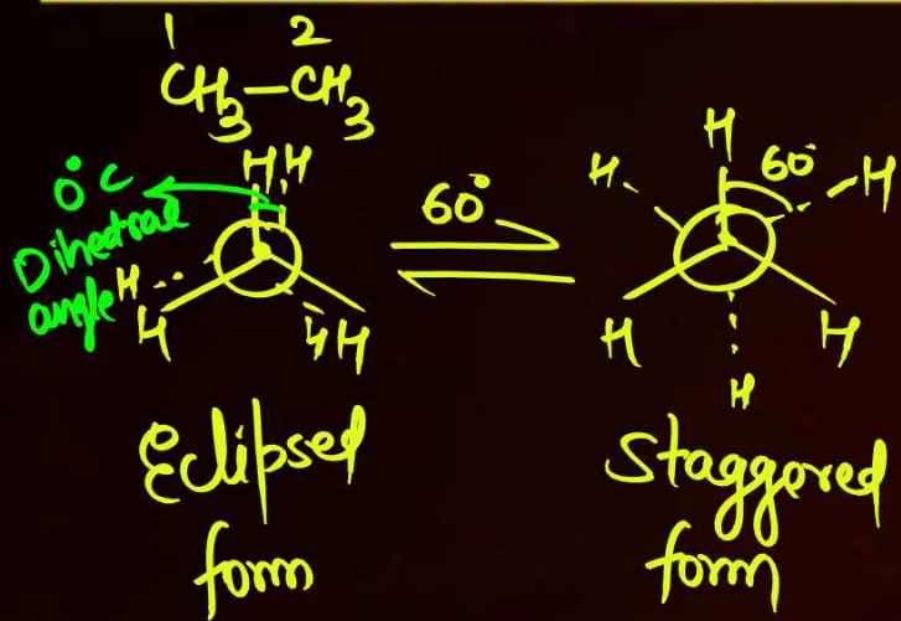


Newmann

Sawhorse Formula



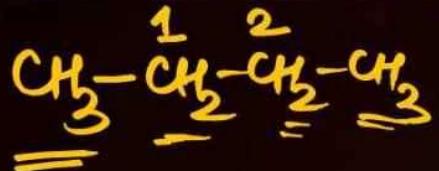
Conformation Isomerism in Ethane



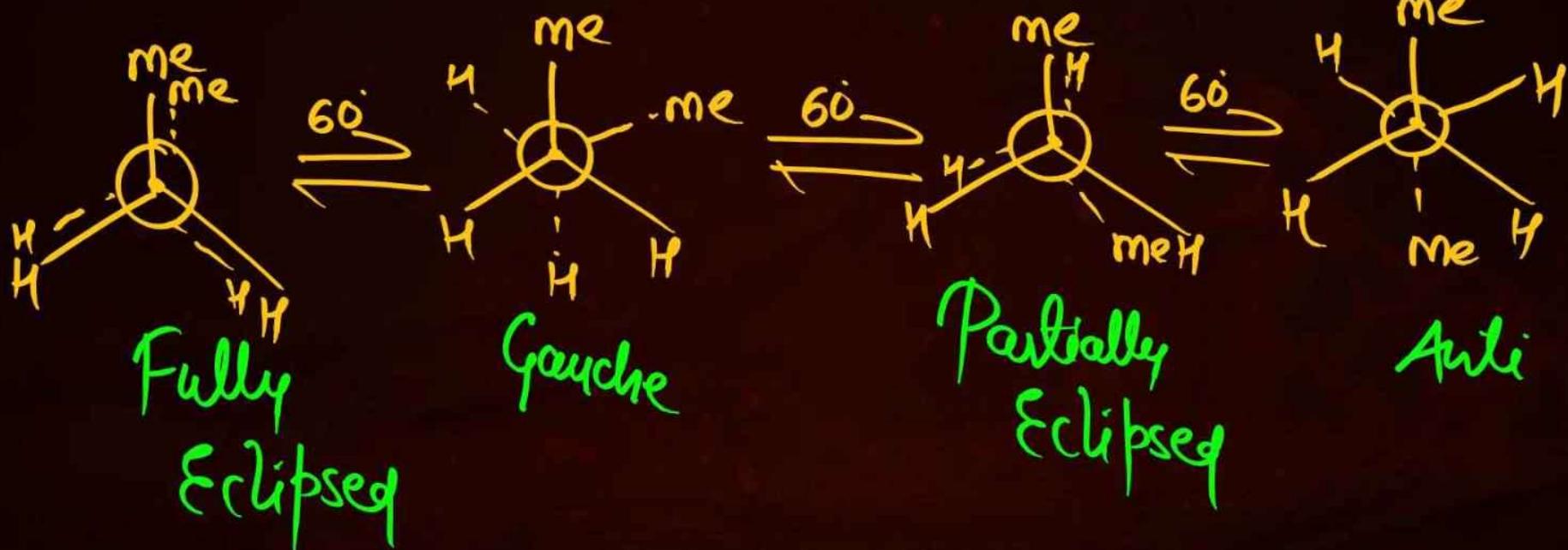
Stability $E < S$
 Energy $E > S$

All forms b/w E & S are
 Skew form

Conformation Isomerism in Butane



Stability

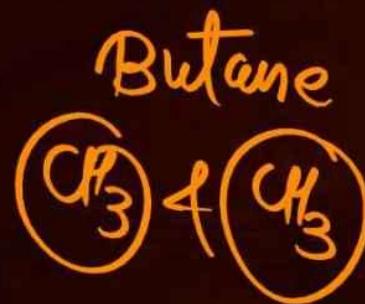
 $A > G > PE > FE$ 

Strain (Destabilization):

Torsional: The strain arises due to repulsion b/w bond pair electrons.

Ethane butane

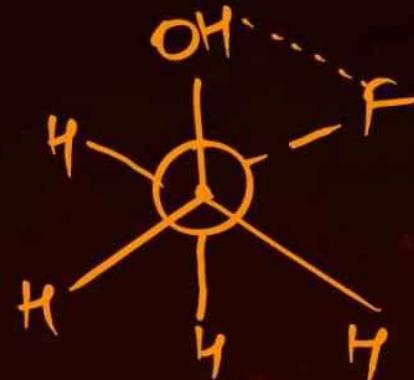
Vander Waal: The strain arises due to repulsion of front & back atoms or group
due to steric factor (bulkiness).



Gauche Effect:

In case of H bonding

($\text{H} > \text{A} > \text{PE} > \text{FE}$)



Conformation Isomerism in Cyclohexane

Chair



stability

Twist boat (O-A)



C > TB > B > HC

Boat



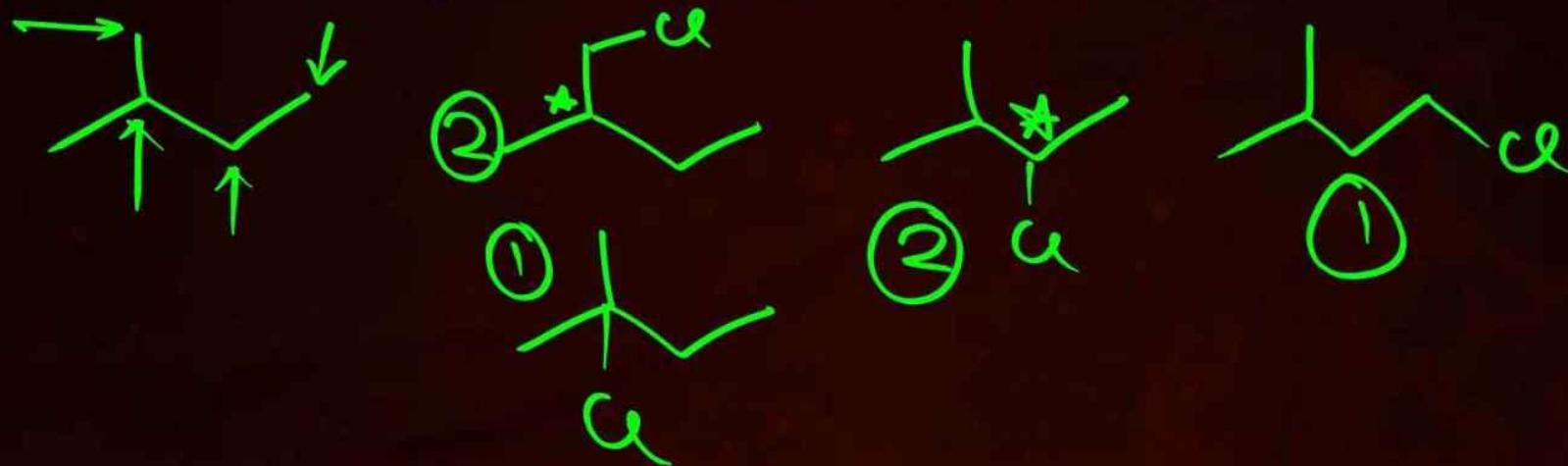
Half chain



QUESTION (JEE Mains 1st Feb 2024, Evening Shift)



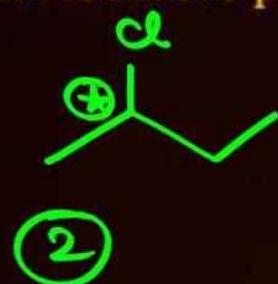
Total number of isomeric compounds (including stereoisomers) formed by monochlorination of 2-methylbutane is 6.



QUESTION (JEE Mains 1st Feb 2024, Morning Shift)



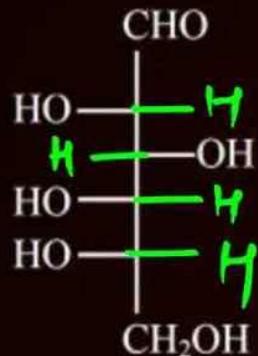
Number of optical isomers possible for 2-chlorobutane



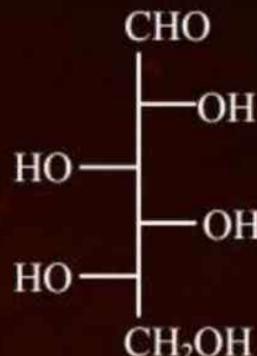
QUESTION (JEE Mains 4th April 2024, Morning Shift)

Which of the following is the correct structure of L-Glucose?

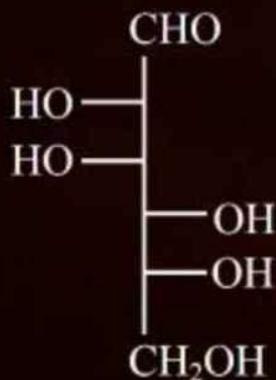
A



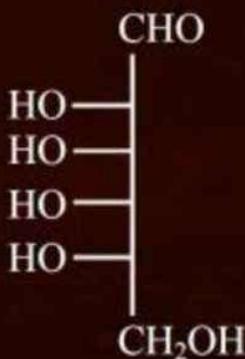
B



C



D



QUESTION (JEE Mains 4th April 2024, Morning Shift)



The number of different chain isomers for C_7H_{16} is 9.

C_4	2
C_5	3
C_6	5
C_7	9
C_8	18
C_9	35
C_{10}	75

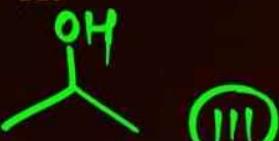
QUESTION (JEE Mains 5th April 2024, Evening Shift)



Match List - I with List - II.

List - I

(Pair of Compounds)



- (A) n-propanol and Isopropanol
- (B) Methoxy propane and ethoxyethane
- (C) Propanone and propanal
- (D) Neopentane and Isopentane

List - II

(Isomerism)

- (I) Metamerism
- (II) Chain Isomerism
- (III) Position Isomerism
- (IV) Functional Isomerism

A

(A)-(II), (B)-(I), (C)-(IV), (D)-(III)

C

(A)-(I), (B)-(III), (C)-(IV), (D)-(II)

B

(A)-(III), (B)-(I), (C)-(II), (D)-(IV)

D

(A)-(III), (B)-(I), (C)-(IV), (D)-(II)

QUESTION (JEE Mains 5th April 2024, Morning Shift)

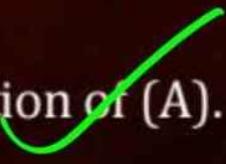


Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): Cis form of alkene is found to be more polar than the trans form.

Reason (R): Dipole moment of trans isomer of 2-butene is zero.

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

- A** Both (A) and (R) are true but (R) is NOT the correct explanation of (A).
- B** (A) is true but (R) is false.
- C** Both (A) and (R) are true and (R) is the correct explanation of (A). 
- D** (A) is false but (R) is true.

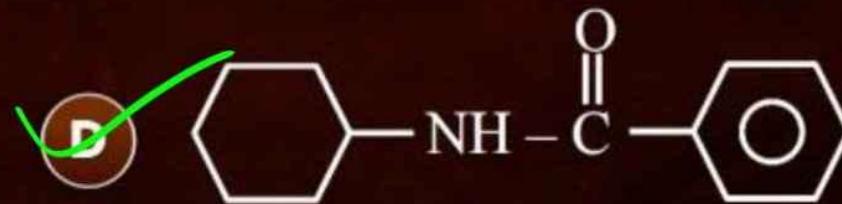
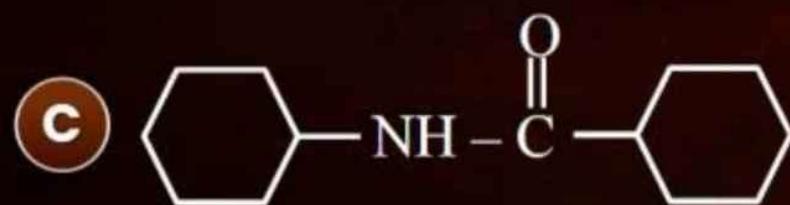
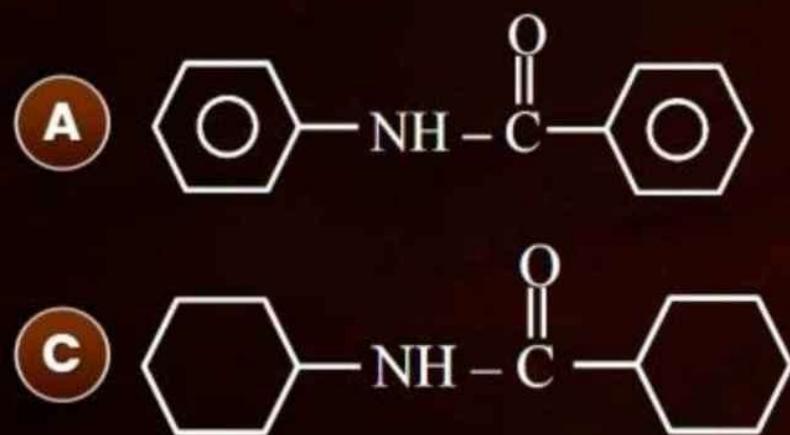
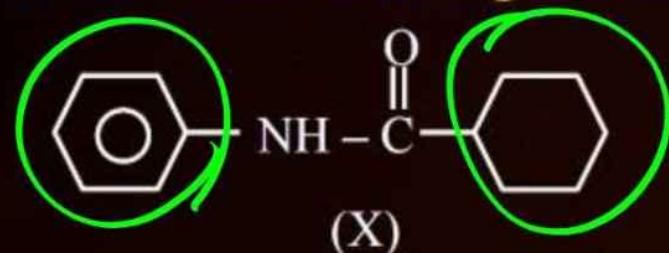
QUESTION (JEE Mains 6th April 2024, Evening Shift)

The incorrect statement regarding the geometrical isomers of 2-butene is:

- A** cis-2-butene and trans-2-butene are not interconvertible at room temperature.
- B** cis-2-butene has less dipole moment than trans-2-butene.
- C** trans-2-butene is more stable than cis-2-butene.
- D** cis-2-butene and trans-2-butene are stereoisomers.

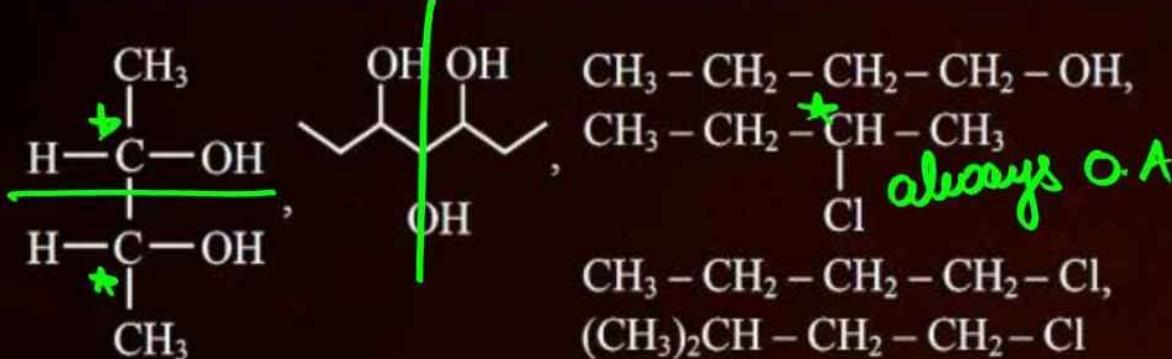
QUESTION (JEE Mains 6th April 2024, Morning Shift)

Which of the following is metamer of the given compound (X)?



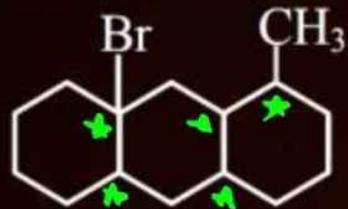
QUESTION (JEE Mains 8th April 2024, Evening Shift)

Total number of optically active compounds from the following is 1.



QUESTION (JEE Mains 8th April 2024, Morning Shift)

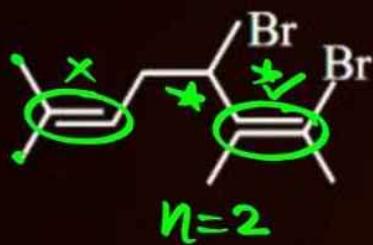
The number of optical isomers in following compound is: ____.



$$\varrho^5 = 32$$

QUESTION (JEE Mains 9th April 2024, Evening Shift)

Total number of stereo isomers possible for the given structure:



$$\eta = 2$$
$$2^2 = 4$$

A 8

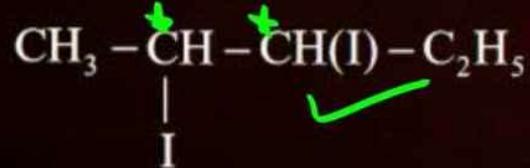
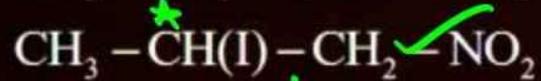
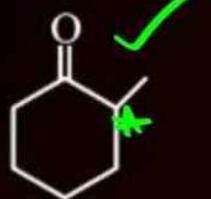
B 2

C 4

D 3

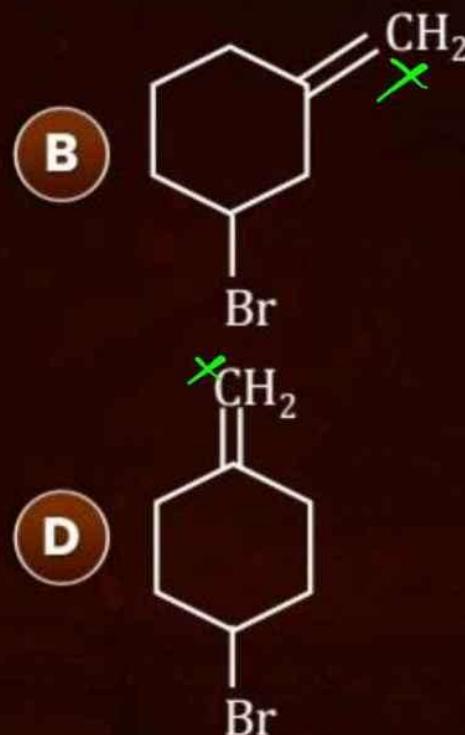
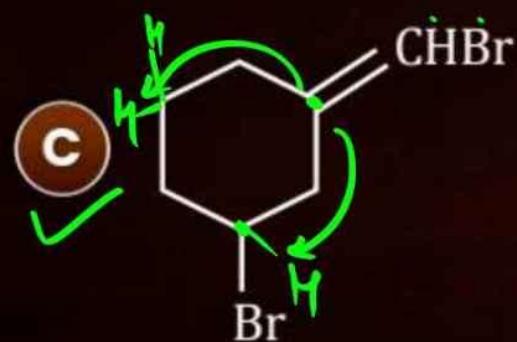
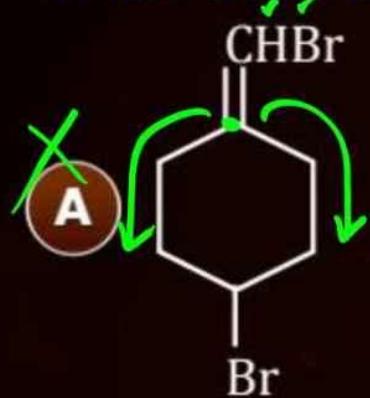
QUESTION (JEE Mains 27th January 2024, Evening Shift)

Total number of compounds with Chiral carbon atoms from following is 5.



QUESTION (JEE Mains 29 January 2024, Evening Shift)

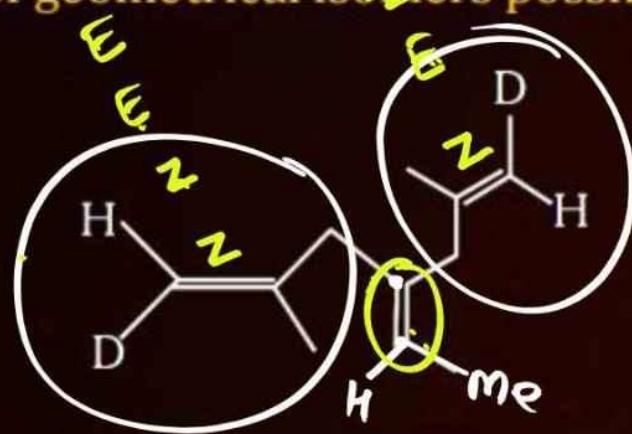
Which one of the following will show geometrical isomerism?



QUESTION (JEE Mains 30 January 2024, Evening Shift)



Number of geometrical isomers possible for the given structure is/are _____.



(4)

QUESTION (NCERT Exemplar)

In which of the following, functional group isomerism is not possible?

- A** Alcohols
- B** Aldehydes
- C** Alkyl halides
- D** Cyanides

QUESTION (NCERT Exemplar)



Assertion (A): Pent-1-ene and pent-2-ene are position isomers.

Reason (R): Position isomers differ in the position of functional group or a substituent.



- A** Both A and R are correct and R is the correct explanation of A.
- B** Both A and R are correct but R is not the correct explanation of A.
- C** Both A and R are not correct.
- D** A is not correct but R is correct.



GOC

Electronegativity & Electron Density

Electronegativity: The tendency to attract electron pair towards itself in a covalently bonded bond.



Electron Density:



Electronic displacement Effect



Permanent Effect

- 1. Inductive Effect
- 2. Mesomeric Effect
- 3. Hyperconjugation

Temporary Effect

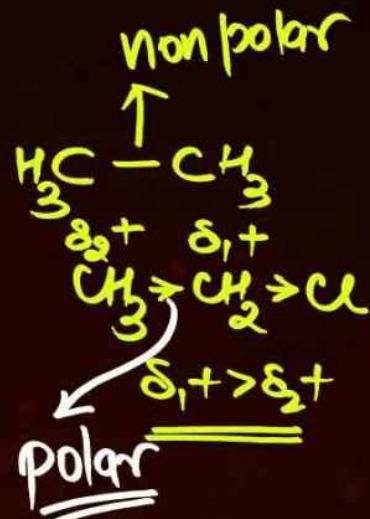
- 1. Electrostatic Effect

Reagent
Ke time
per operate



Inductive Effect

1. Operate to sigma bond. ✓
2. Partial charge development. ✓
3. Distance dependent effect ✓
4. Can be neglected after 3rd carbon atom. ✓



+ I



$$\delta_1^- > \delta_2^- > \delta_3^-$$

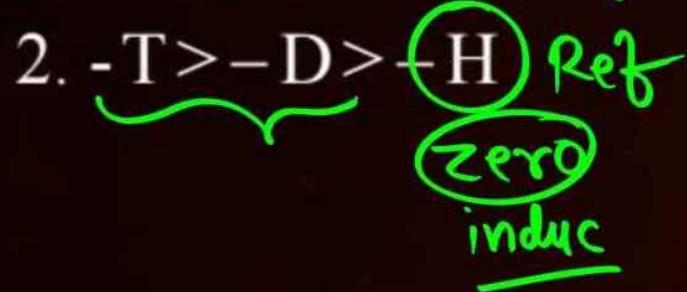
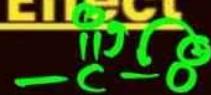
- I



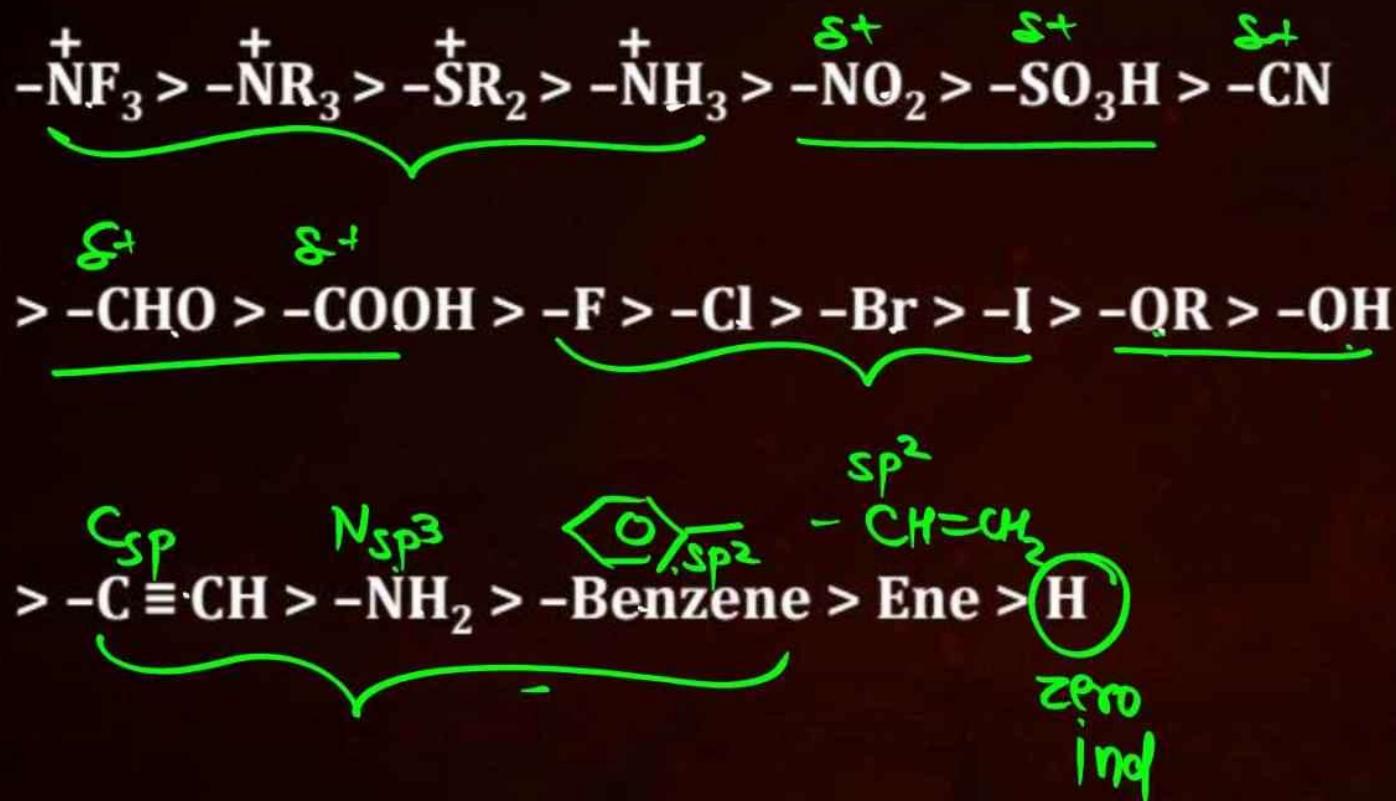
$$\delta_1^+ > \delta_2^+ > \delta_3^+$$



Power of (+I) Inductive Effect



Power of (-I) Inductive Effect



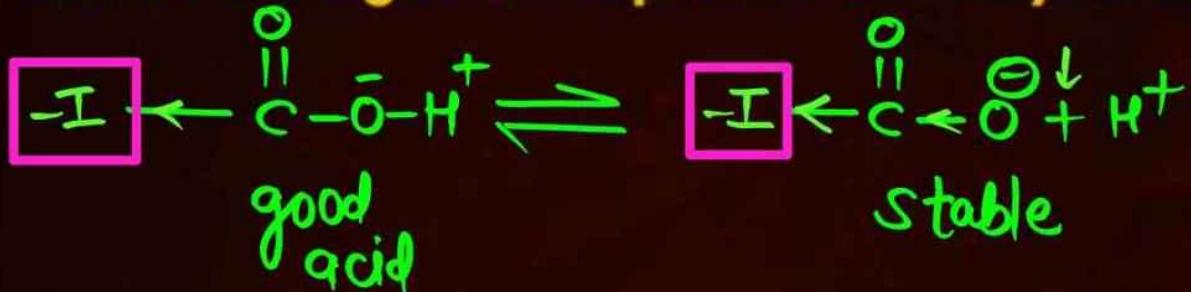


Applications of Inductive Effect

D > N > P
Distance Number Power



1. To compare acidic strength of Aliphatic carboxylic acids and alcohols.



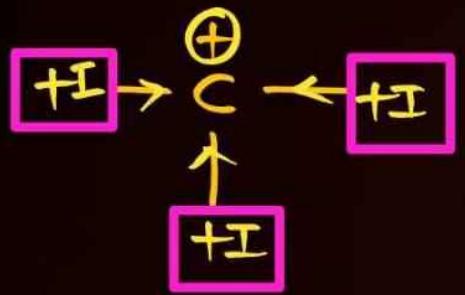
$$A \cdot S \propto -I \propto \frac{1}{+I}$$

Example: 1. $\text{HCOOH} > \text{CH}_3\text{COOH} > \text{C}_2\text{H}_5\text{COOH} > \text{C}_3\text{H}_7\text{COOH} > \text{C}_4\text{H}_9\text{COOH}$

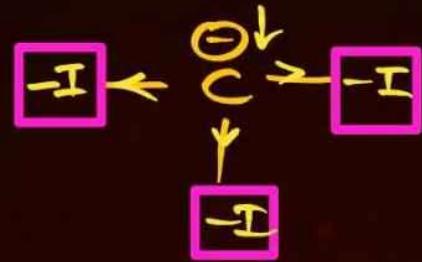
2. $\text{FCH}_2\text{COOH} > \text{ClCH}_2\text{COOH} > \text{BrCH}_2\text{COOH} > \text{ICH}_2\text{COOH}$

3. $\text{CCl}_3\text{COOH} > \text{CHCl}_2\text{COOH} > \text{CH}_2\text{ClCOOH} > \text{CH}_3\text{COOH}$

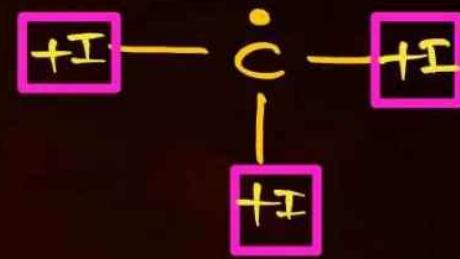
2. To compare stability of intermediates



$$\text{Stability} \propto +I \propto \frac{1}{-I}$$



$$\text{Stability} \propto -I \propto \frac{1}{+I}$$



$$\text{Stability} \propto +I \propto \frac{1}{-I}$$

3. To compare Basic Strength of Amines (In aq media)

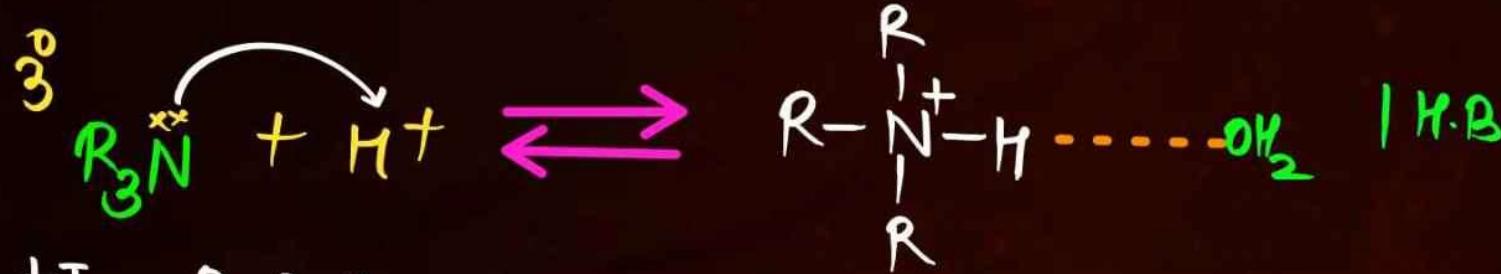


3 H.B

Solvation
or
Hydration
 $1^\circ > 2^\circ > 3^\circ$



2 H.B



1 H.B

$\text{R} = \text{Me}$

$2^\circ > 1^\circ > 3^\circ$

$\text{R} = \text{Et}$

$2^\circ > 3^\circ > 1^\circ$

+ I $3^\circ > 2^\circ > 1^\circ$



Resonance



1. When a single Lewis structure cannot explain all the properties of a molecule then we need more than one such structures.
2. These structures are called Resonating structures (or canonical form).
3. R. S. are hypothetical.
4. Resonance hybrid is the real structure.



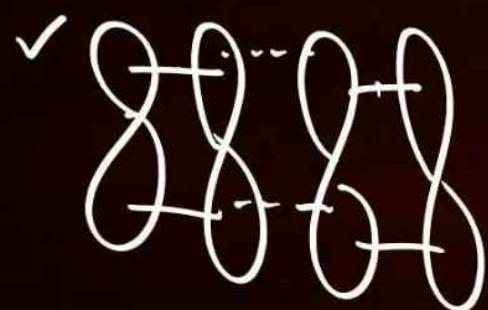
Resonance

Definition: Delocalization of π electrons in conjugated system.

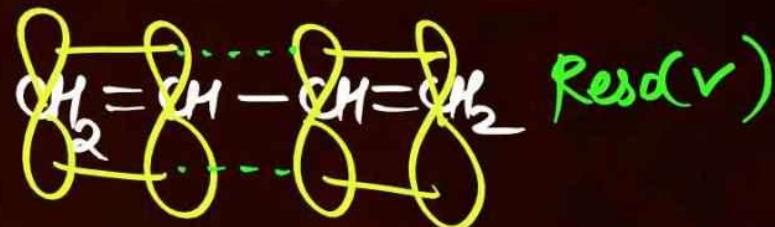
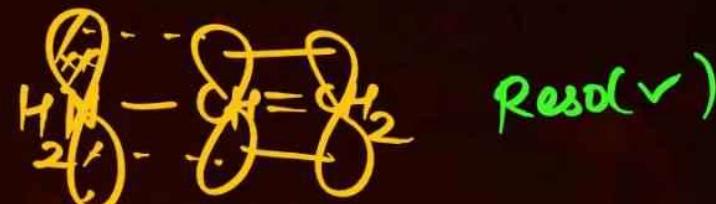
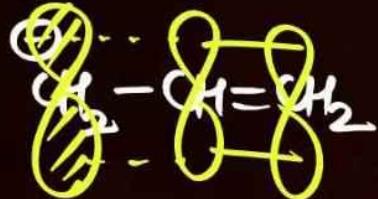
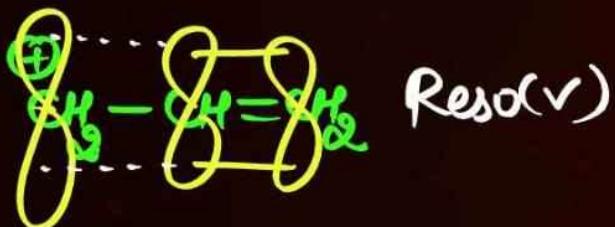


P P P

Parallel position of 'p' orbital



Types of Conjugation



Condition for Resonance

1. Molecule should be planner.
2. Conjugated system.

$2P, 3P, 4P$

OP Points

1. Hypothetical concept ✓
2. Intramolecular process ✓
3. RS are imaginary concept. ✓
4. RH is real. ✓
5. Atom cannot move in resonance. ✓
6. Total number of paired unpaired electrons remain same. ✓
7. Total number of electrons remain same. ✓
8. Any structure violating the fundamental rule is not accepted as RS.

Lewis

~~S bond 'N'~~

Compare Stability in Pankaj sir's style

1. Neutral R.S > Charged R.S

2. Stability of R.S \propto no. of π bonds

Compare Stability in Pankaj sir's style



3. Stability of R.S & Stability of Charge ✓

Priority $\ominus > \oplus$

$\bar{C} < \bar{N} < \bar{O} < \bar{F^-}$ L to R EN

$\bar{F^-} < \bar{Cl^-} < \bar{Br^-} < \bar{I^-}$ T to B size

Compare Stability in Pankaj sir's style

4. Charge separating R.S are less stable.

⊕

⊖ Less stable

⊕ ⊖

more stable

Compare Stability in Pankaj sir's style

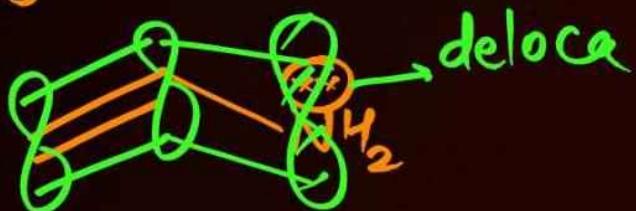
- Like charges on adjacent position are least stable.



Localized & Delocalized lone pairs

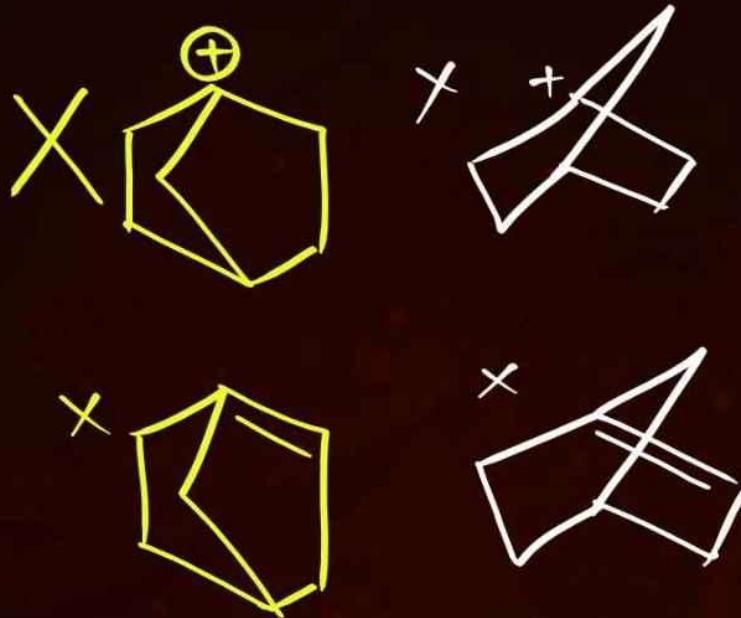


L-P
not in conju L-P in conju



Bredt's Rule

Bridge head
position par
planarity
nahi
honi
Chaiye



Equivalent Resonance

Same Starkke

1. When P.E of all R.S are equal then R.S are called equivalent R.S.
2. Contribution of all R.S are same.



Extended and Cross Conjugation

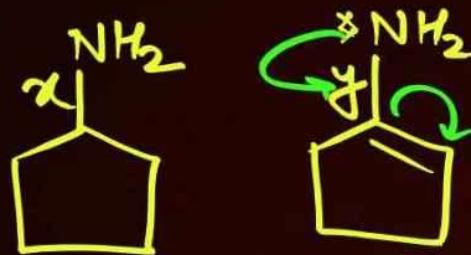
↓
Ex Saans
main

do alay alay Saanson main



Ex > Cross

Bond Length



B.L
 $x > y$



Mesomeric Effect

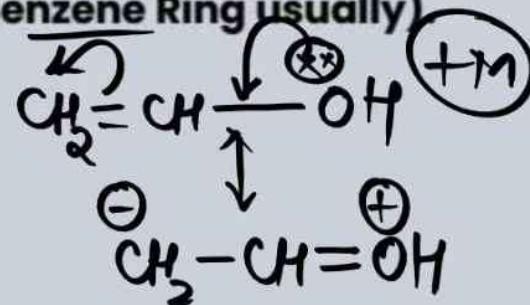


Definition

1. Permanent effect.
2. Operate to π bond.
3. Distance Independent effect.
4. Actual Charge Develop.

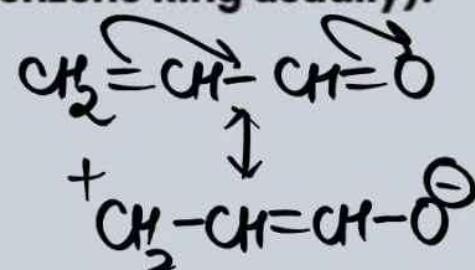
+M Effect

If an atom or group donate P orbital e⁻s to conjugated system (like double bond or Benzene Ring usually)



-M Effect

If an atom or group withdraw P orbital e⁻s to conjugated system (like double bond or Benzene Ring usually).

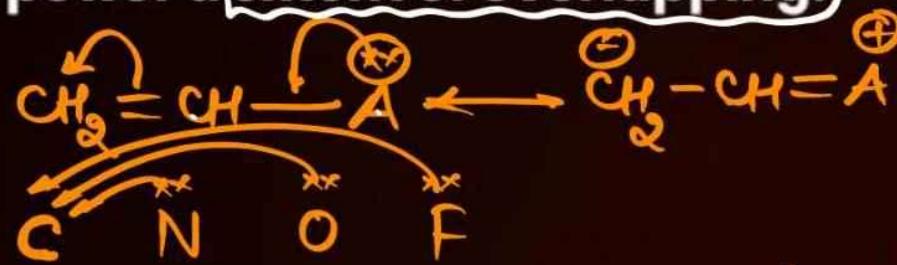


1st atom ke pass L.P

1st atom ke pass Bond

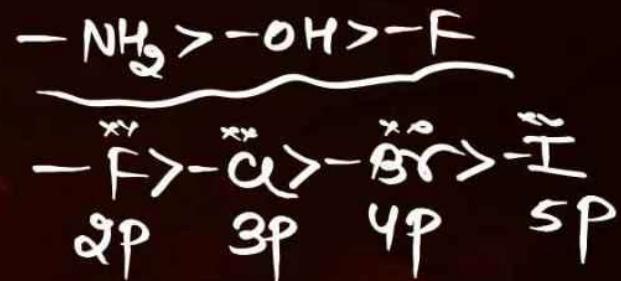
Comparison Power of +M Groups

1. +M power \propto extent of overlapping.



Size diff \uparrow Extent of overlap \downarrow

2. +M due to L.P $>$ +M due to L.P with internal conjugation.



Comparison Power of -M Groups

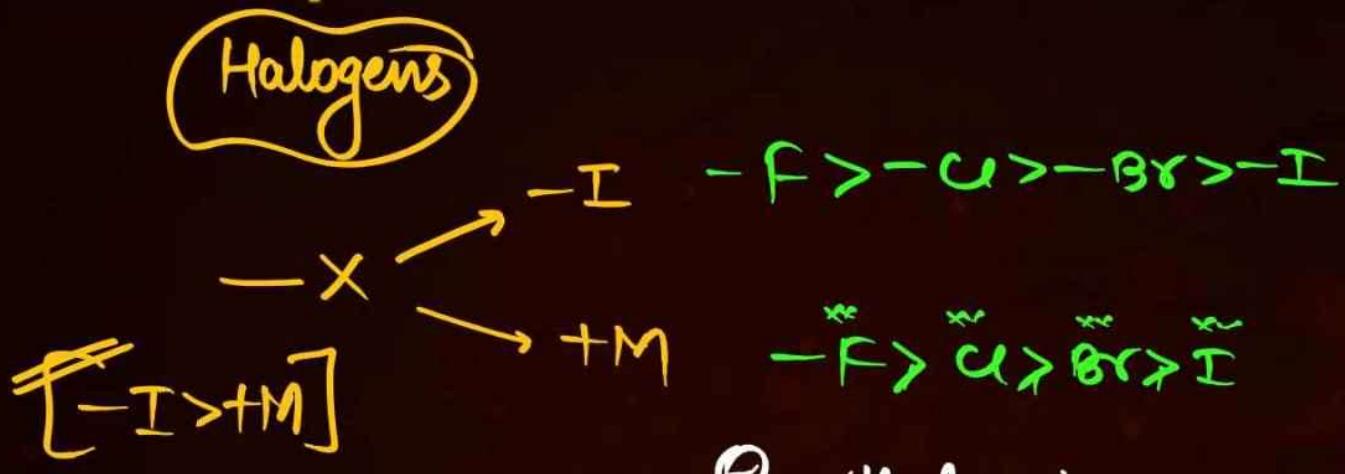
$\text{-NO}_2 > \text{-CN} > \text{-SO}_3\text{H} > \text{-CHO} > \text{-CO} > \text{-COOCO} > \text{-COOR} > \text{-COOH} >$
 $\text{-CONH}_2 > \text{-COO}^-$

(EN)

Nsp^2 Csp Csp^2
 $\text{-NO}_2 > \text{-CN} > \text{-CHO}$



Chameleon Groups

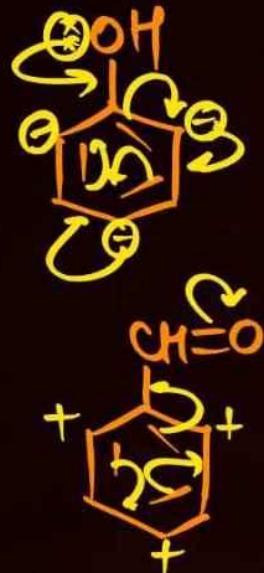


Overall O^\ominus with drawing

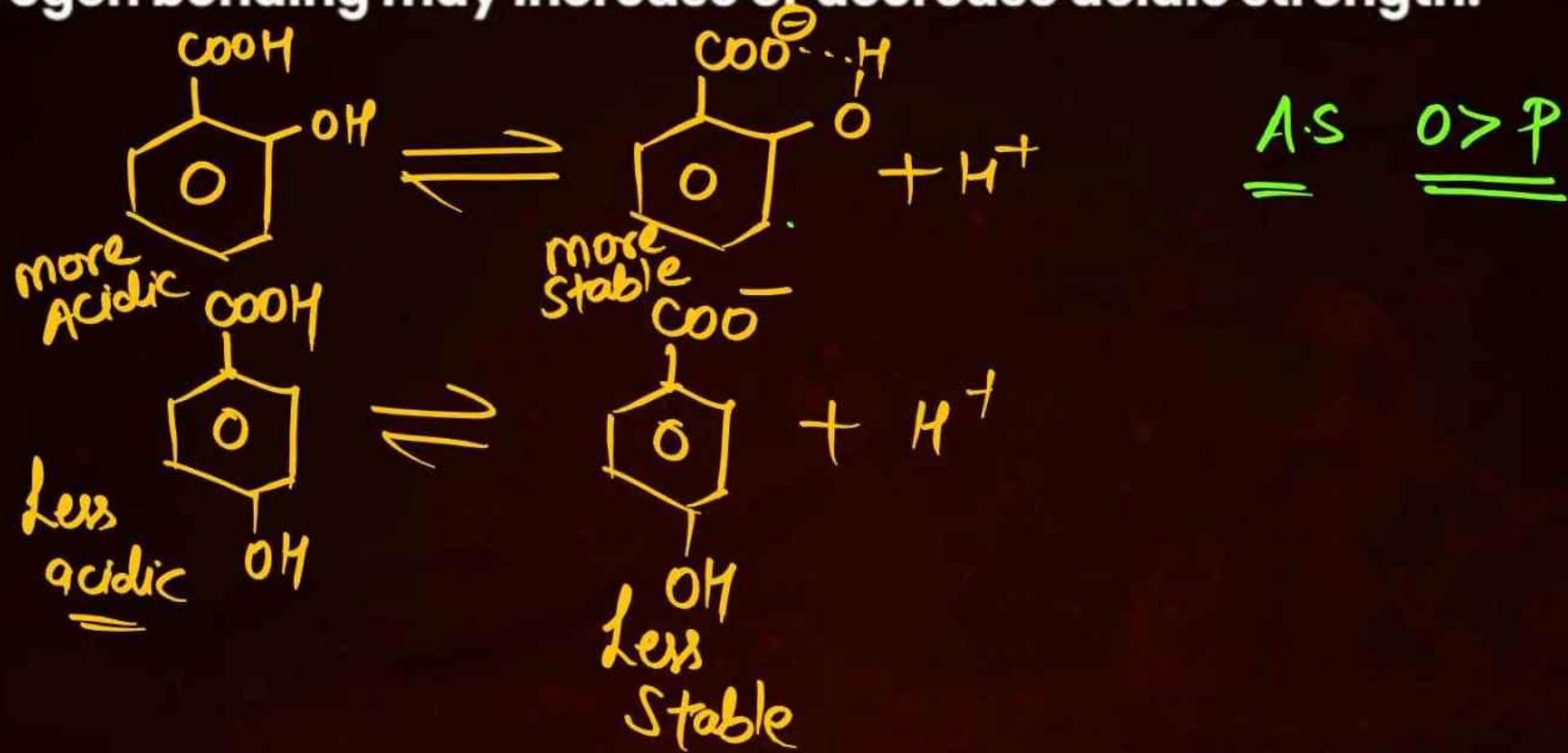
$$F < Cl < Br < I$$

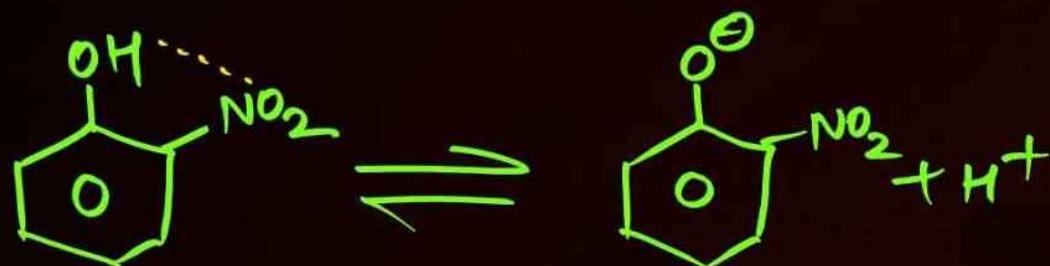
OP Points

1. M effect does not operate on meta position.

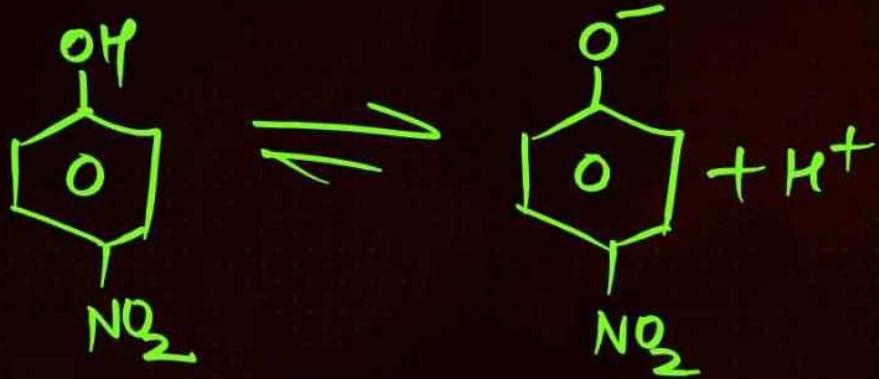


2. Hydrogen bonding may increase or decrease acidic strength.





A.S
 $O < P$



3. Ortho effect $\div \Delta S$ increases

SIR

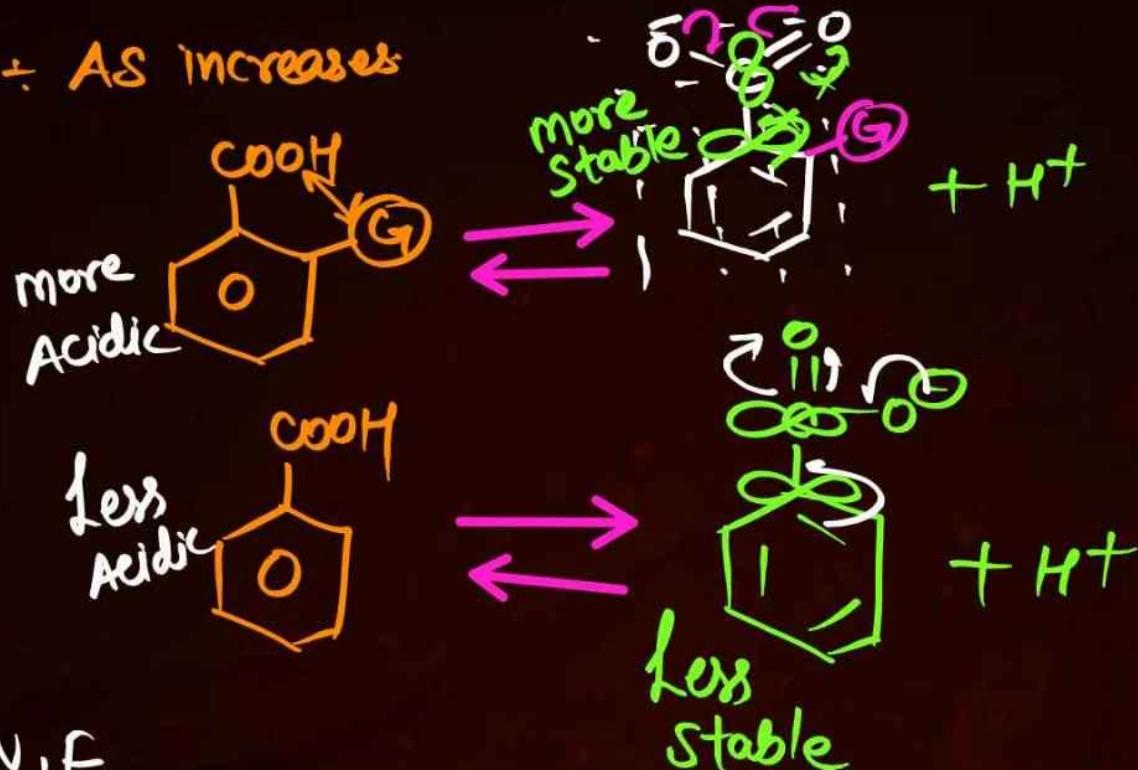
Steric
inhibition
increased

Cl, Br, I CHO
 $Q = NO_2, R, COOH$ etc

$G = H, D, T$

OH, NH_2, CN, F

etc



4. Usually $M > I$

$+M > -I$ } 2nd period $N \leq O$

$-NH_2, -OH, -NHCOCH_3, -OOCCH_3$
etc

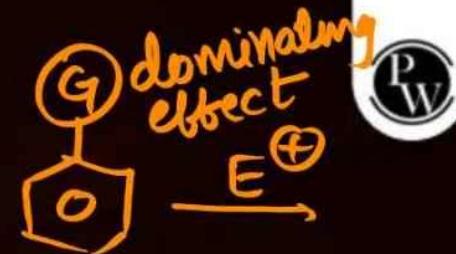
$-I > +M$ } Halogens



Application of M effect

1. Electron density on benzene ring & Rate of E.S.R.

Electrophilic
subs rxn



check dominating effect



2. Stability of Intermediates

$$\text{Stability of } C^{\oplus} \propto +M_1 + I \propto \frac{1}{-M_1 - I}$$

$$C^{\ominus} \propto -M_1 - I \propto \frac{1}{+M_1 + I}$$

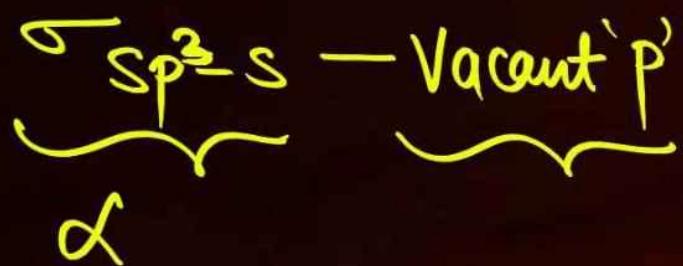
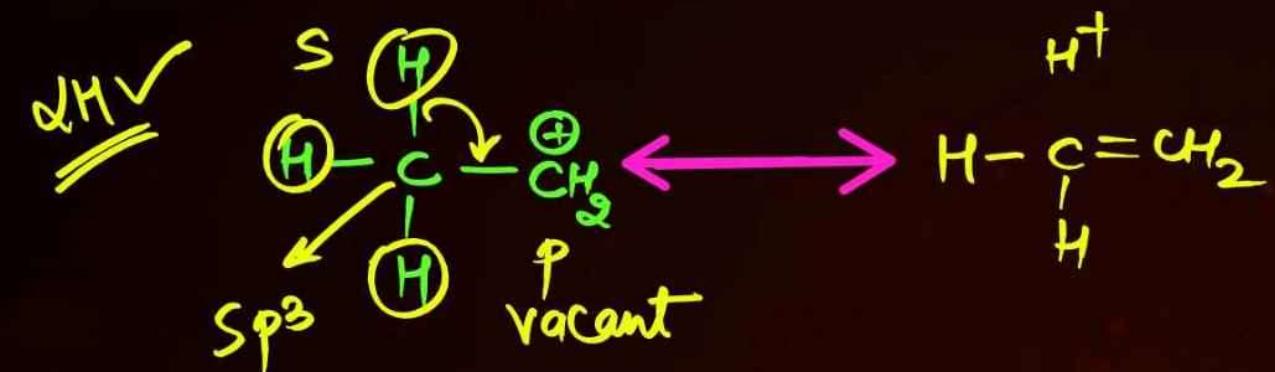


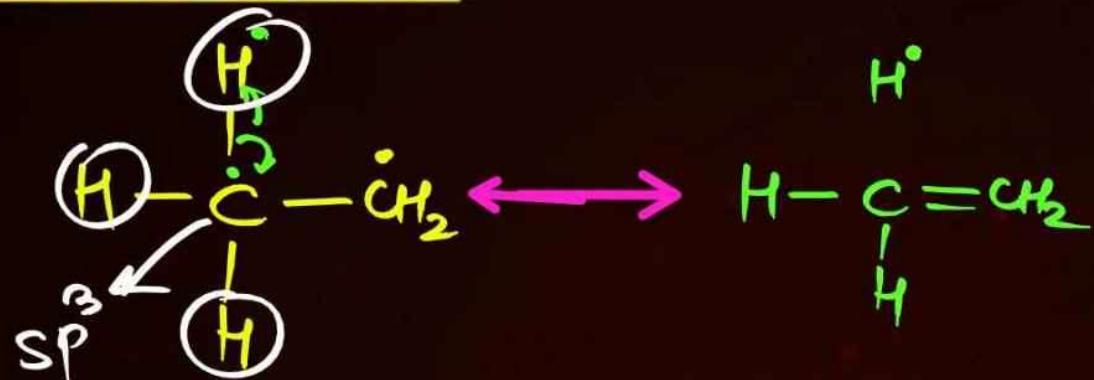
Hyperconjugation

Definition: It involves delocalization of σ electrons of C–H bond of an alkyl group directly attached to an atom of unsaturated system or to an atom with an unshared p orbital.

1. Hyperconjugation is a permanent effect.
2. Also Known as **No Bond Resonance** or **Baker-Nathan Effect**.

Case 01 Carbocation

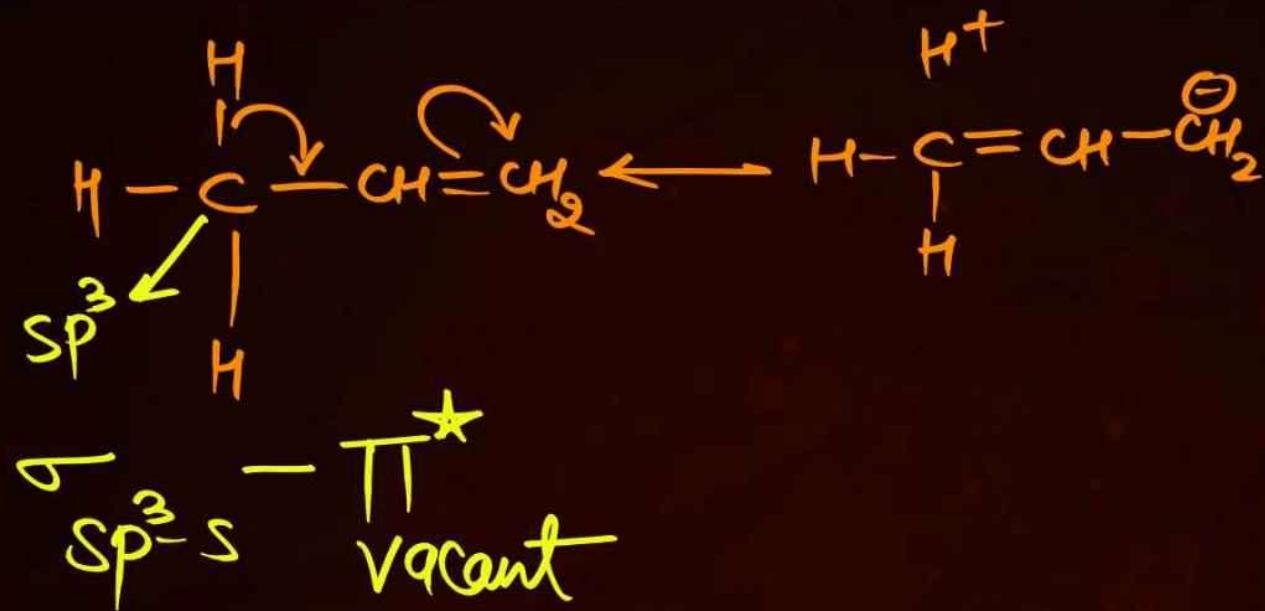


Case 02 Free Radical

σ_{sp^3-s} — Half filled p

α

Case 03 Alkenes & Benzene



OP Points

1. CO, CN cannot show hyper due to high energy of π^* orbital.
2. Hyper conjugative structures (Involving C-H bond breaking)
= NO. of α -H
3. Hyper conjugative structure = NO. of α -H + 1

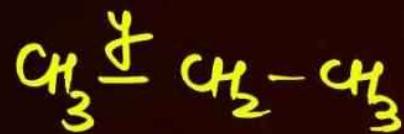
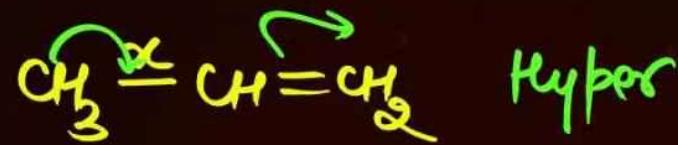
Application of Hyperconjugation

1. To compare stability of Carbocations, Free radicals and Alkenes.

Stability \propto No. of α -H

Application of Hyperconjugation

2. Bond length



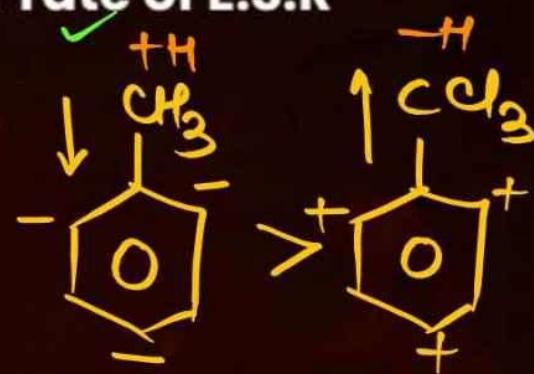
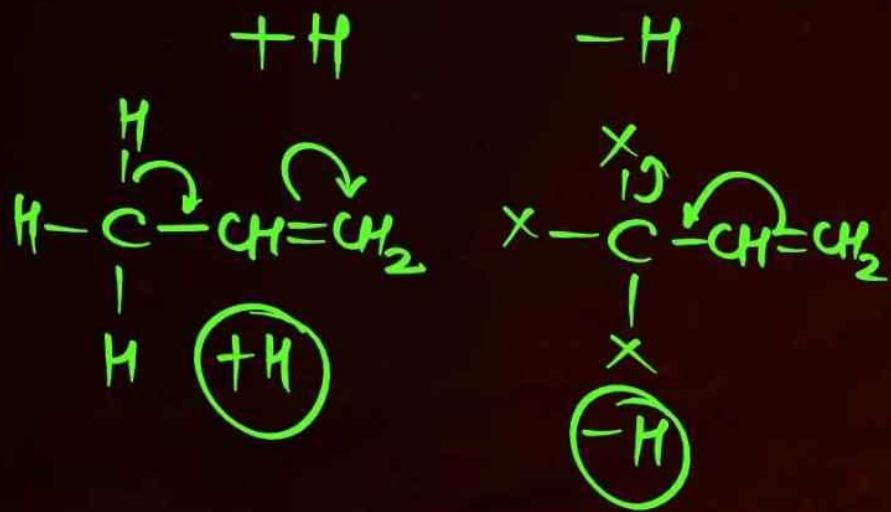
$$\boxed{x < y}$$

Application of Hyperconjugation

M > H > I



3. To compare electron density in benzene or rate of E.S.R.





*Aromaticity

1. Cyclic ✓
2. Planar ✓
3. Conjugation ✓
4. Huckel's Rule ✓

$$(4n+2)\pi e^-$$

$n=0, 1, 2 \dots$

$$2\pi e^-, 6\pi e^-, 10\pi e^-$$

A

intend
mainse ek
Bhi fail ho jaye
NA

$$, 4n\pi e^-$$

AA



$$4\pi e^- \text{ AA}$$



NA due to tublike struc



NA due to non planarity

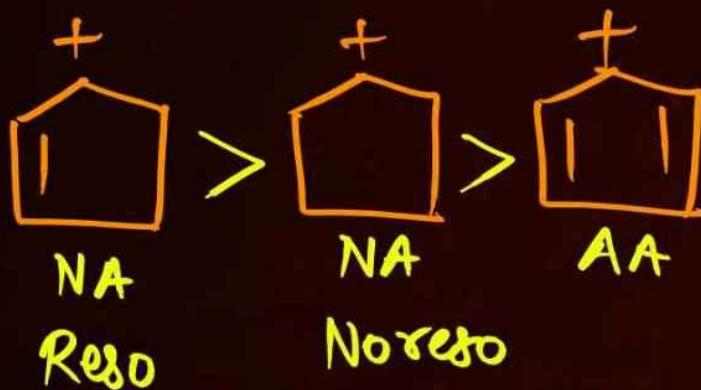
Application of Aromaticity

(A > R > H > I)



1. Stability of Intermediates

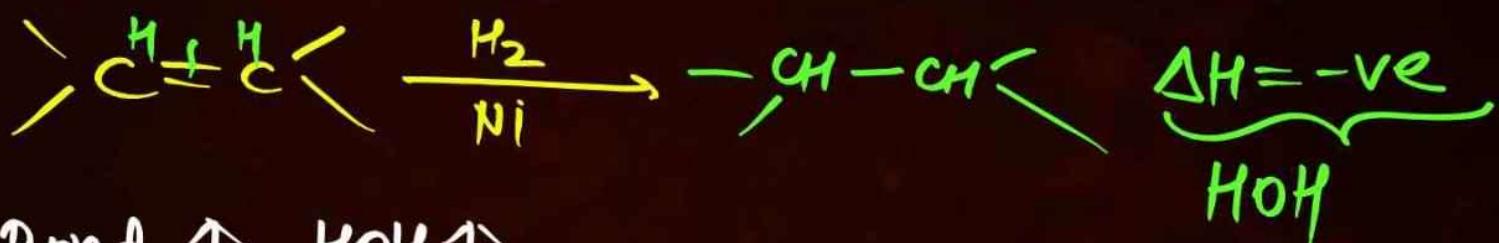
(A > NA > AA)





Heat of Hydrogenation

Definition: The amount of energy released during hydrogenation reaction.



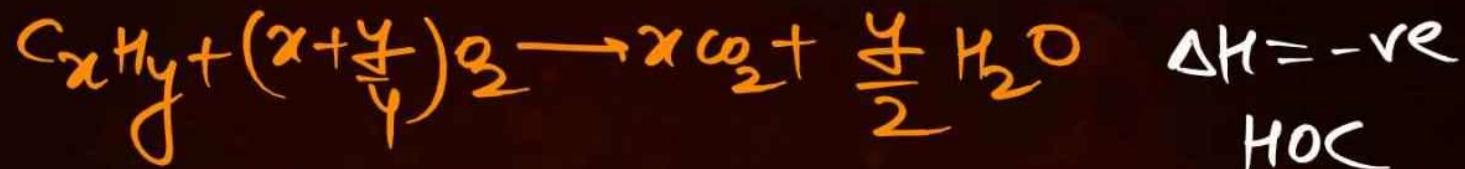
No. of π Bond \uparrow HOH \uparrow

if No. of π Bond same HOH \propto Stability



Heat of Combustion

Definition: The amount of energy released during combustion reaction.



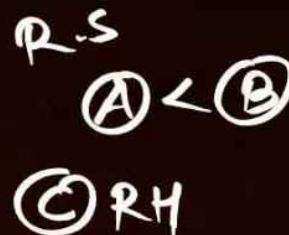
$HOC \propto$ no of 'c' atom

if no of 'c' atoms are same

$HOC \propto \frac{1}{\text{stability}}$



Resonance Energy



Energy diff b/w
 $\textcircled{C} < \textcircled{B}$

Definition: The potential energy difference between resonance hybrid and most stable resonating structure.

1. R.E is always negative.
2. R.E can be calculated by HOH data.

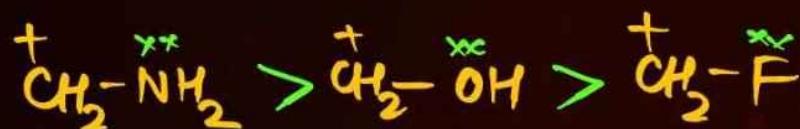
$RE \propto$ extent of reso



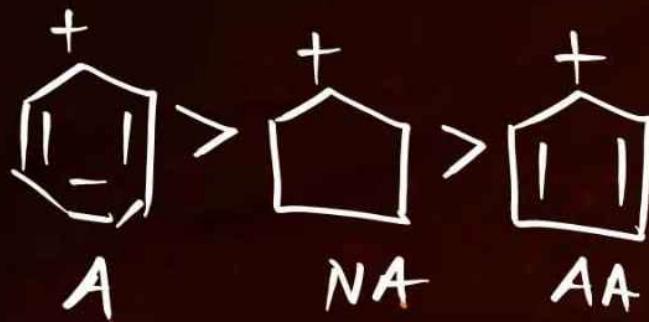


Stability of Intermediates

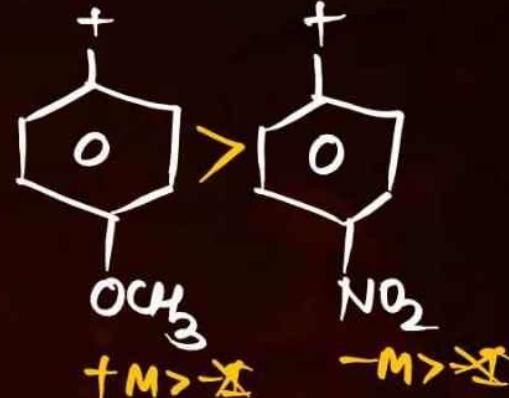
① B-B



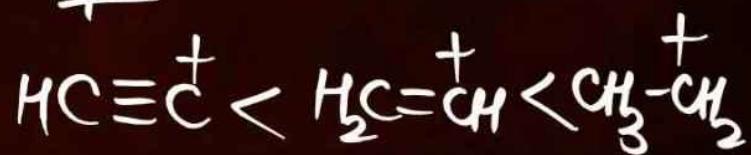
② Aro



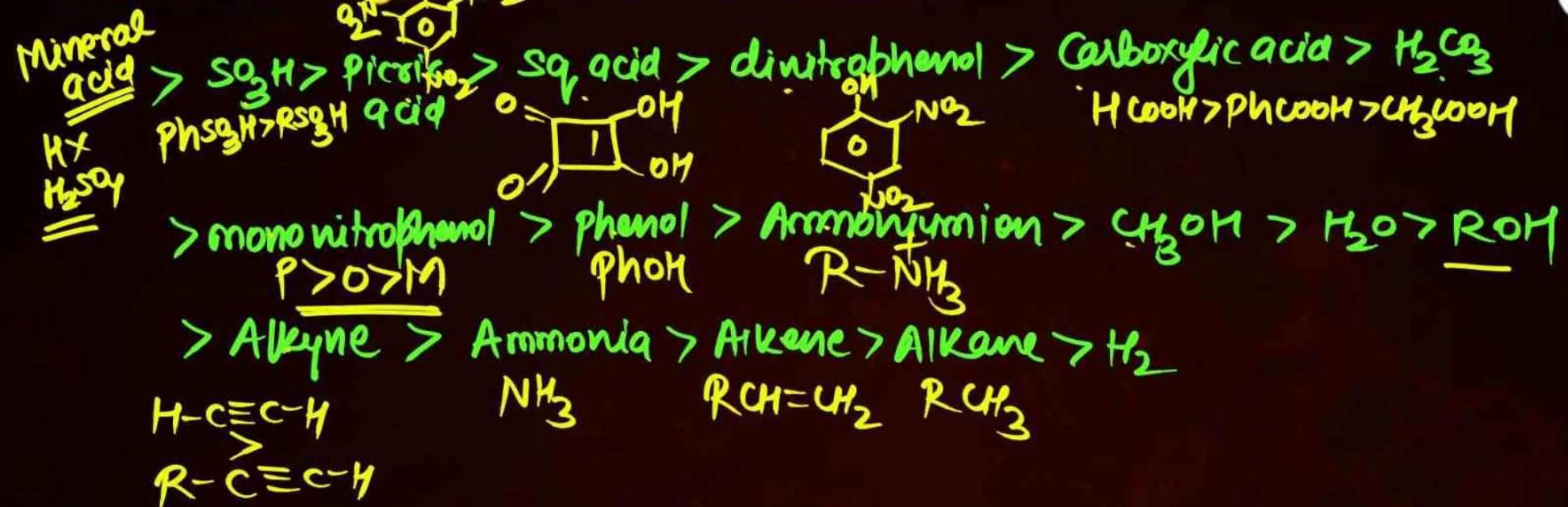
③ effects M, H, I



④ Hybri



Acidic Strength in different families

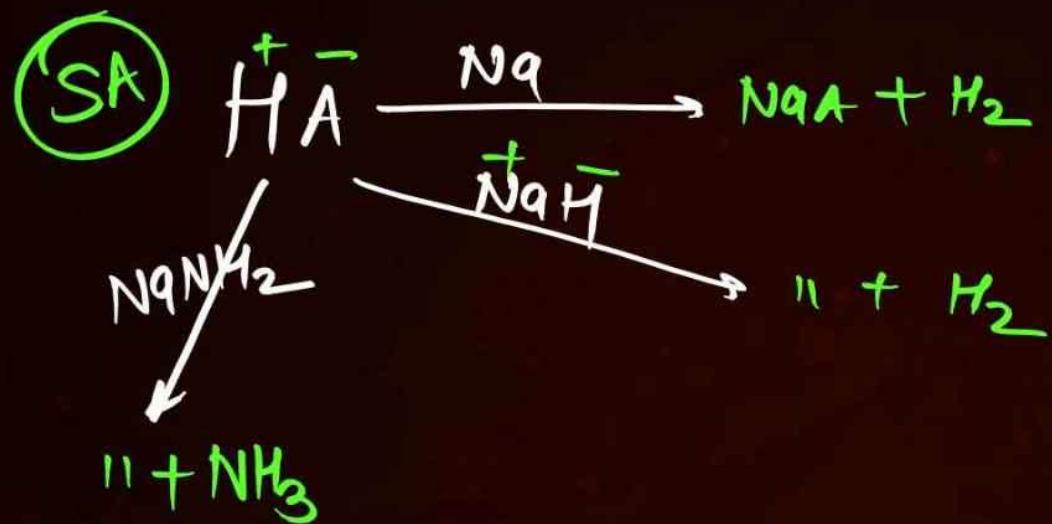


Application of Acidic Strength in different families

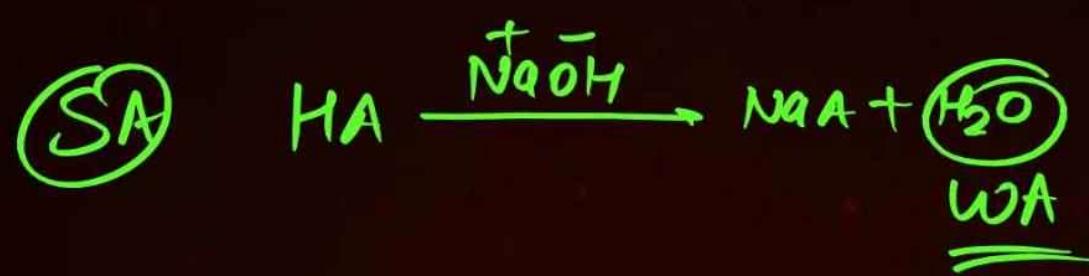
How to check the feasibility of Reaction on microseconds in Pankaj sir's style



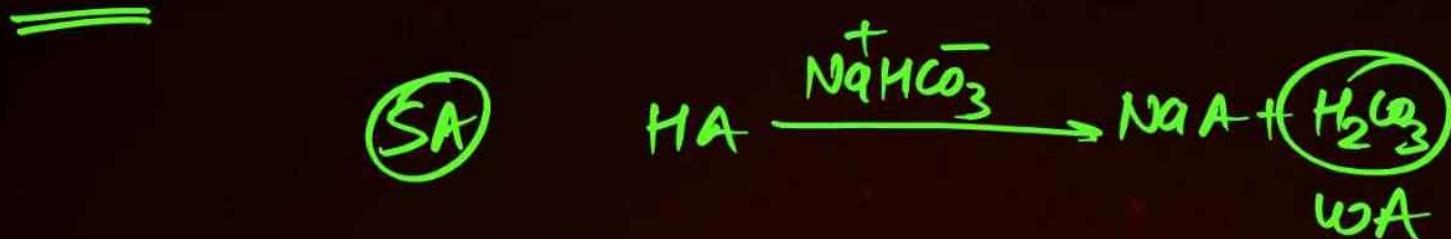
1. Na, NaH & NaNH₂ Test



2. NaOH Test

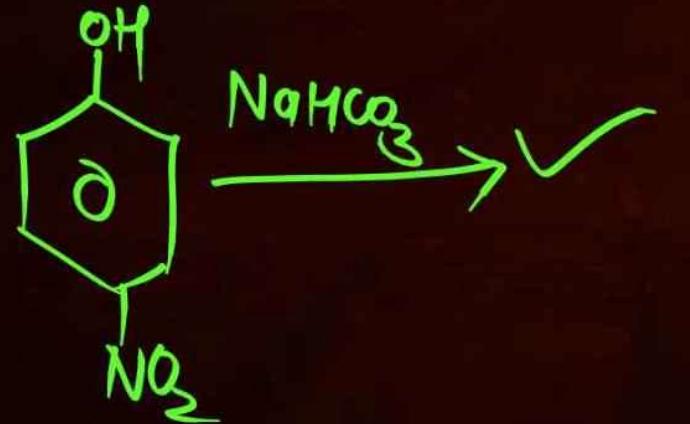


3. NaHCO_3 Test



$\text{A.S} > \text{H}_2\text{O}_3^- \checkmark$

p-nitrophenol





Basic Strength



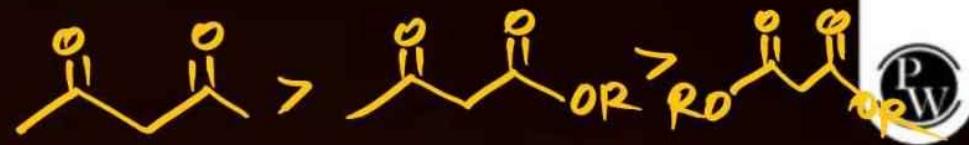
Availab \uparrow BS \uparrow

Loca LP $>$ deloca LP





Enol Content



Keto \rightleftharpoons enol K_{eq}

$$K_{eq} = \text{enol content} = \frac{[\text{enol}]}{[\text{keto}]}$$

enol content \propto stability

A

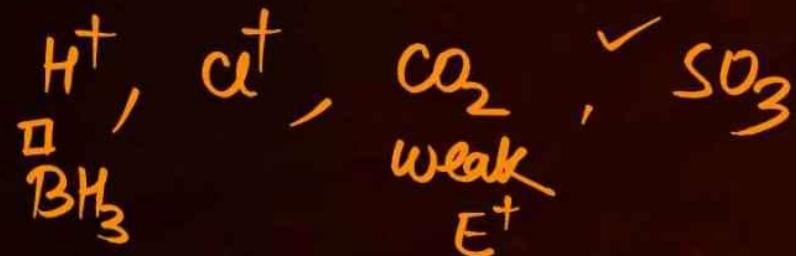
R

Hydrogen bonding



Electrophile

1. Electron loving species ✓
2. Having or not having vacant orbital

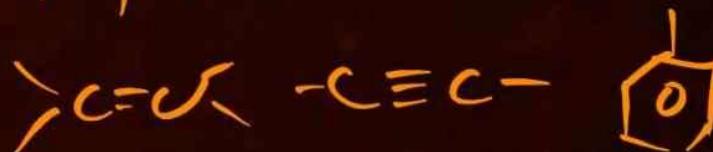




Nucleophile

1. Electron Rich and Precise Species

2. Having or not having lone pair



QUESTION (JEE Mains 1st Feb 2024, Evening Shift)~~+M
-M~~~~-M~~

The set of meta directing functional group from the following sets is:

- A** ~~X~~ -CN, ~~-M~~ -NH₂, ~~+M~~ -NHR, -OCH₃
- B** ~~X~~ ~~-M~~ -NO₂, ~~+M~~ -NH₂, -COOH, -COOR
- C** ~~X~~ ~~-M~~ -NO₂, ~~-M~~ -CHO, ~~-M~~ -SO₃H, ~~-M~~ -COR
- D** -CN, ~~-M~~ -CHO, ~~-M~~ -NHCOCH₃, ~~+M~~ -COOR

QUESTION (JEE Mains 1st Feb 2024, Evening Shift)

The functional group that shows negative resonance effect is:

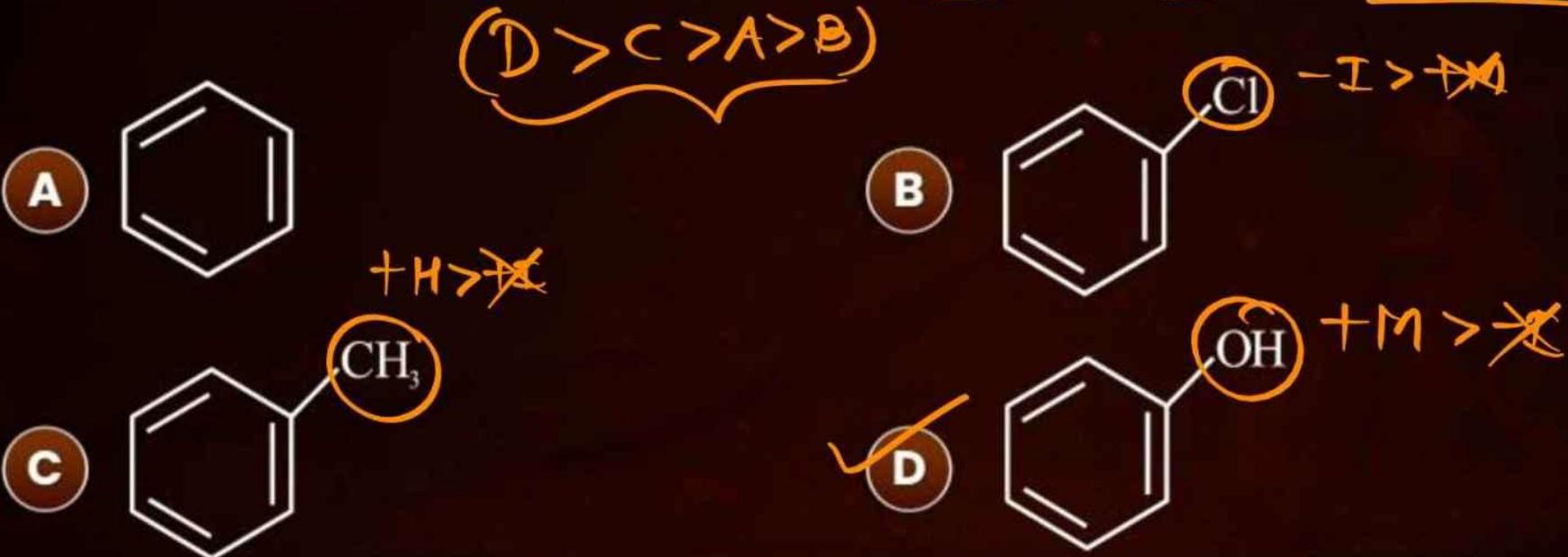
- A $-\overset{\text{N}}{\text{x}}\text{H}_2$
- C $-\overset{\text{C}}{\text{x}}\text{OOH}$

- B $-\overset{\text{O}}{\text{x}}\text{H}$
- D $-\overset{\text{O}}{\text{x}}\text{R}$

QUESTION (JEE Mains 1st Feb 2024, Morning Shift)

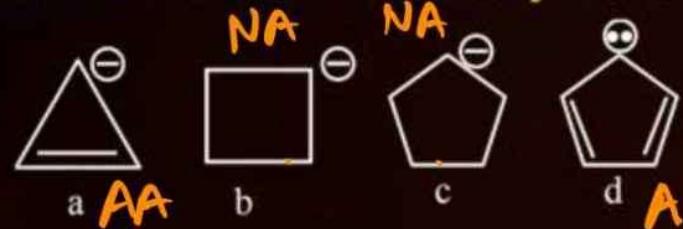


Which of the following compound will most easily be attacked by an electrophile?



QUESTION (JEE Mains 4th April 2024, Evening Shift)

Correct order of stability of carbanion is:

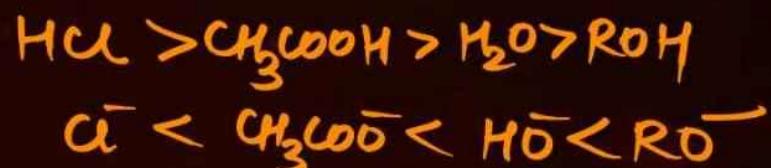


- A** $c > b > d > a$
- B** $a > b > c > d$
- C** $d > a > c > b$
- D** $d > c > b > a$ ✓

QUESTION (JEE Mains 4th April 2024, Morning Shift)



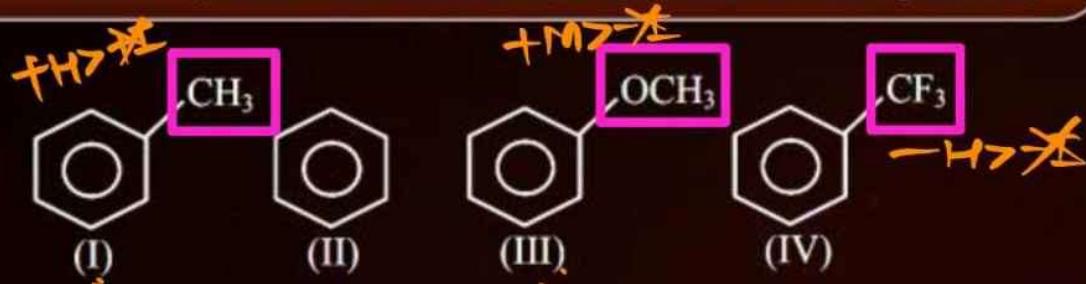
What will be the decreasing order of basic strength of the following conjugate bases?



- A $\text{Cl}^- > \text{OH}^- > \text{R}^- > \text{CH}_3\text{COO}^-$
- B $\text{R}^- > \text{OH}^- > \text{CH}_3\text{COO}^- > \text{Cl}^-$
- C $\text{OH}^- > \text{R}^- > \text{CH}_3\text{COO}^- > \text{Cl}^-$
- D $\text{Cl}^- > \text{R}^- > \text{OH}^- > \text{CH}_3\text{COO}^-$

QUESTION (JEE Mains 6th April 2024, Evening Shift)

PW



for in ESR & δ density
(dominating effect)

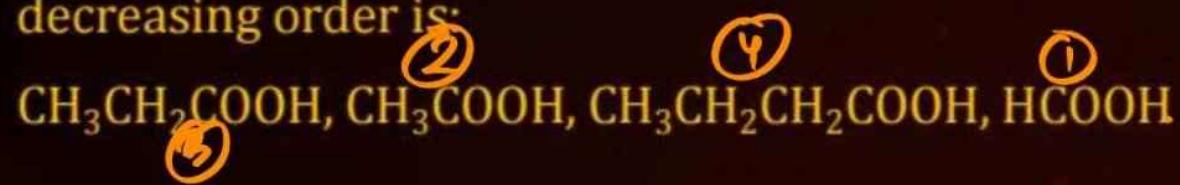
The **correct** arrangement for decreasing order of electrophilic substitution for above compounds

- A ~~(IV) > (I) > (II) > (III)~~
- C ~~(I) > (IV) > (III) > (II)~~

- B ~~(III) > (I) > (II) > (IV)~~
- D ~~(III) > (IV) > (II) > (I)~~

QUESTION (JEE Mains 8th April 2024, Evening Shift)

The correct sequence of acidic strength of the following aliphatic acids in their decreasing order is:

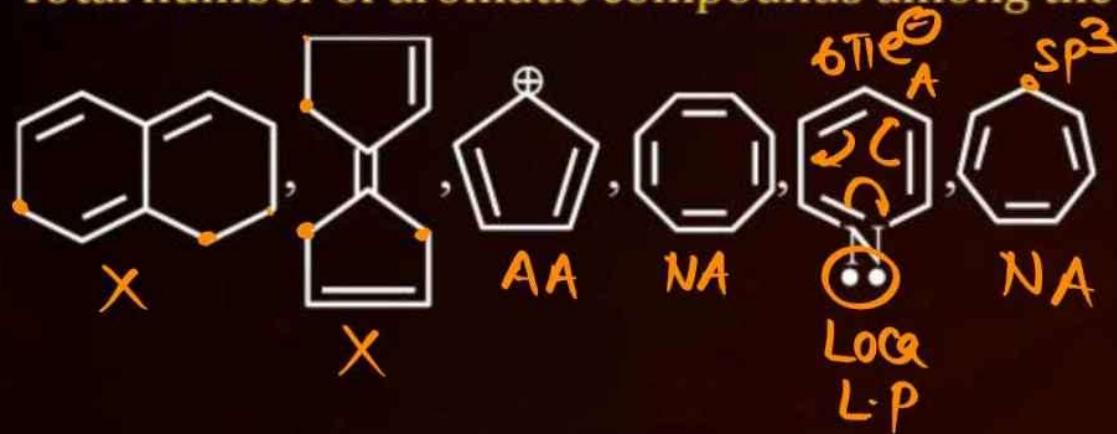


- A** HCOOH > CH₃COOH > CH₃CH₂COOH > CH₃CH₂CH₂COOH
- B** HCOOH > CH₃CH₂CH₂COOH > CH₃CH₂COOH > CH₃COOH
- C** CH₃CH₂CH₂COOH > CH₃CH₂COOH > CH₃COOH > HCOOH
- D** CH₃COOH > CH₃CH₂COOH > CH₃CH₂CH₂COOH > HCOOH

QUESTION (JEE Mains 8th April 2024, Evening Shift)

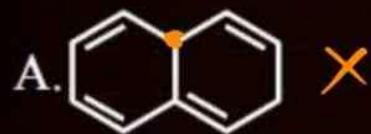


Total number of aromatic compounds among the following compounds is 1.



QUESTION (JEE Mains 8th April 2024, Morning Shift)

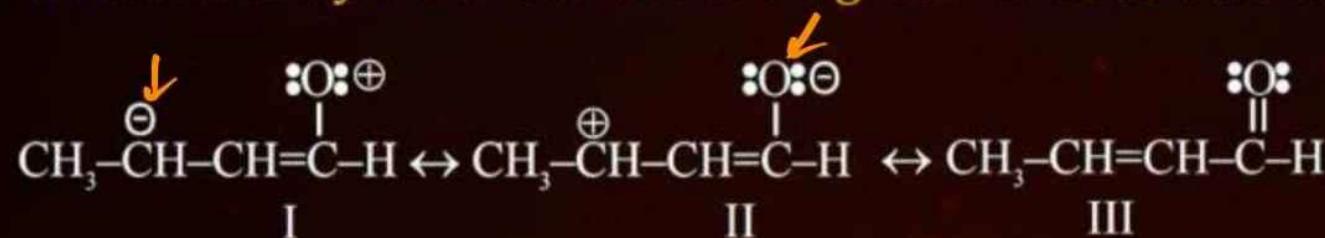
Which of the following are aromatic?



- A B and D only
- B A and C only
- C A and B only
- D C and D only

QUESTION (JEE Mains 9th April 2024, Evening Shift)

The correct stability order of the following resonance structures of $\text{CH}_3\text{-CH}=\text{CH-CHO}$ is:



- A** II > III > I
- B** ~~III > II > I~~
- C** I > II > III
- D** II > I > III

QUESTION (JEE Mains 9th April 2024, Morning Shift)

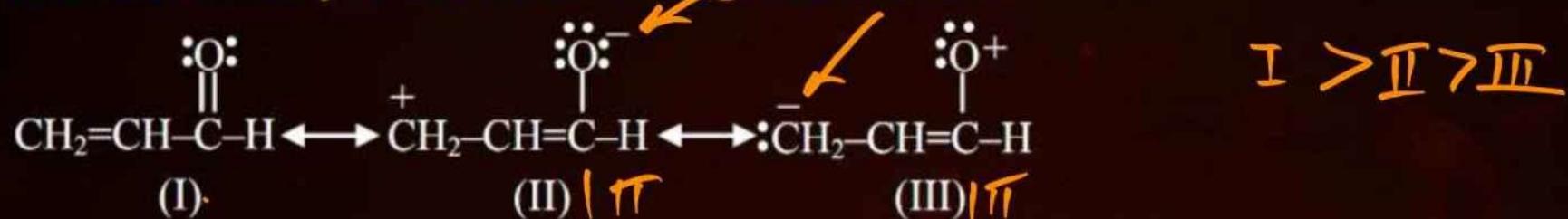
Correct order of basic strength of Pyrrole



- A Piperidine > Pyridine > Pyrrole
- B Pyrrole > Pyridine > Piperidine
- C Pyridine > Piperidine > Pyrrole
- D Pyrrole > Piperidine > Pyridine

QUESTION (JEE Mains 9th April 2024, Morning Shift)

Relative stability of the contributing structures is:



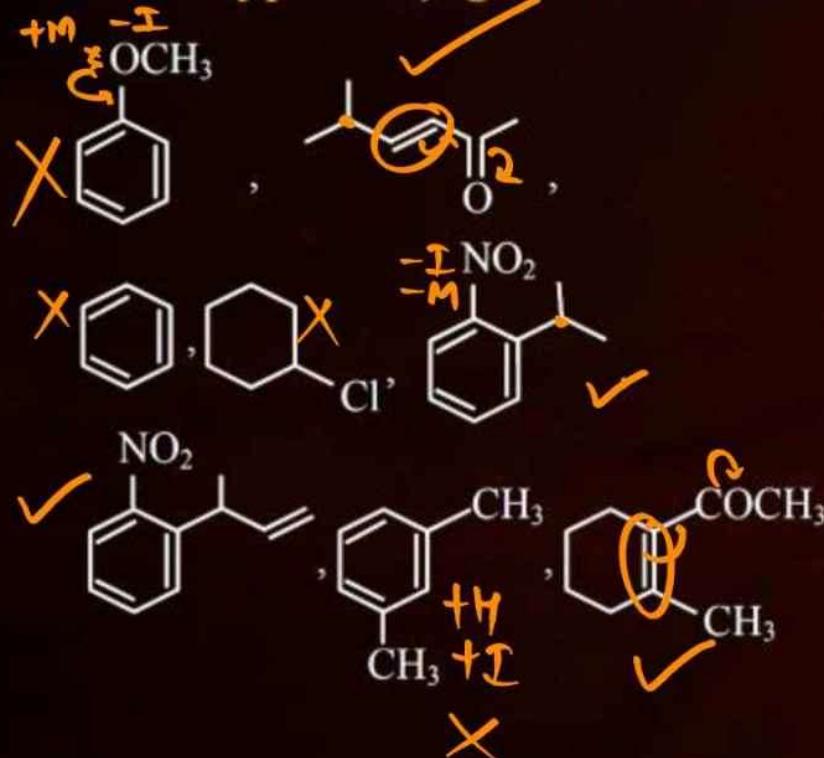
- A (I) > (III) > (II)
- B (I) > (II) > (III)
- C (II) > (I) > (III)
- D (III) > (II) > (I)

QUESTION (JEE Mains 9th April 2024, Morning Shift)



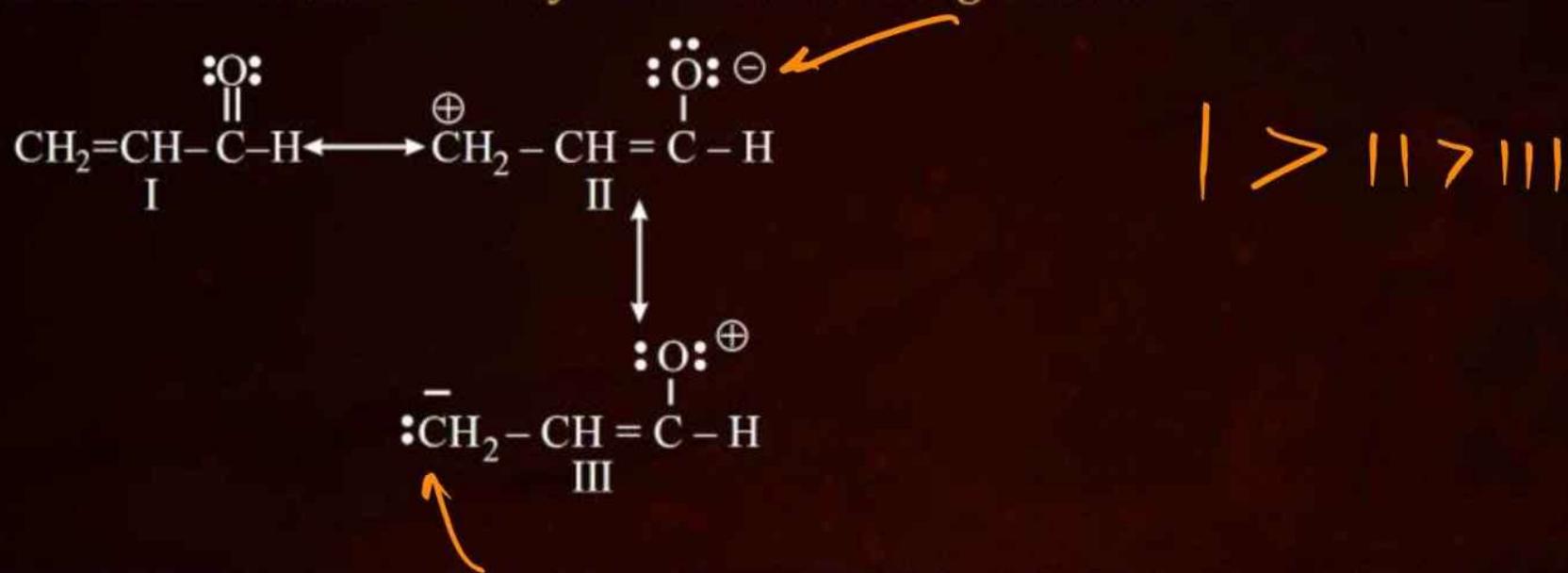
How many compounds among the following compounds show inductive, mesomeric as well as hyperconjugation effects?

Ans (4)



QUESTION (JEE Mains 27th January 2024, Evening Shift)

The order of relative stability of the contributing structure is:



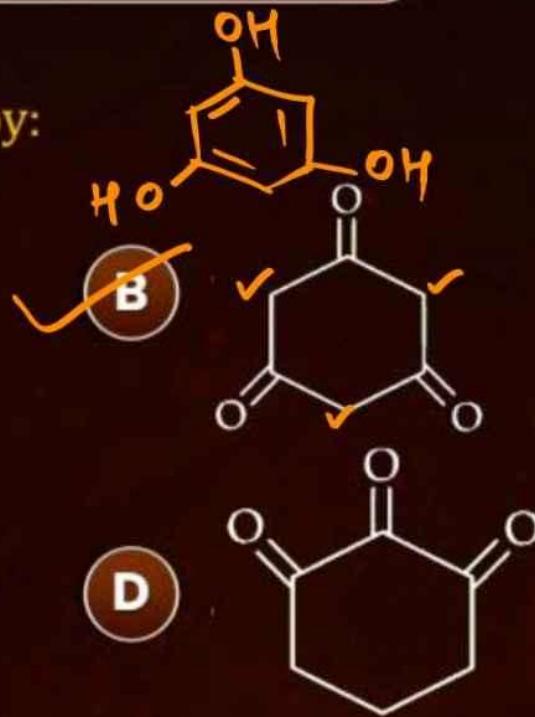
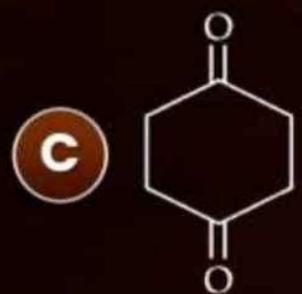
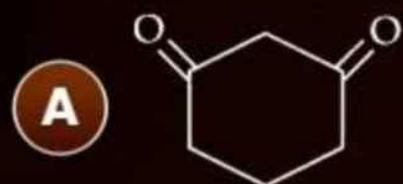
Choose the **correct** answer from the options given below:

- A** I > II > III ✓
- C** I = II = III

- B** II > I > III
- D** III > II > I

QUESTION (JEE Mains 27th January 2024, Morning Shift)

Highest enol content will be shown by:



QUESTION (JEE Mains 27th January 2024, Morning Shift)

Lewis Base

Which of the following is strongest Bronsted base?

A



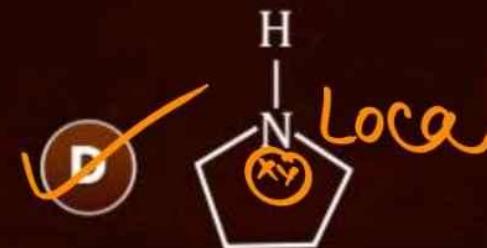
B



C



D

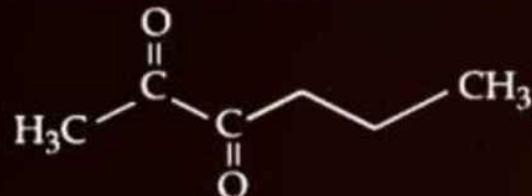


QUESTION (JEE Mains 27th January 2024, Morning Shift)

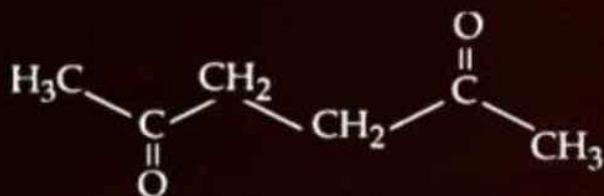


Which of the following has highly acidic hydrogen?

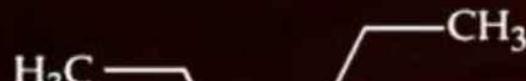
A



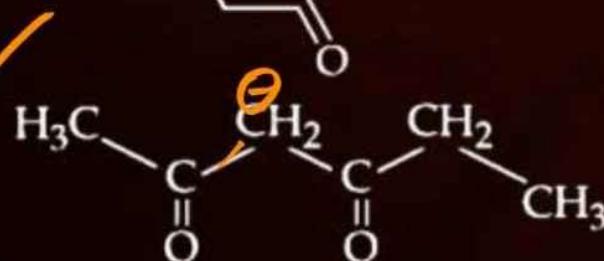
B



C

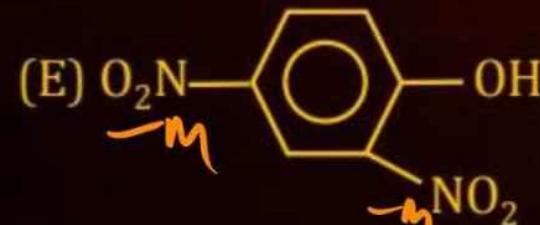


D



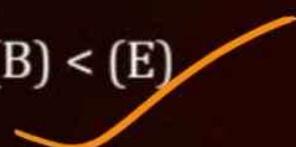
QUESTION (JEE Mains 27th January 2024, Morning Shift)

The ascending order of acidity of -OH group in the following compounds is:

 $E > B > D > C > A$ 

Choose the correct answer from the options given below:

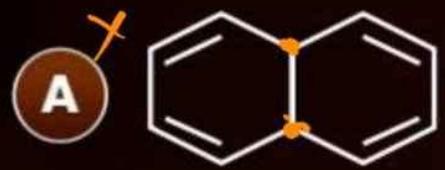
- A** (A) < (D) < (C) < (B) < (E)
- B** (C) < (A) < (D) < (B) < (E)
- C** (C) < (D) < (B) < (A) < (E)
- D** (A) < (C) < (D) < (B) < (E)



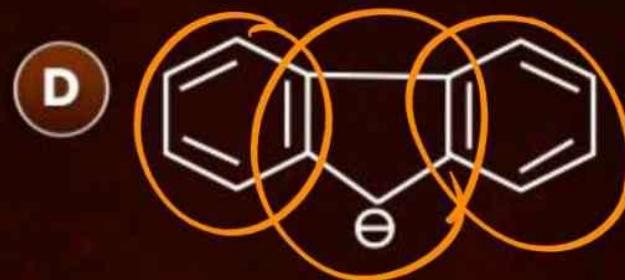
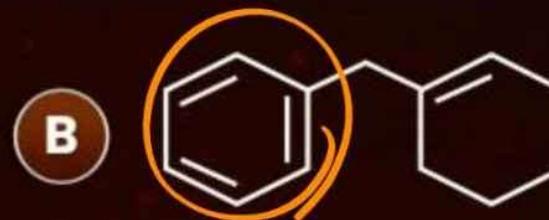
QUESTION (JEE Mains 27th January 2024, Morning Shift)



Among the given organic compounds, the total number of aromatic compounds is:



Ans(3)



QUESTION (JEE Mains 27th January 2024, Morning Shift)



Among the following, total number of meta directing functional groups is: (Integer based) -OCH₃, -NO₂, -CN, -CH₃, -NHCOCH₃, -COR, -OH, -COOH, -Cl

+M -M -M +M +M -M +M -M +M

-M

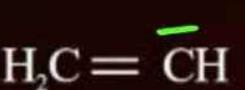
Aus (4)

QUESTION (JEE Mains 29 January 2024, Evening Shift)

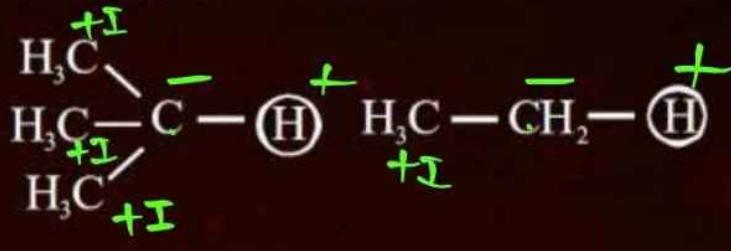
The ascending acidity order of the following H atoms is:



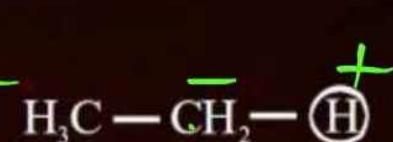
A



B



C



D

A

$$\text{C} < \text{D} < \text{B} < \text{A}$$

B

$$\text{A} < \text{B} < \text{C} < \text{D}$$

C

$$\text{A} < \text{B} < \text{D} < \text{C}$$

D

$$\text{D} < \text{C} < \text{B} < \text{A}$$

QUESTION (JEE Mains 29 January 2024, Evening Shift)**Match List I with List II.**

List-I (Compound)		List-II (pK_a value)	
A.	Ethanol II	I.	10.0
B.	Phenol I	II.	15.9
C.	m-Nitrophenol IV	III.	7.1
D.	p-Nitrophenol III	IV.	8.3

$R_a \uparrow$ AS ↑
 $pK_a \downarrow$

Choose the correct answer from the options given below:

- A** A-I, B-II, C-III, D-IV
- B** A-IV, B-I, C-II, D-III
- C** A-III, B-IV, C-I, D-II
- D** A-II, B-I, C-IV, D-III

QUESTION (JEE Mains 30 January 2024, Evening Shift)



The correct stability order ~~of~~^{of} carbocations is:

- A $(\text{CH}_3)_3\text{C}^+ > \text{CH}_3 - \overset{+}{\text{CH}}_2 > (\text{CH}_3)_2\overset{+}{\text{CH}} > \overset{+}{\text{CH}}_3$
- B $\overset{+}{\text{CH}}_3 > (\text{CH}_3)_2\overset{+}{\text{CH}} > \text{CH}_3 - \overset{+}{\text{CH}}_2 > (\text{CH}_3)_3\text{C}^+$
- C $(\text{CH}_3)_3\text{C}^+ > (\text{CH}_3)_2\overset{+}{\text{CH}} > \text{CH}_3 - \overset{+}{\text{CH}}_2 > \overset{+}{\text{CH}}_3$
~~9αH~~ ~~6αH~~ ~~3αH~~ ~~0αH~~
- D $\overset{+}{\text{CH}}_3 > \text{CH}_3 - \overset{+}{\text{CH}}_2 > \text{CH}_3 - \overset{+}{\text{CH}} - \text{CH}_3 > (\text{CH}_3)_3\text{C}^+$

BB X

ArO X

Reso X

Hyper ✓

QUESTION (JEE Mains 30 January 2024, Morning Shift)

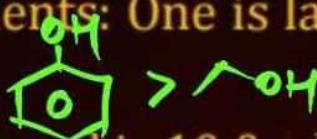


Which of the following molecule/species is most stable?



QUESTION (JEE Mains 31 January 2024, Morning Shift)

Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R:



Assertion A: pK_a value of phenol is 10.0 while that of ethanol is 15.9.

Reason R: Ethanol is stronger acid than phenol.

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

- A A is true but R is false.
- B A is false but R is true.
- C Both A and R are true and R is the correct explanation of A.
- D Both A and R are true but R is NOT the correct explanation of A.

QUESTION (NCERT Exemplar)

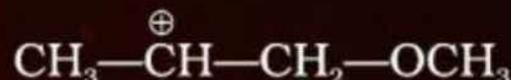
What is the correct order of decreasing stability of the following cations?



I. *6αH*



II. *BB*



III. *5δH*

A *II > I > III*

B *II > III > I*

C *III > I > II*

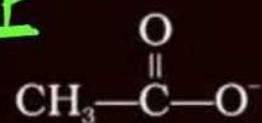
D *I > II > III*

QUESTION (NCERT Exemplar)

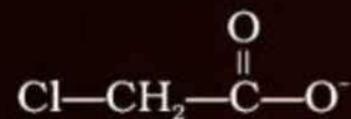
Ionic species are stabilized by the dispersal of charge. Which of the following carboxylate ion is the most stable?

DNP

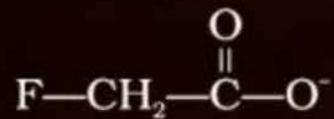
A



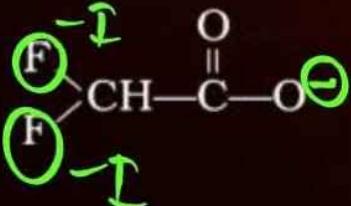
B



C

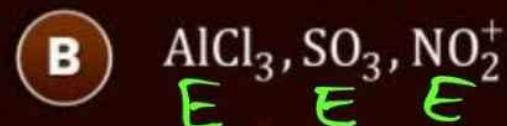
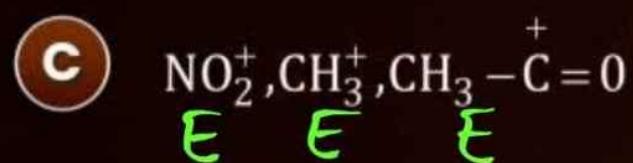
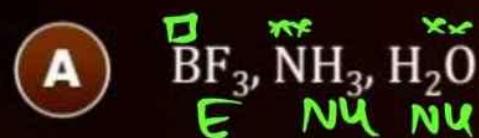


D



QUESTION (NCERT Exemplar)

Electrophiles are electron seeking species. Which of the following groups contain only electrophiles?



D Both (B) & (C)

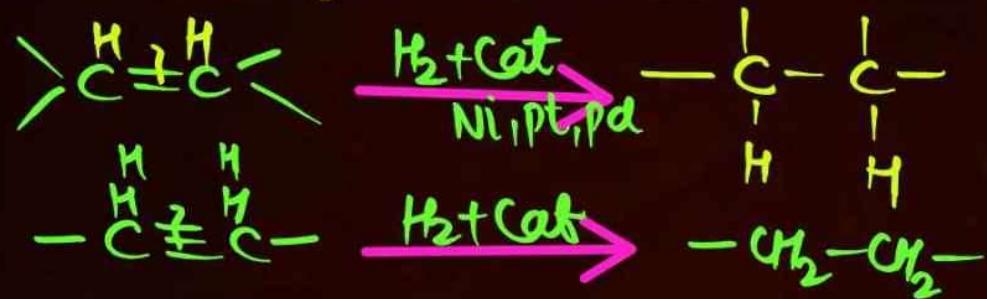


HYDROCARBONS



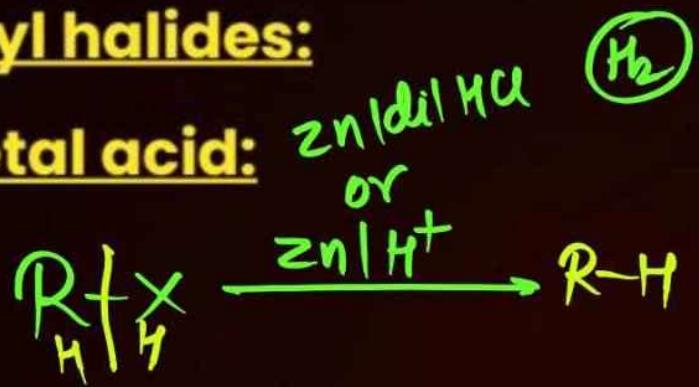
Methods of Preparation of Alkanes

1. From Unsaturated hydrocarbons:



2. From Alkyl halides:

A. From metal acid:



(H₂)

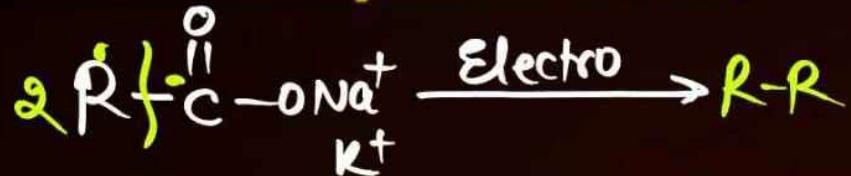
ROR



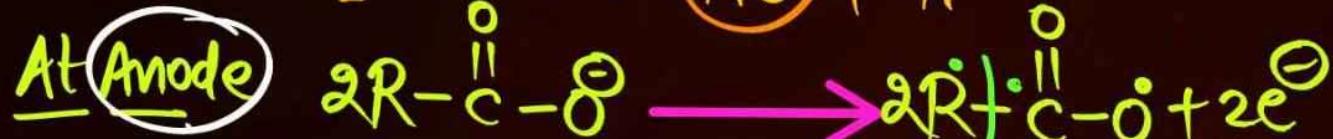
B. Wurtz Reaction:



3. Kolbe's electrolytic method:



Mech

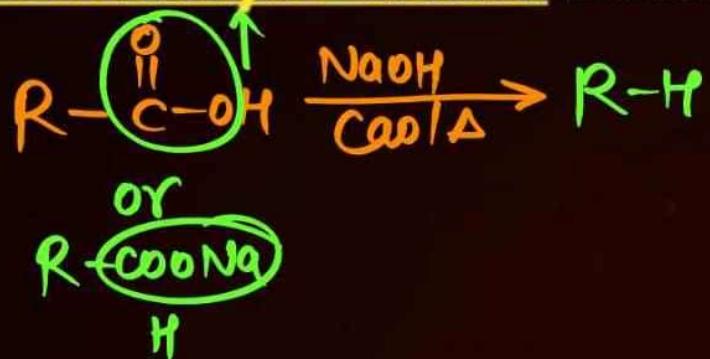


At Cathode



Nature of soln after
electrolysis Basic
pH ↑

4. From Carboxylic acids: Decarboxylation

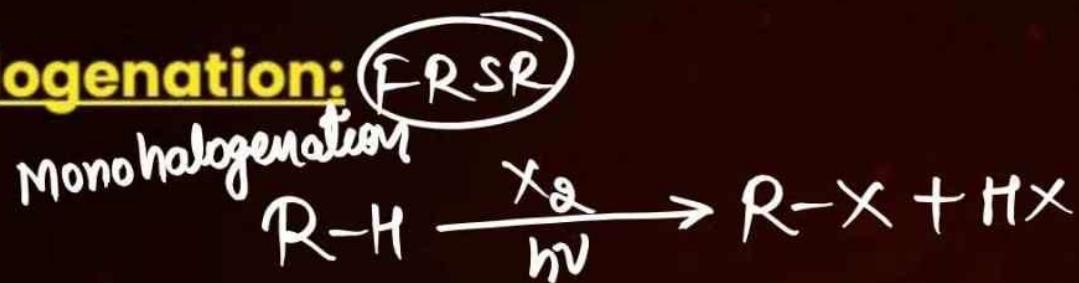




Chemical Properties of Alkanes

1. Halogenation: FRSR

Monohalogenation





Mech

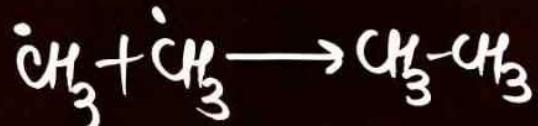
① chain initiation



② chain prop



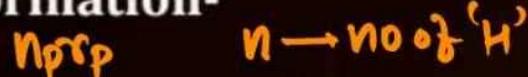
③ chain termina



OP Points:

1. Radical formation ✓
2. Formation of alkyl radical is RDS ✓
3. No rearrangement ✓
4. R.O.R for C-H $3^\circ > 2^\circ > 1^\circ$ ✓
5. R.O.R for X_2 ----- $F_2 > Cl_2 > Br_2 > I_2$ ✓
6. Maximum amount of R-X is formed in chain propagation step. ✓
7. Fluorination- It is highly exothermic & uncontrolled Reaction. ✓

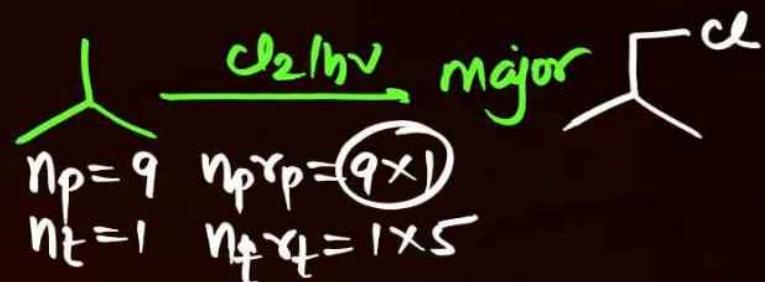
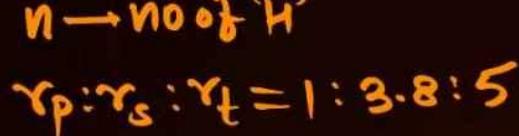
8. Chlorination-



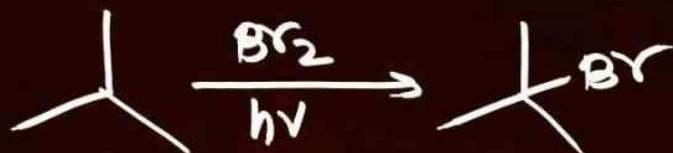
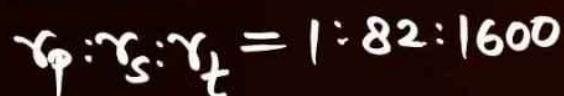
$n_p \gamma_p$

$n_s \gamma_s$

$n_t \gamma_t$



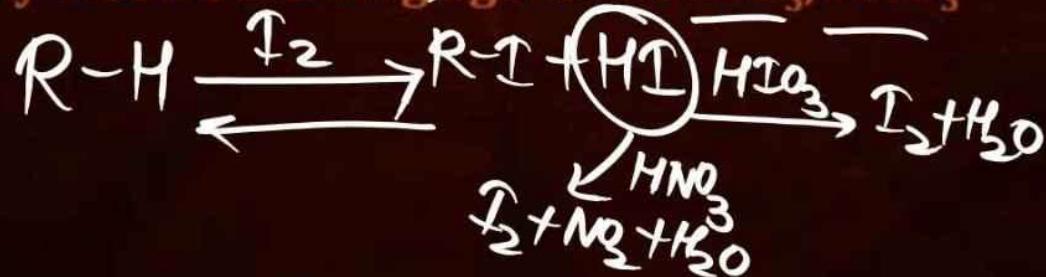
9. Bromination



10. Iodination

Bond energy: $\text{H}-\text{F} > \text{HCl} > \text{HBr} > \text{HI}$ Reducing agent

It takes place only when Oxidizing agent like HIO_3 , HNO_3



11. Radical reaction involves

A. Initiation ✓

B. Propagation ✓

C. Termination ✓

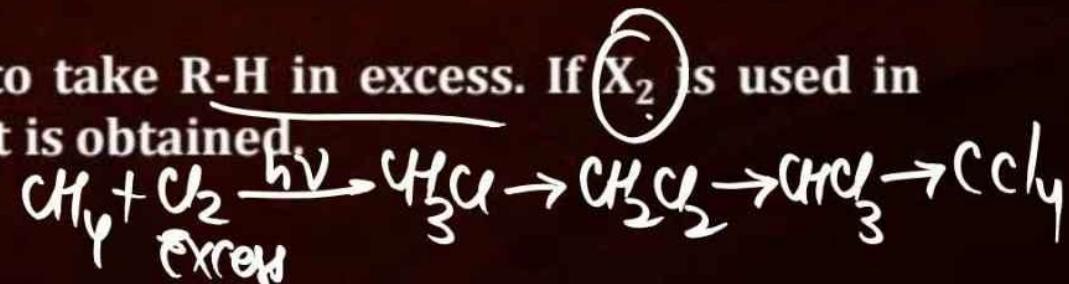
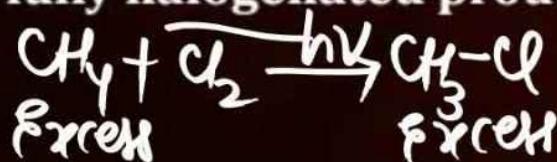
12. Radical reaction can be slow down by adding O₂, S₂ or any other peroxide.



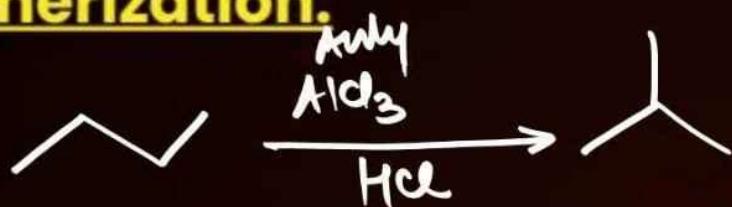
13. Chlorination is more reactive less selective.

Bromination is more selective less reactive.

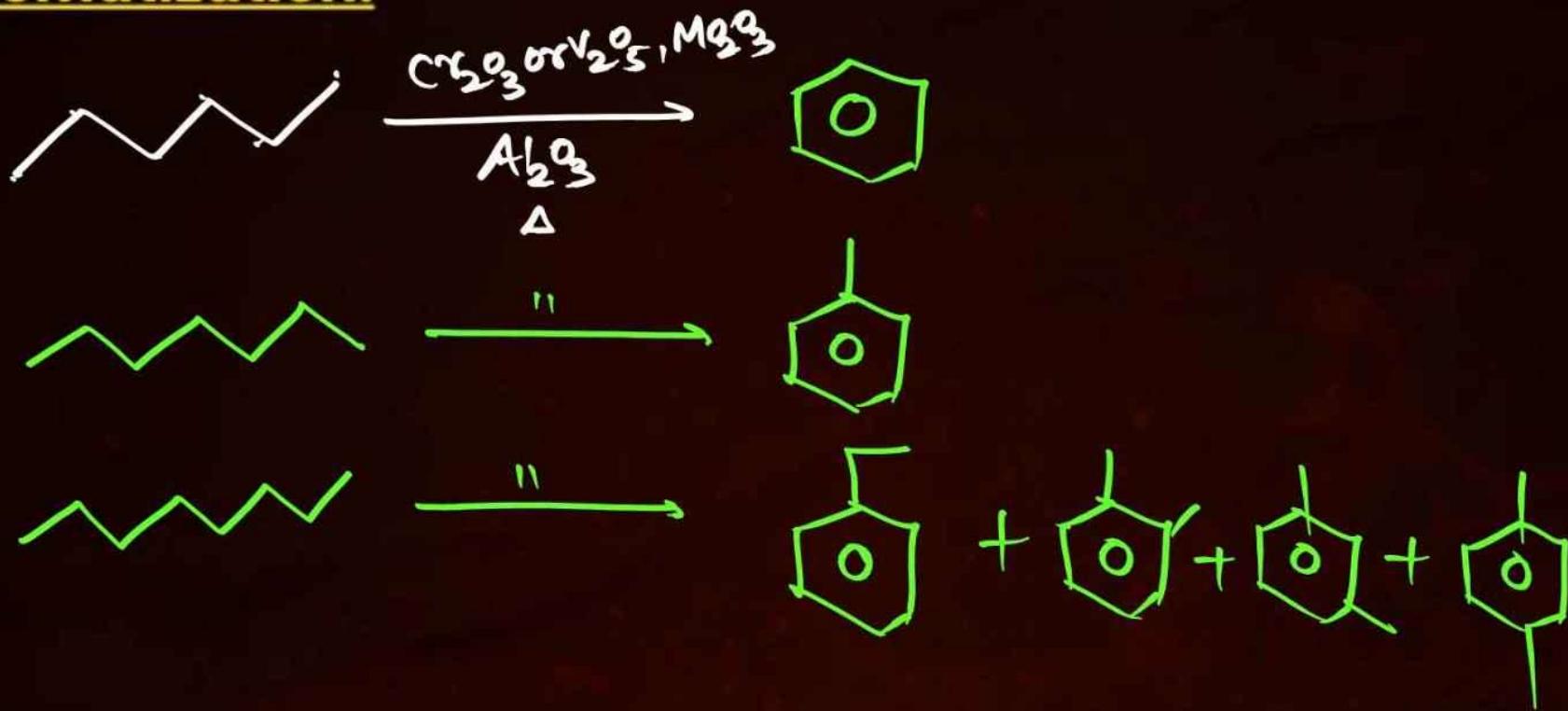
14. For good yield of R-X we have to take R-H in excess. If X₂ is used in excess then fully halogenated product is obtained.



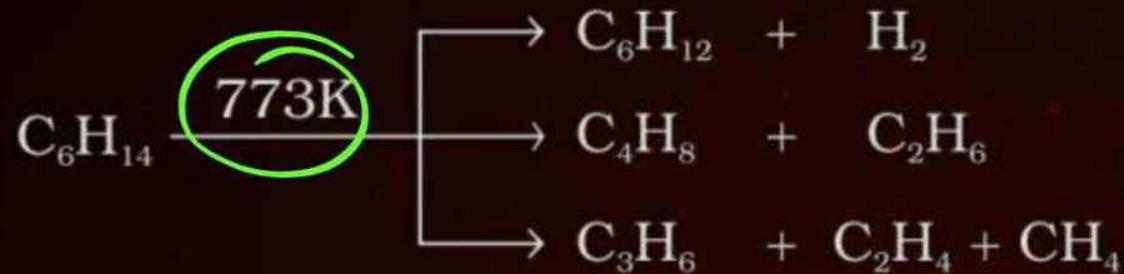
2. Isomerization:



3. Aromatization:

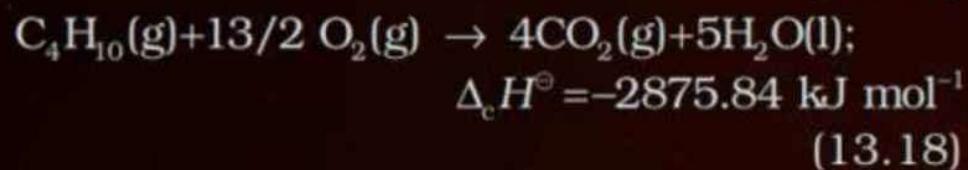
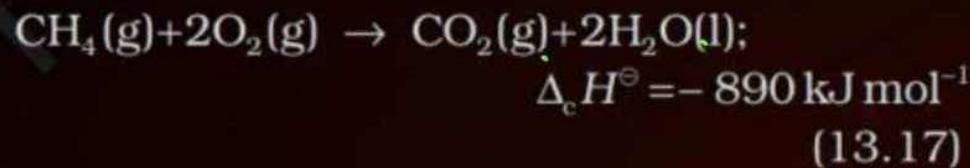


4. Pyrolysis or cracking:

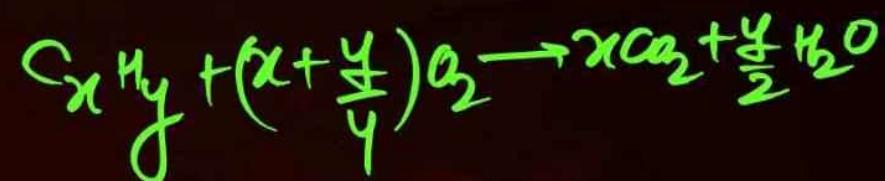
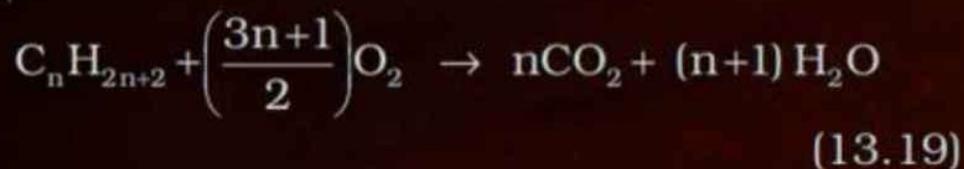


5. Combustion:

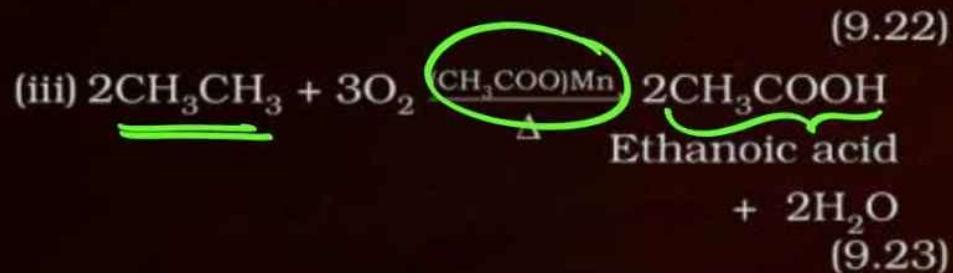
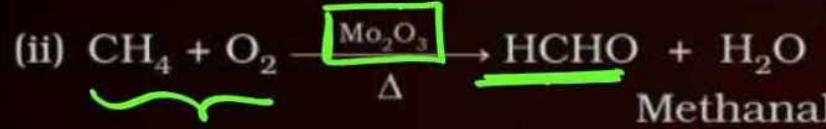
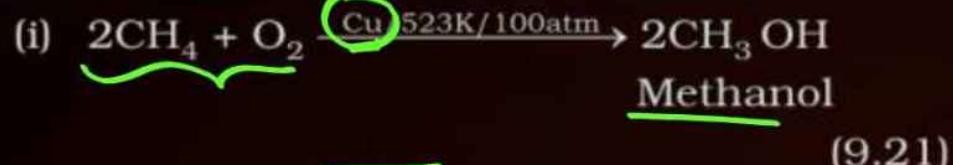
C, H, O



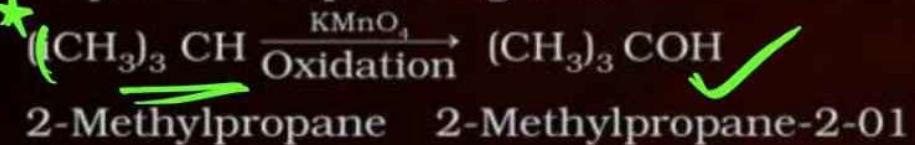
The general combustion equation for any alkane is :



6. Controlled Oxidation:



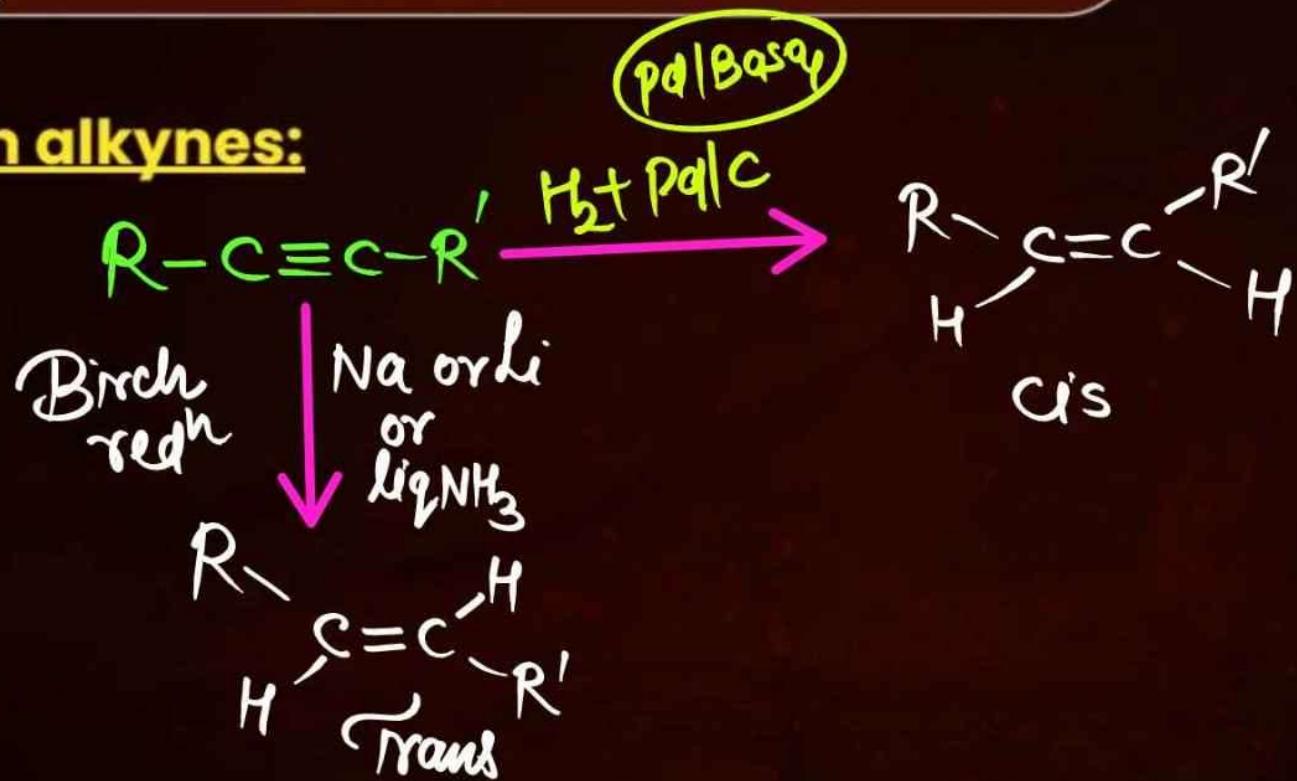
(iv) Ordinarily alkanes resist oxidation but alkanes having tertiary H atom can be oxidized to corresponding alcohols by potassium permanganate.



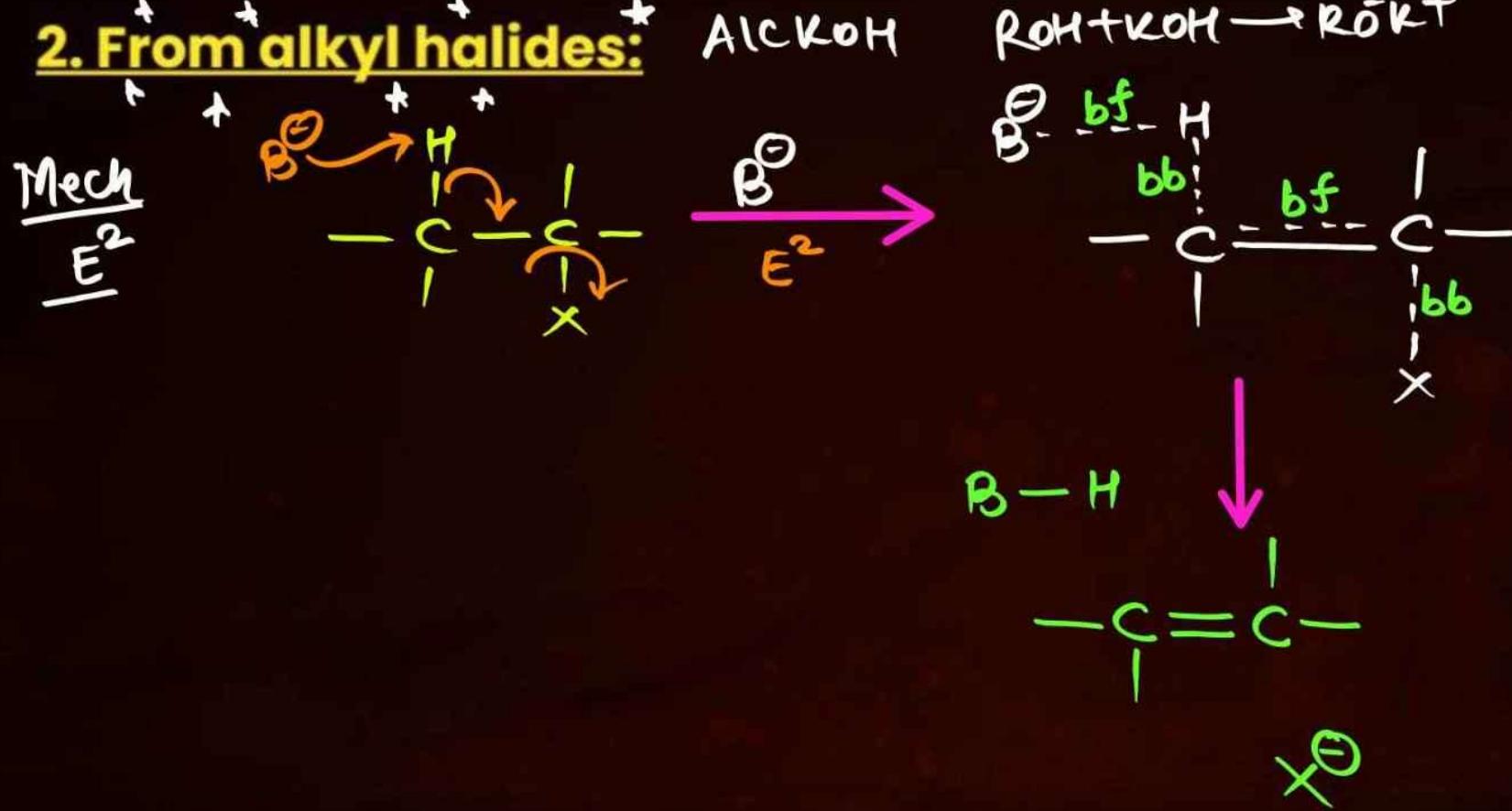


Methods of Preparation of Alkenes

1. From alkynes:

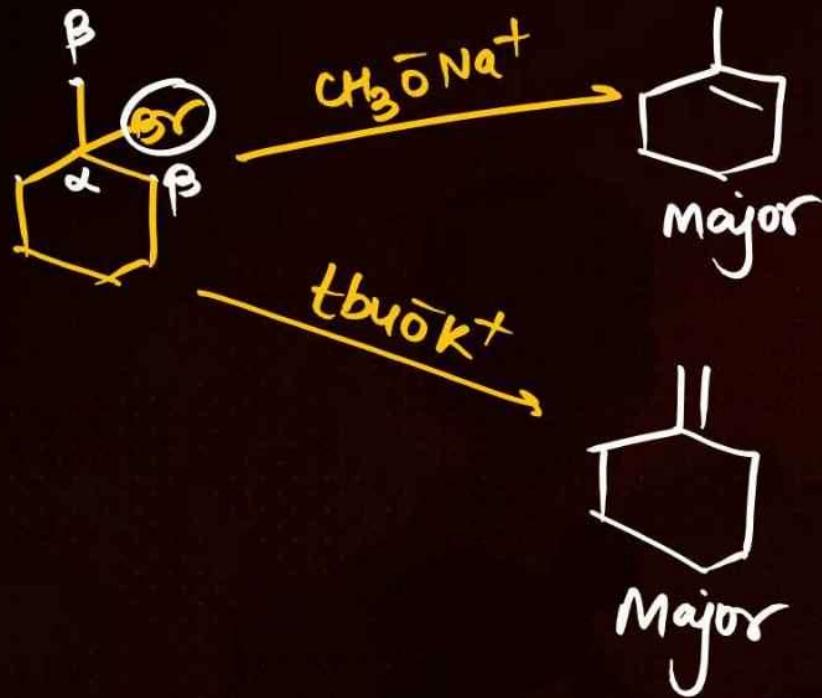


2. From alkyl halides:

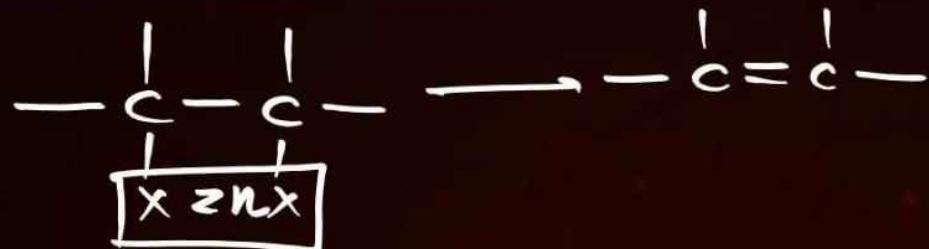


OP Points of E₂:

1. No Carbocation formation, Only Transition state is formed
2. No Rearrangement
3. R.O.R w.r.t. Halogen $R - F < R - Cl < R - Br < R - I$ BE ↓ leaving ability
4. Rate $r = k[R-X]^1 [B^-]^1$
5. Order = 2 & Molecularity = 2
6. Anti Elimination
- * 7. More stable alkene is the major product when L.G is Cl, Br & I.
8. More stable carbanion will decide the major product when L.G is F.
9. If Bulky base is present then less hindered beta carbon will decide the major product.



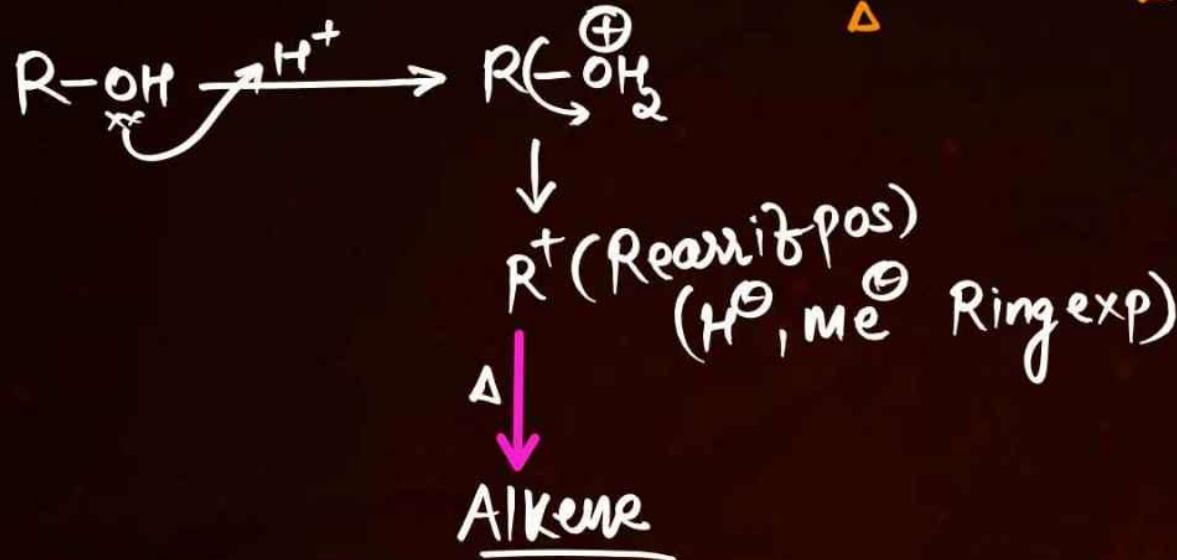
3. From vicinal dihalides:



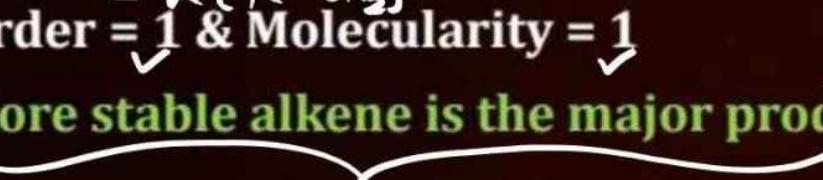
4. From alcohols by acidic dehydration:

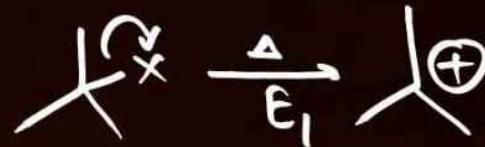
H^+/Δ or conc CH_3SO_4 or conc H_3PO_4

Mech



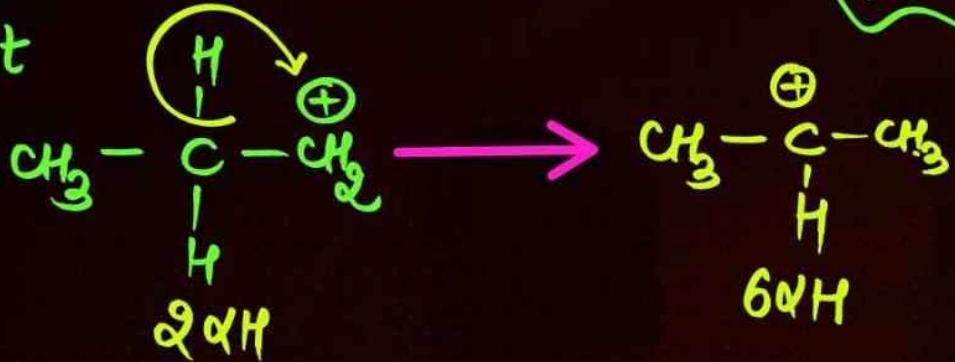
OP Points of E1:

1. Carbocation intermediate formation 
2. Rearrangement if possible 
3. R.O.R w.r.t. Halogen  $R - F < R - Cl < R - Br < R - I$
4. Rate $r = k[R-X]^1$ 
5. Order = 1 & Molecularity = 1 
6. More stable alkene is the major product. 



Rearrangement :

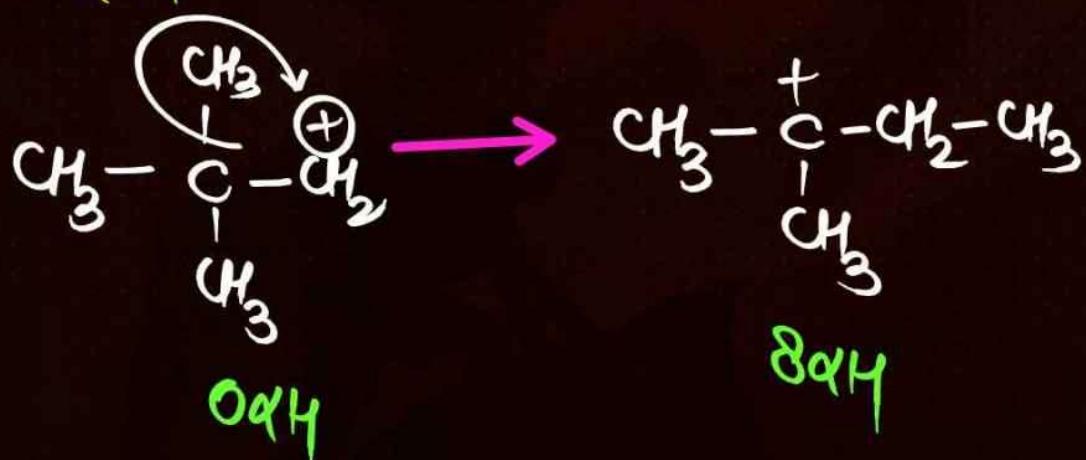
① H^\ominus shift



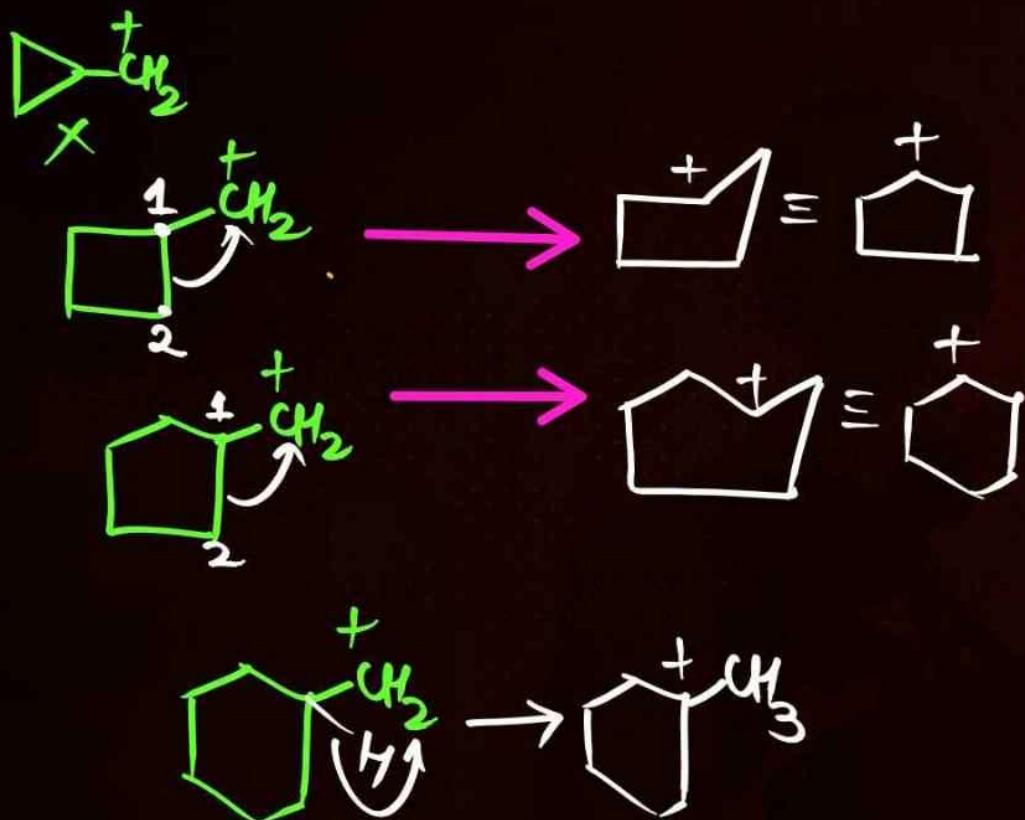
$\text{R.E} > \text{H}^\ominus > \text{Me}^\ominus$



② Me^\ominus shift



③ R.E





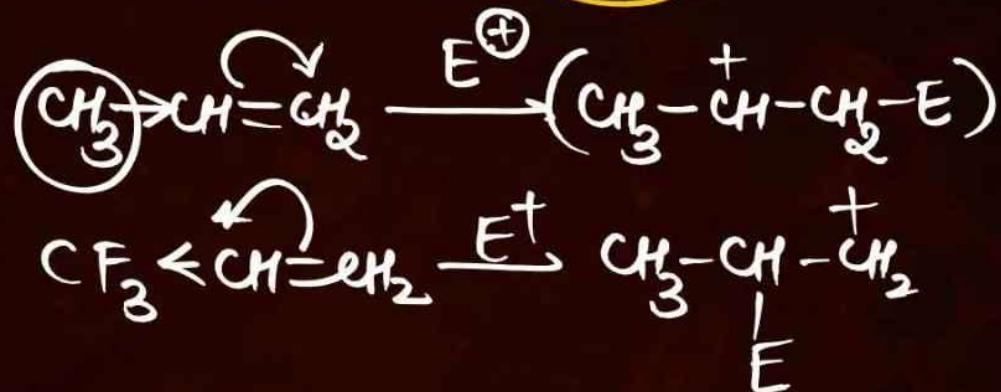
Chemical Properties of Alkenes

1. Electrophilic Addition Reaction

+ E

Electromeric Effect:

E > I





Electrophilic Addition Reaction

A. Via Classical Carbocation

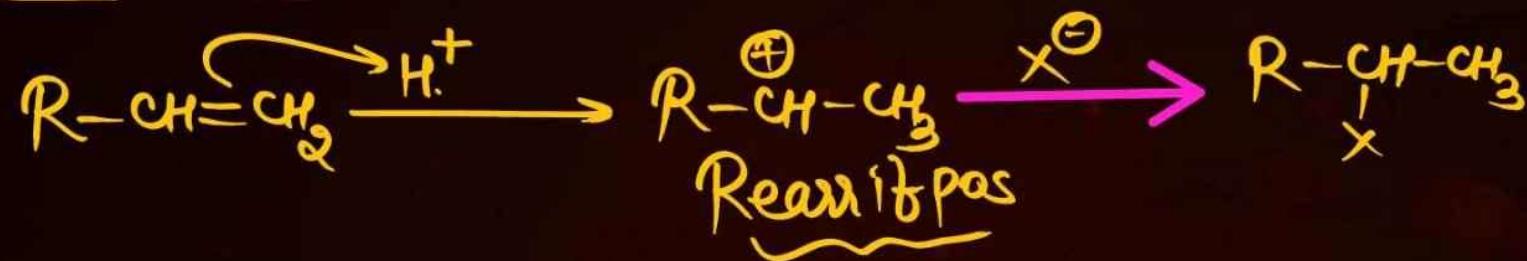
1. Hydro-Halogenation (Addition of HX)
2. Hydration (Addition of water in acidic medium)

B. Via Non-Classical Carbocation

1. Addition of Halogen in Inert solvent
2. Addition of Halogen in Non-Invert Solvent like water

A. Via Classical Carbocation

1. Hydro-Halogenation (Addition of HX)



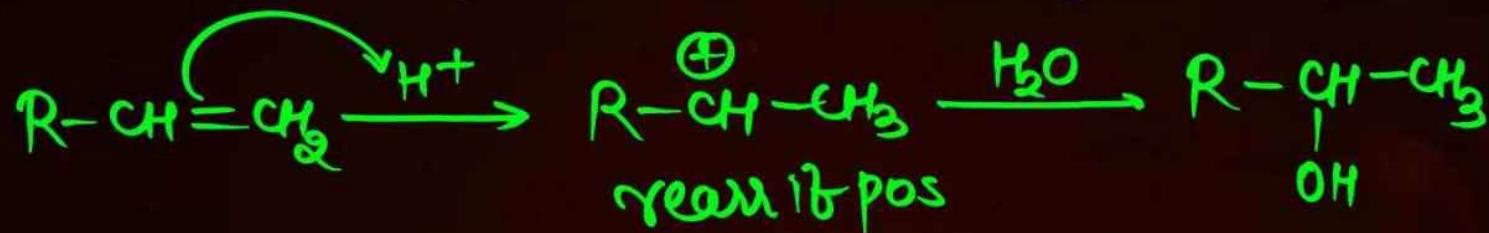
OP Points

1. 1st Carbocation formation is the RDS ✓
2. ROR α Nucleophilicity of Alkene α Stability of 1st Carbocation ✓
3. Rearrangement of Carbocation occurs. ✓

A. Via Classical Carbocation

2. Hydration (Addition of water in acidic medium)

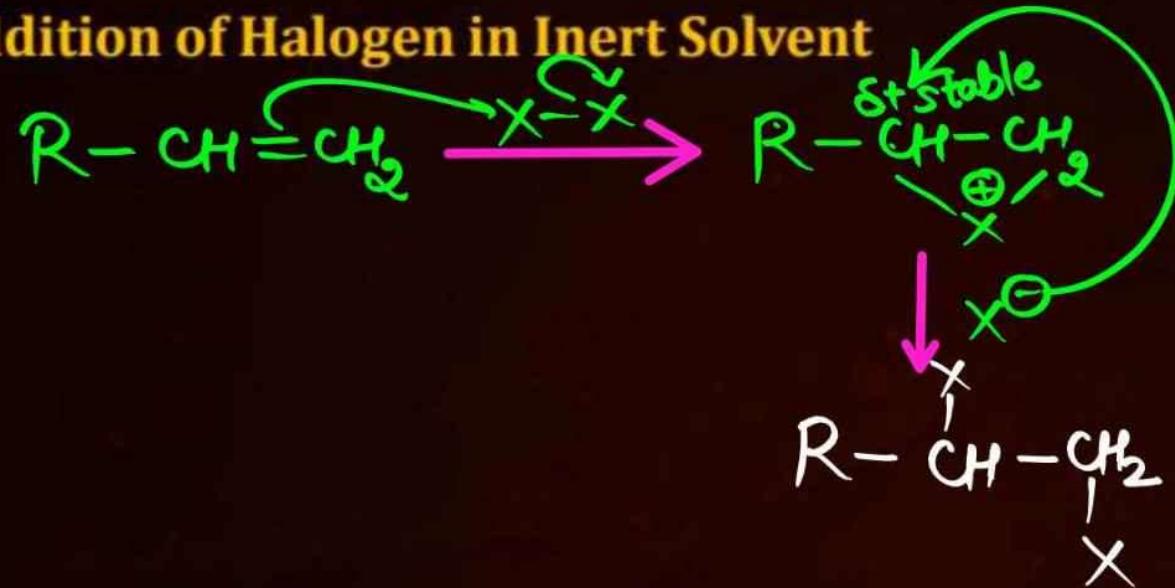
dl H₂SO₄ or H⁺/H₂O or H₃O⁺



B. Via Non-Classical Carbocation**1. Addition of Halogen in Inert solvent****2. Addition of Halogen in Non-Invert Solvent like water**

B. Via Non-Classical Carbocation

1. Addition of Halogen in Inert Solvent

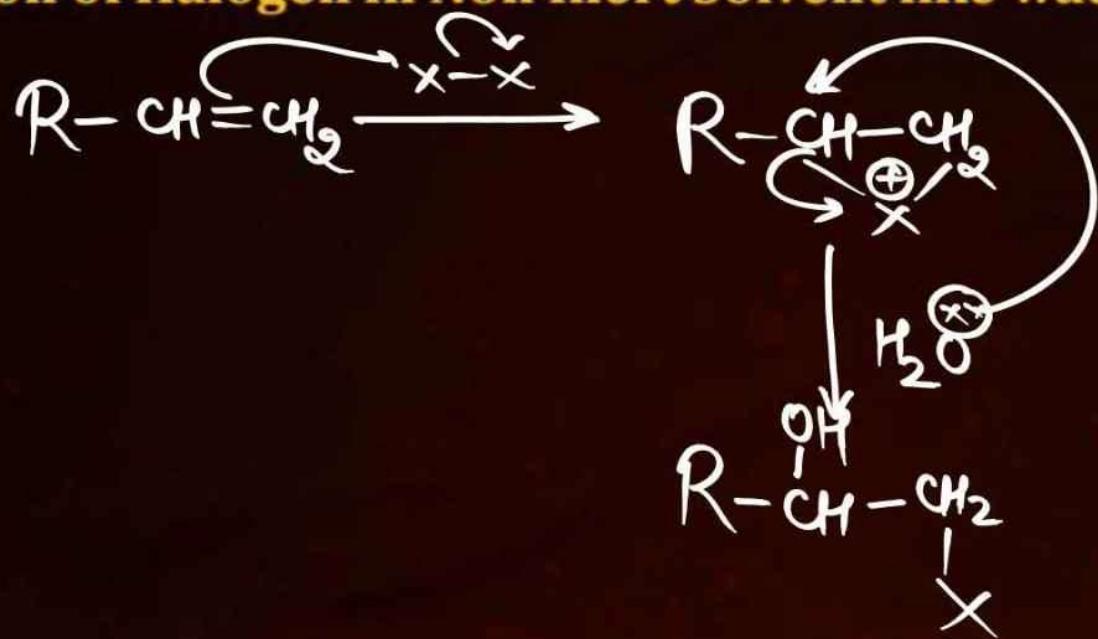


OP Points

1. Non Classical Carbocation formation is the RDS.
2. ROR α Nucleophilicity of Alkene α Stability of partial positive C.
3. No Rearrangement occurs
4. Cyclic Halonium ion formation
5. CCl_4 or CH_2Cl_2 can be used as inert solvent.
6. Anti Addition

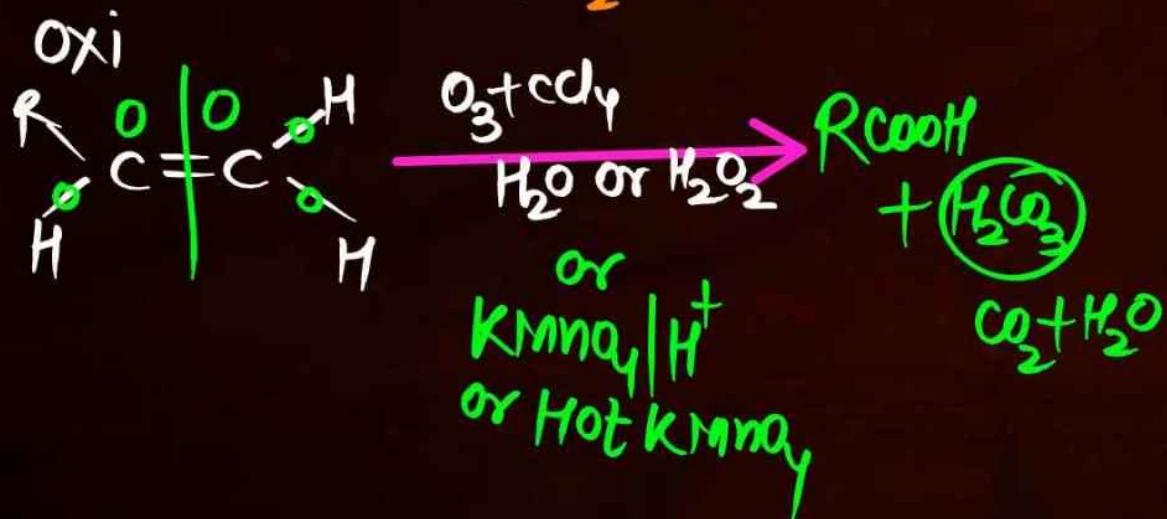
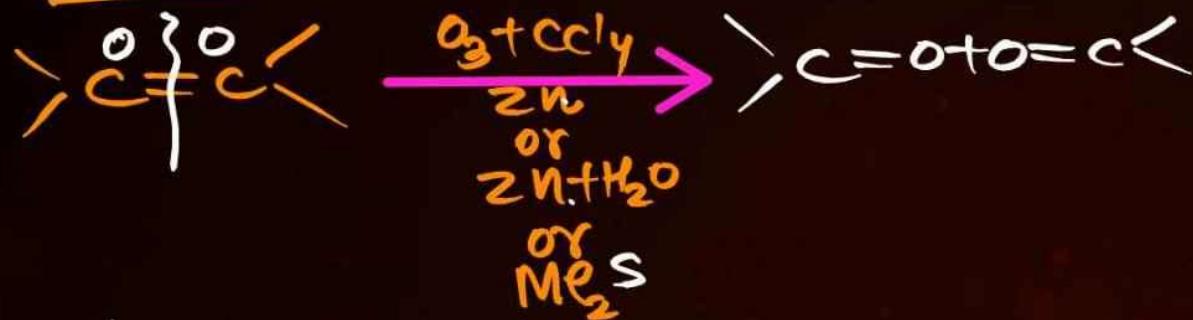
B. Via Non-Classical Carbocation

2. Addition of Halogen in Non Inert Solvent like water



2. Ozonolysis:

Reductive



**Double bond exists:
Ozonolysis:**



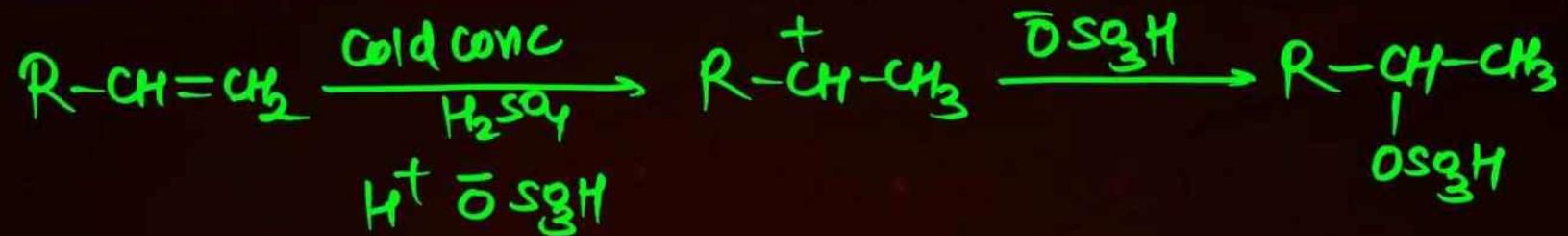
OP Points

1. Used for detection of olefins ✓
2. ROR α Nucleophilicity of Alkene ✓
3. Formation of formaldehyde means terminal alkene is present.
4. Formation of glyoxal means conjugated diene is present. ✓

3. Oxidation (Baeyer's Reagent):



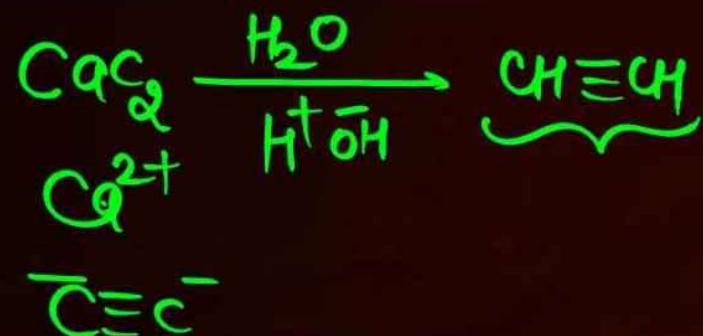
4. Addition of Sulphuric acid:



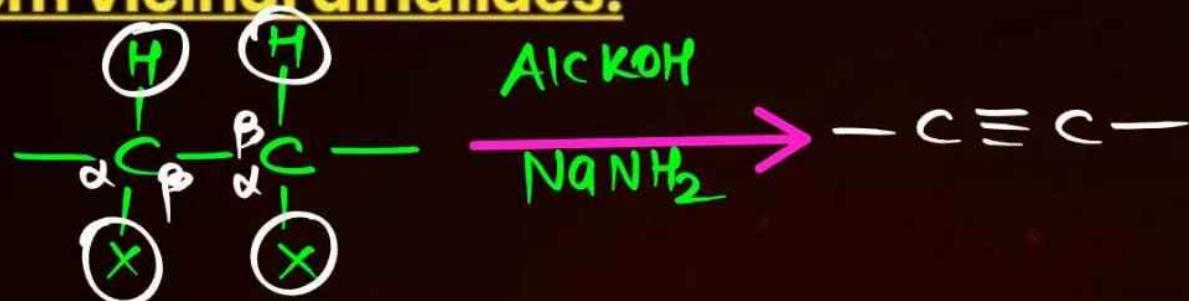


Methods of Preparation of Alkynes

1. From calcium carbide:



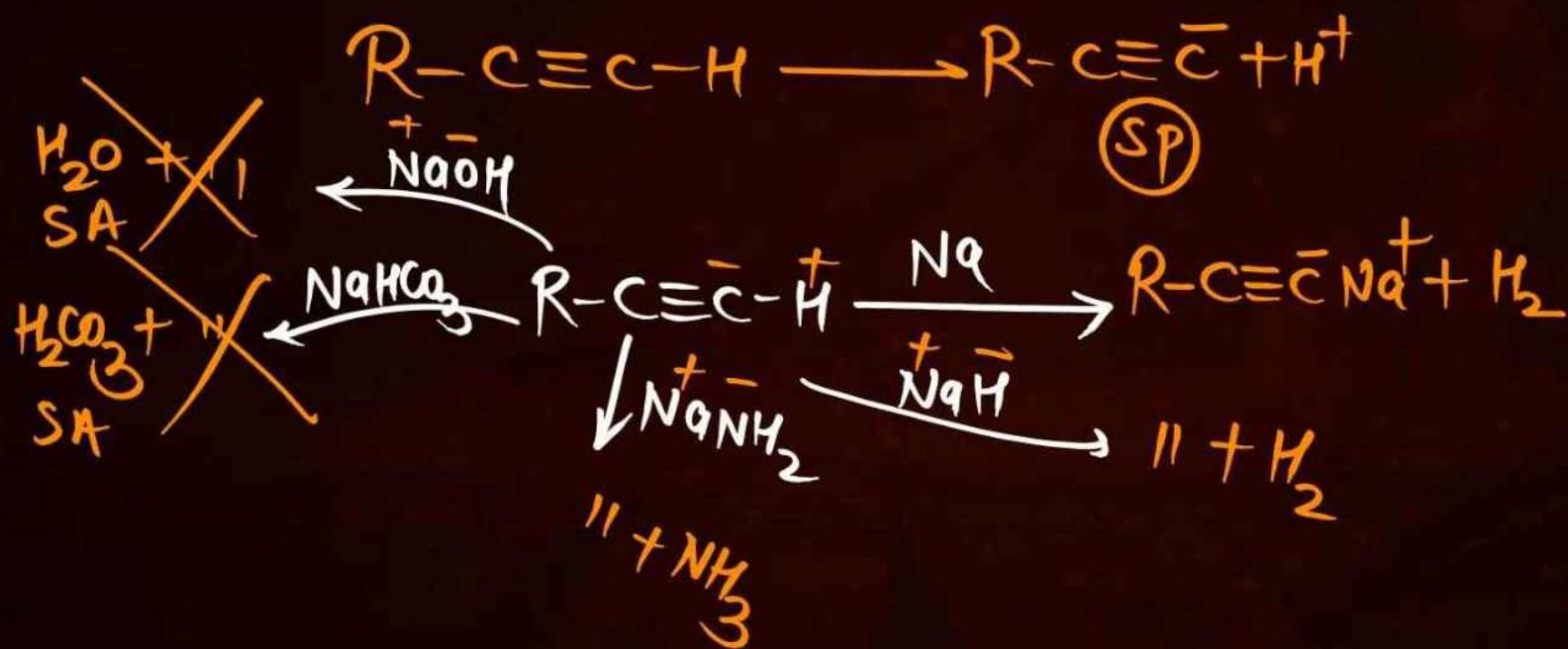
2. From vicinal dihalides:



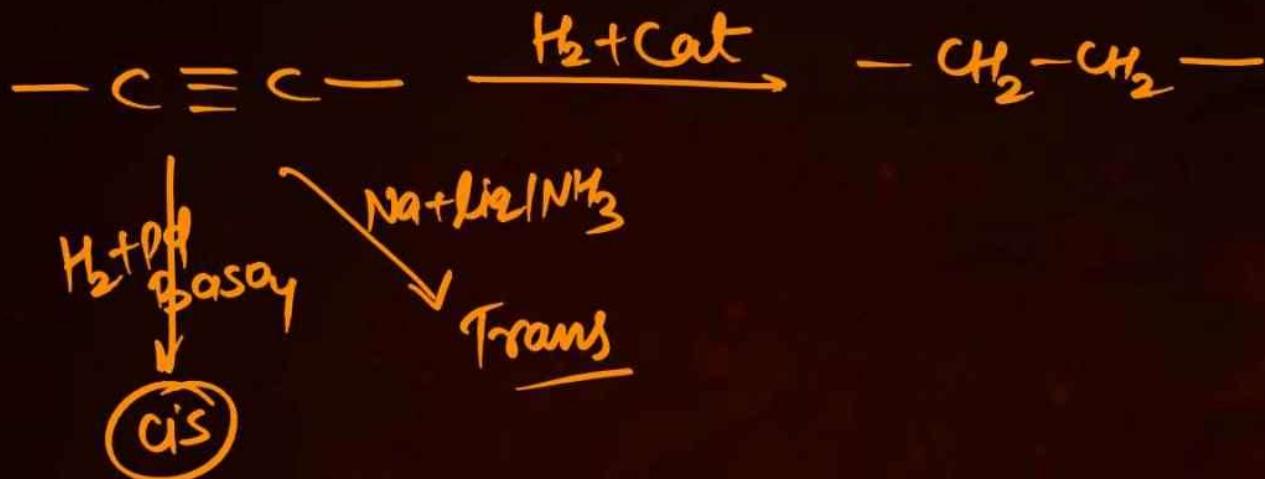


Chemical Properties of Alkynes

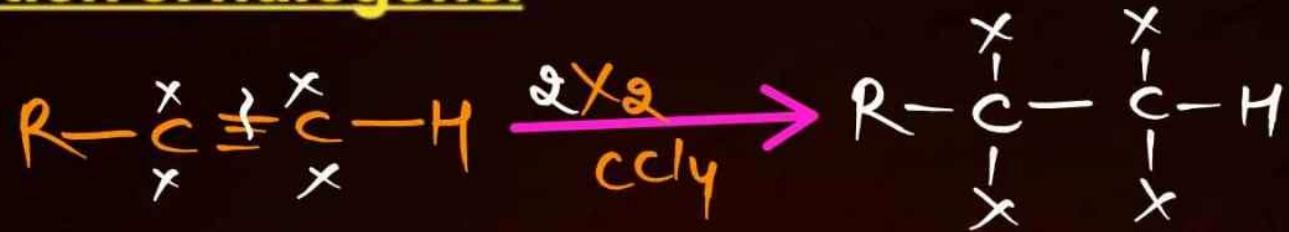
1. Acidic character of alkyne:



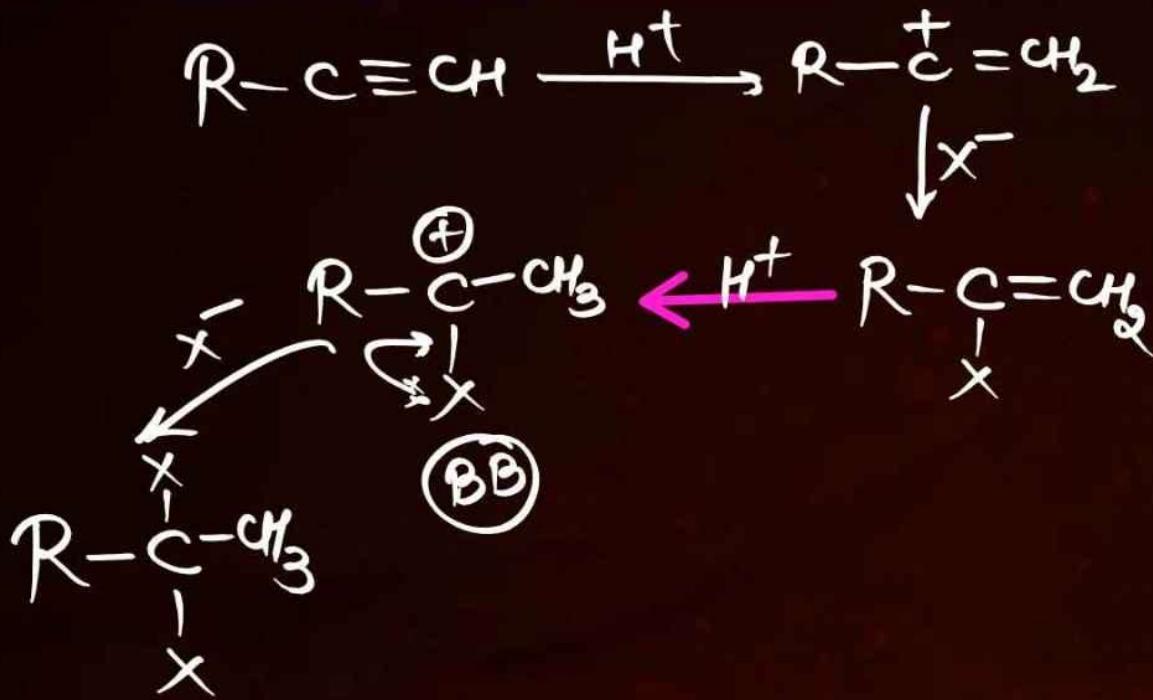
2. Addition of dihydrogen:



3. Addition of halogens:

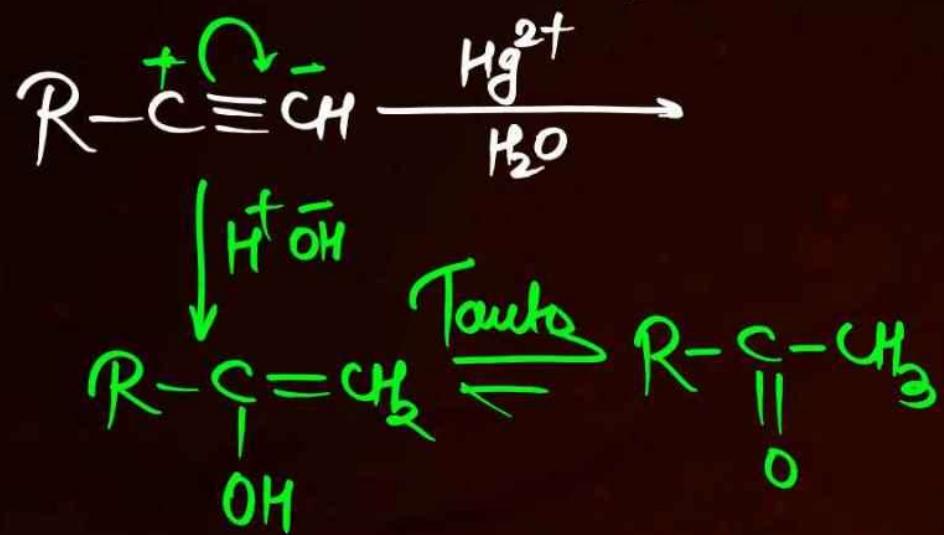


4. Addition of hydrogen halides:

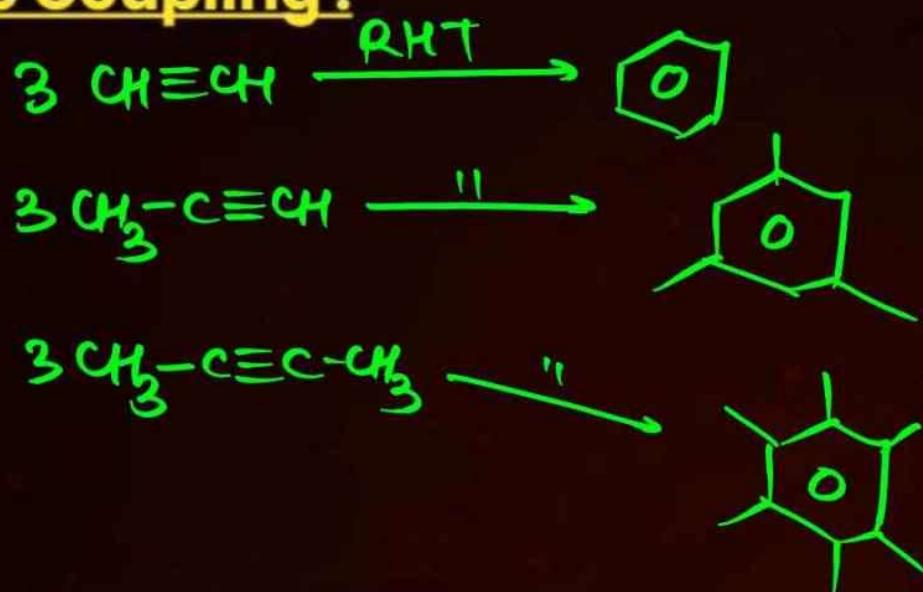


5. Addition of water:

$\text{Hg}^{2+}/\text{H}_2\text{O}$ or dil H_2SO_4
 $\text{or } \text{HgSO}_4$

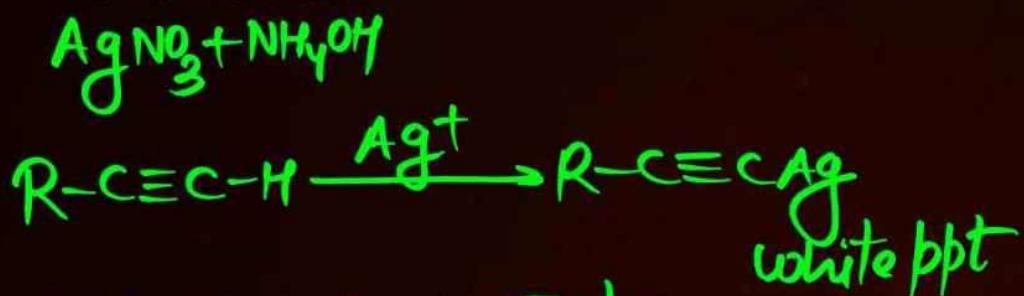


6. Cyclic Coupling:

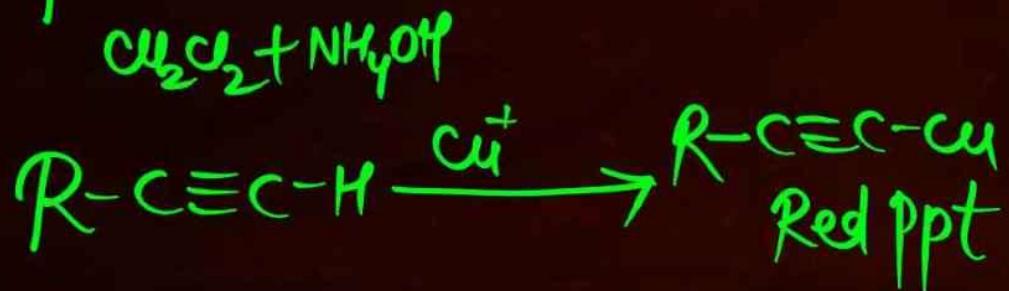


7. Test of Terminal alkynes:

1. Tollen's Test



2. Cuprous chloride Test





Methods of Preparation of Benzene

1. From ethyne:



2. Decarboxylation of aromatic acids:



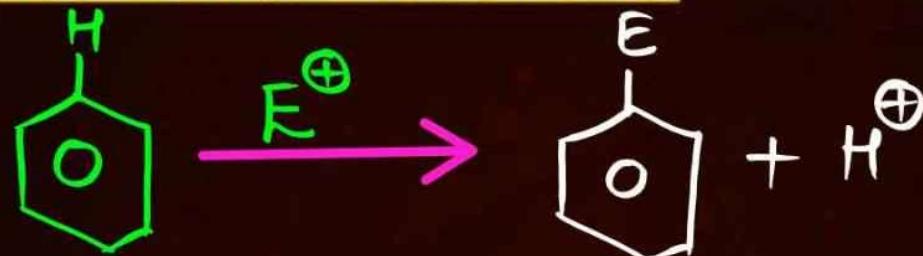
3. Reduction of Phenol:



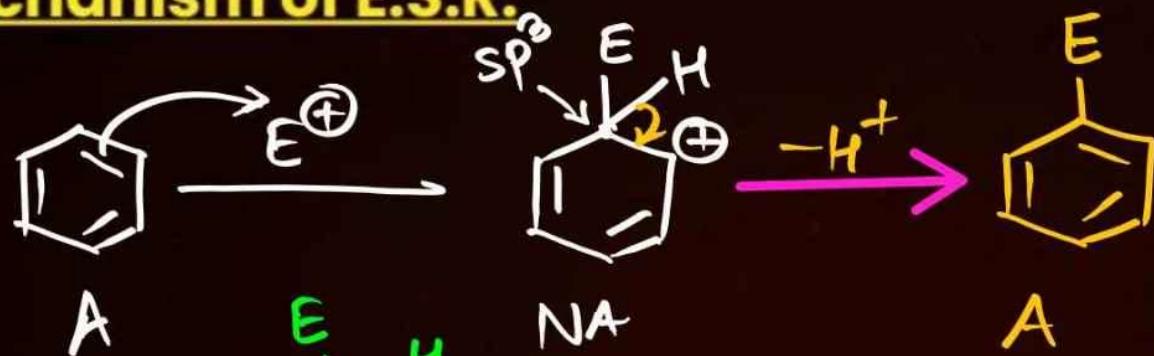


Chemical Properties of Benzene

1. Electrophilic Substitution Reactions:

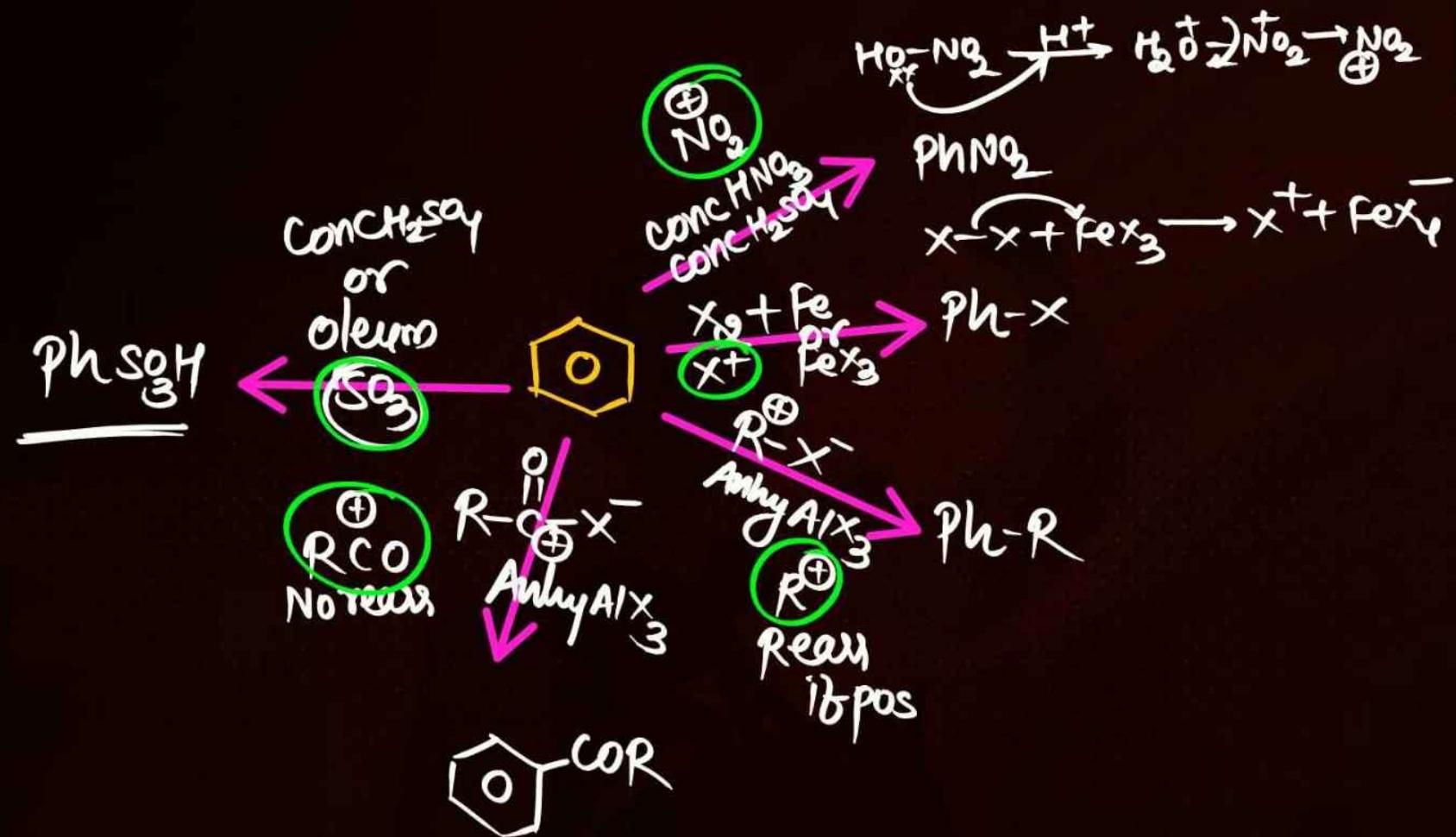


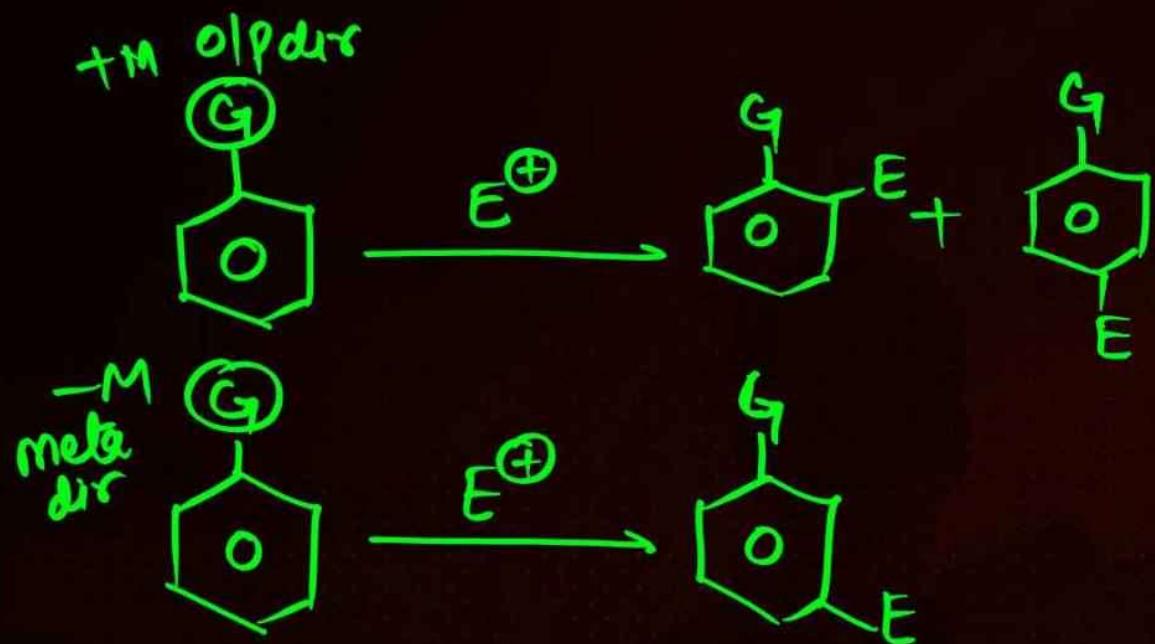
Mechanism of E.S.R.:



Arenium complex or σ complex Wheeland intermediate

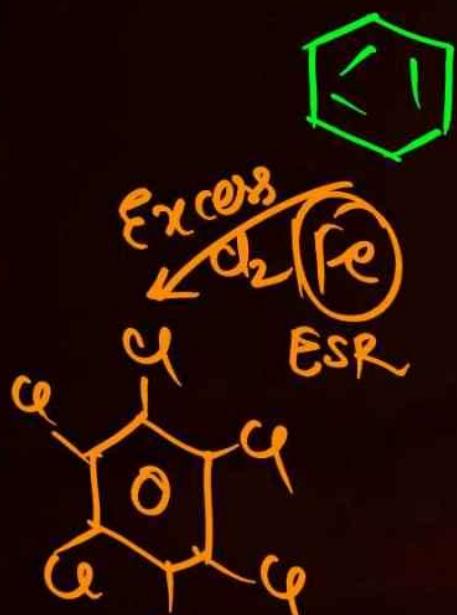
A hand-drawn diagram of the intermediate shows a hexagonal benzene ring with a vertical dashed line through its center. A green 'E' is at the top vertex, and a green 'H' is at the bottom-right vertex. A green '+' sign is inside the hexagon at the center. A green curved arrow originates from the middle-left edge of the hexagon and points to the green 'E'.





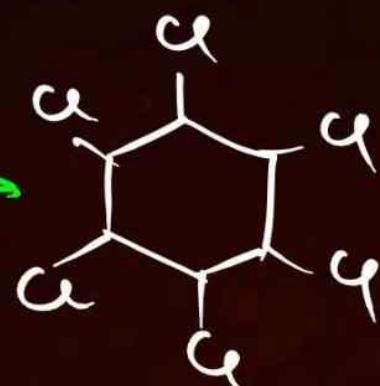
2. Addition Reaction:

a. Addition of chlorine



HxC Hexachlorobenzene

Excess Cl_2
hv Add

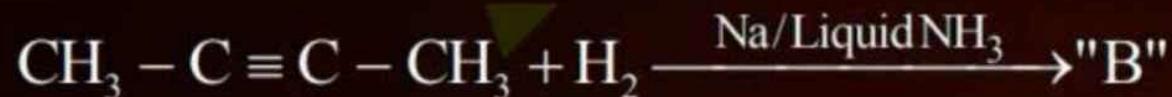
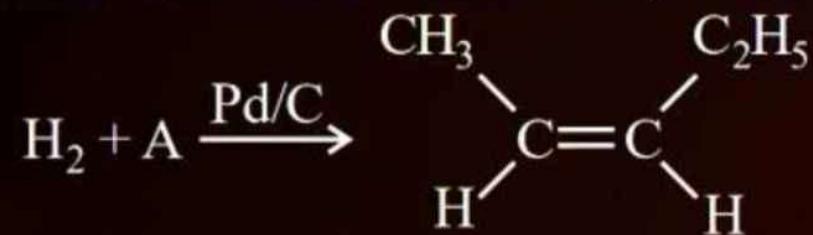


$\gamma\text{-BHC}$ (Benzene hexachloride)
 $\gamma\text{-666}$
Lindane
Gammaxane

b. Addition of Hydrogen

QUESTION (JEE Mains 1st Feb 2024, Evening Shift)

In the given reactions identify A and B.



A A : 2 - Pentyne

B : trans - 2 - butene

B A : n - Pentane

B : trans - 2 - butene

C A : 2- Pentyne

B : Cis - 2 - butene

D A : n - Pentane

B : Cis - 2 - butene

QUESTION (JEE Mains 1st Feb 2024, Evening Shift)

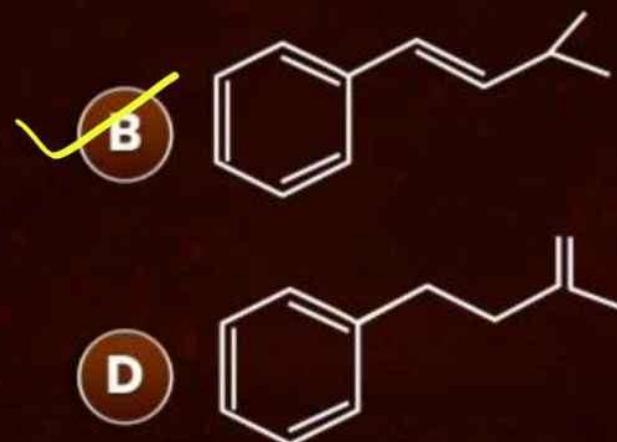
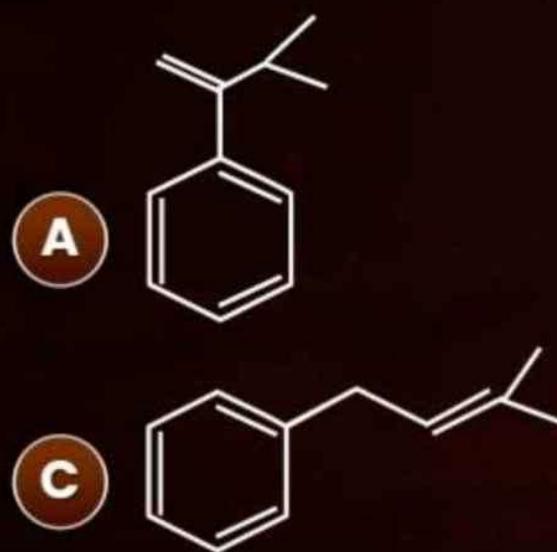


Total number of isomeric compounds (including stereoisomers) formed by monochlorination of 2-methylbutane is ____.



⑥

QUESTION (JEE Mains 4th April 2024, Evening Shift)



QUESTION (JEE Mains 4th April 2024, Morning Shift)

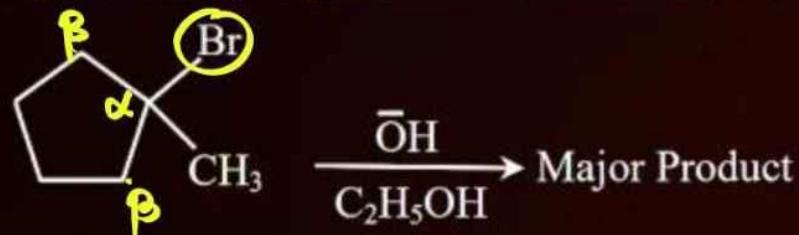
Identify the correct set of reagents or reaction conditions 'X' and 'Y' in the following set of transformation.



- A** X = conc. alc. NaOH, 80°C, Y = Br₂/CHCl₃
- B** X = dil. aq. NaOH, 20°C, Y = HBr/acetic acid
- C** X = conc. alc. NaOH, 80°C, Y = HBr/acetic acid
- D** X = dil. aq. NaOH, 20°C, Y = Br₂/CHCl₃

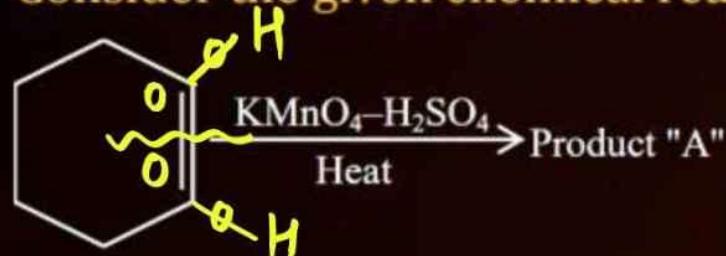
QUESTION (JEE Mains 5th April 2024, Evening Shift)

Identify the major product in the following reaction.



QUESTION (JEE Mains 5th April 2024, Evening Shift)

Consider the given chemical reaction:

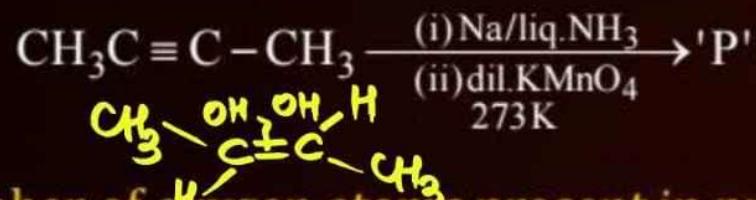


Product "A" is:

- A** picric acid
- B** oxalic acid
- C** acetic acid
- D** adipic acid

QUESTION (JEE Mains 6th April 2024, Morning Shift)

The major product of the following reaction is P.

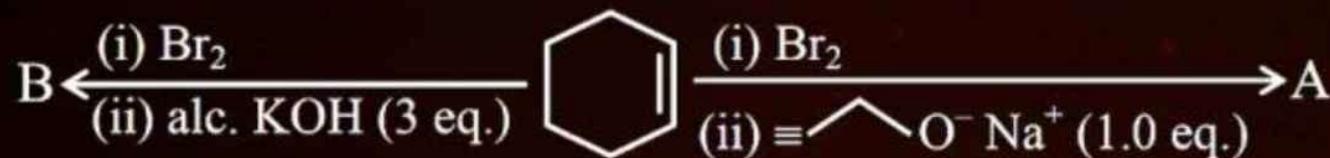


Number of oxygen atoms present in product 'P' is 2 (nearest integer).

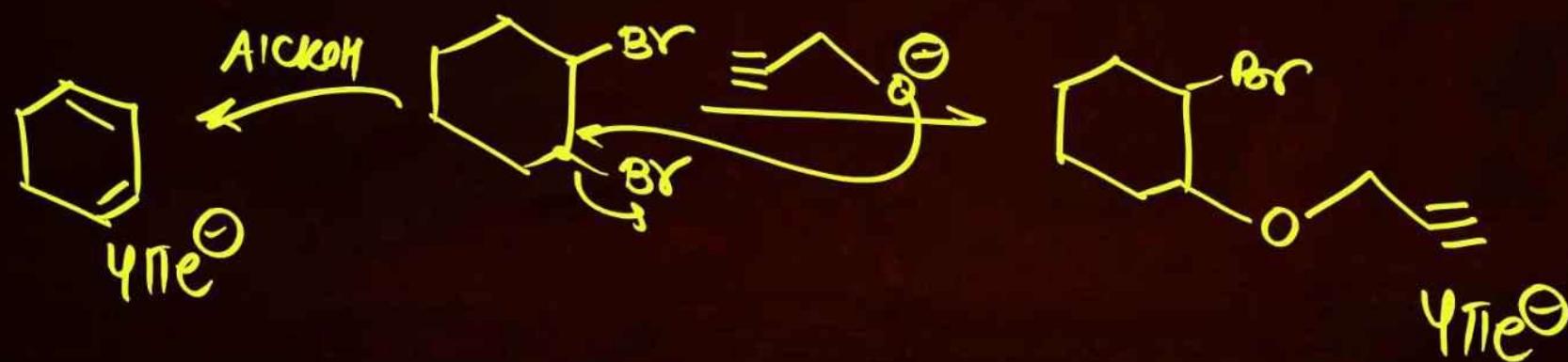
QUESTION (JEE Mains 6th April 2024, Morning Shift)



The major products from the following reaction sequence are product A and product B.



The total sum of π electrons in product A and product B are 8 (nearest integer)

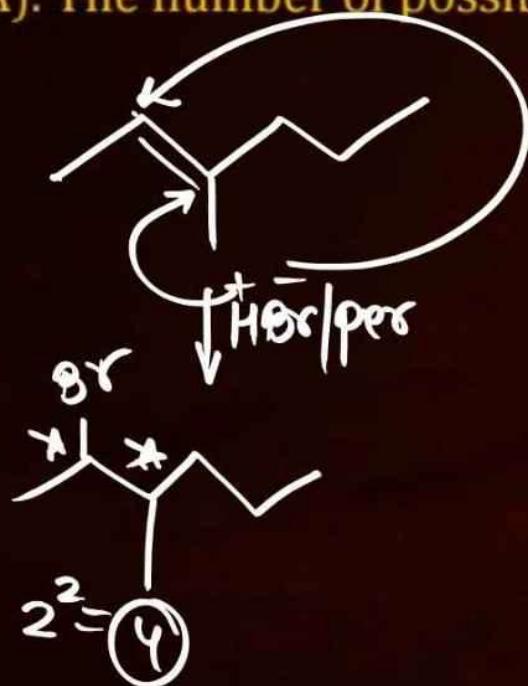


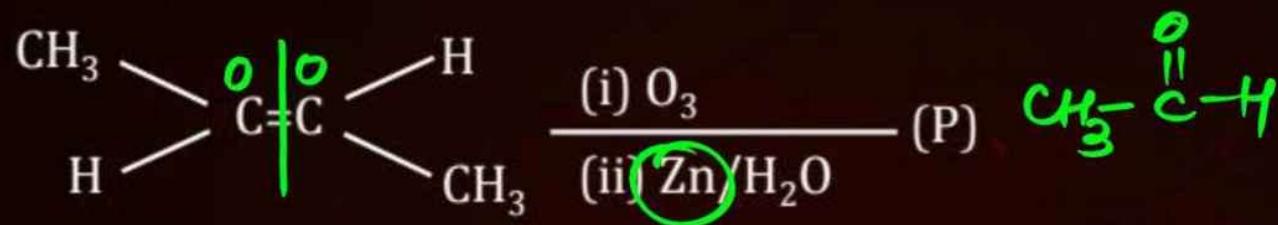
QUESTION (JEE Mains 27th January 2024, Morning Shift)

PW

H⁺ or Antim.

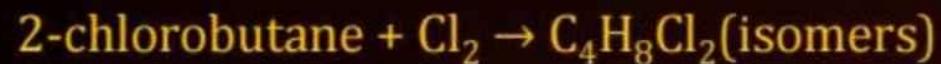
3-Methyl hex-2-ene on reaction with HBr in presence of peroxide forms an addition product (A). The number of possible stereoisomers for 'A' is 4.



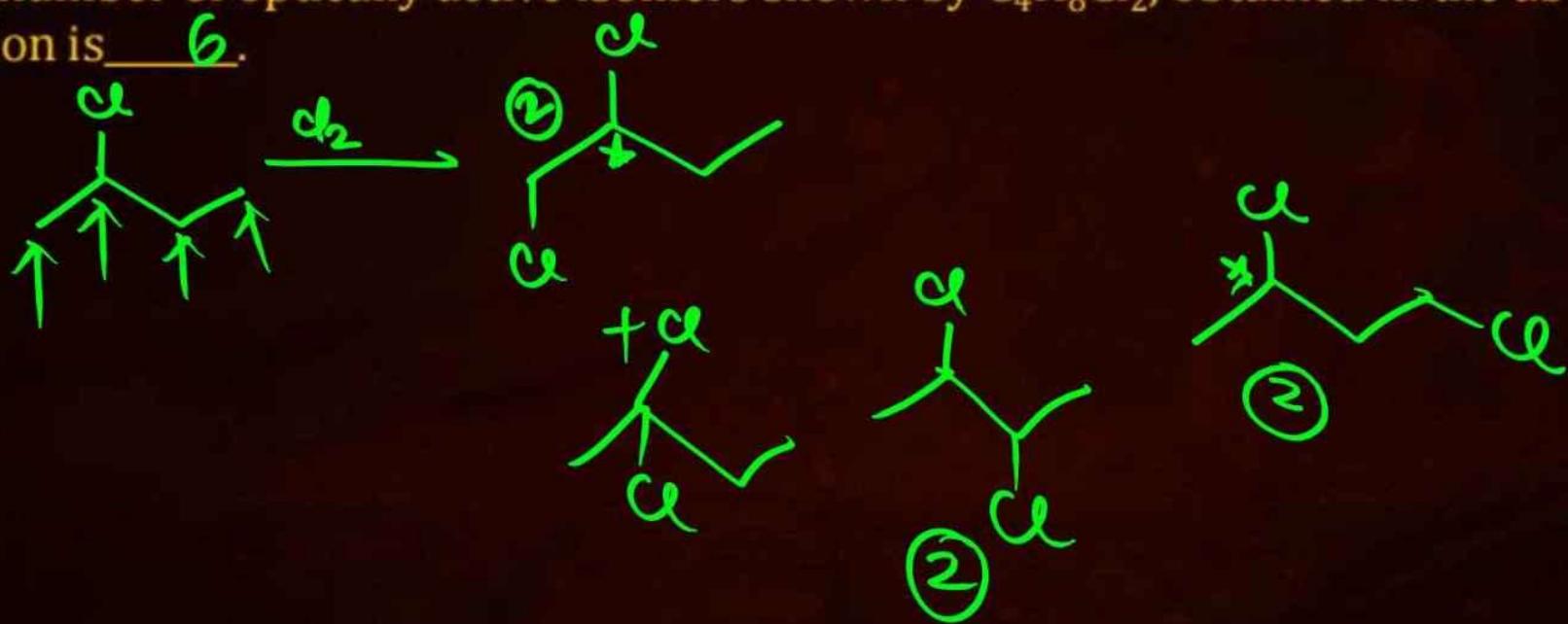
QUESTION (JEE Mains 29 January 2024, Morning Shift)

Consider the given reaction. The total number of oxygen atoms present per molecule of the product (P) is 1.

QUESTION (JEE Mains 30 January 2024, Evening Shift)

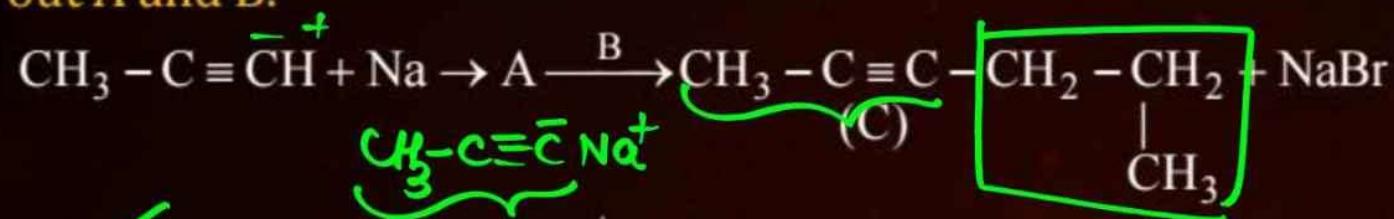


Total number of optically active isomers shown by $\text{C}_4\text{H}_8\text{Cl}_2$, obtained in the above reaction is 6.



QUESTION (JEE Mains 30 January 2024, Morning Shift)

Compound A formed in the following reaction reacts with B gives the product C. Find out A and B.

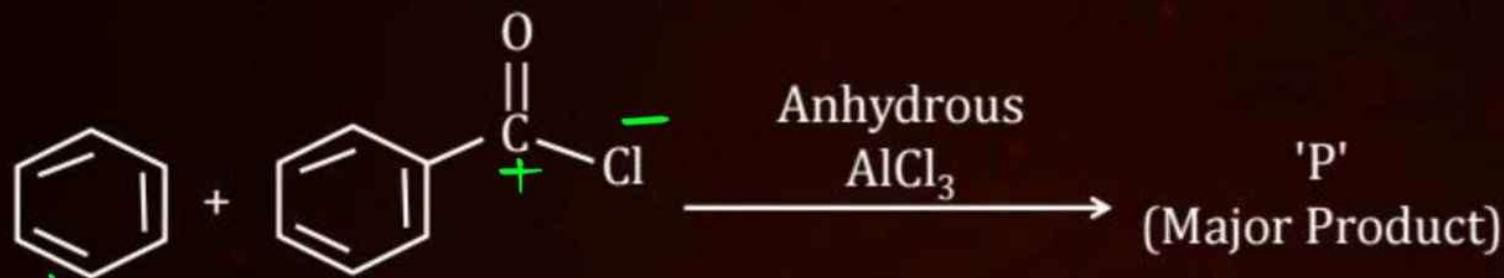


- A** $\text{A} = \text{CH}_3 - \text{C} \equiv \bar{\text{C}}\text{Na}^+, \text{B} = \text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{Br}$
- B** $\text{A} = \text{CH}_3 - \text{CH} = \text{CH}_2, \text{B} = \text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{Br}$
- C** $\text{A} = \text{CH}_3 - \text{CH}_2 - \text{CH}_3, \text{B} = \text{CH}_3 - \text{C} \equiv \text{CH}$
- D** $\text{A} = \text{CH}_3 - \text{C} \equiv \bar{\text{C}}\text{Na}^+, \text{B} = \text{CH}_3 - \text{CH}_2 - \text{CH}_3$

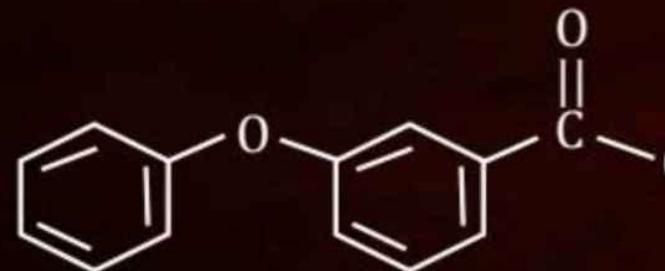
QUESTION (JEE Mains 31 January 2024, Evening Shift)



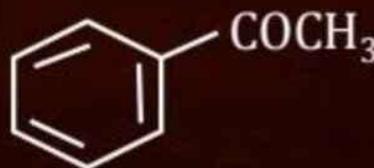
Identify major product 'P' formed in the following reaction.

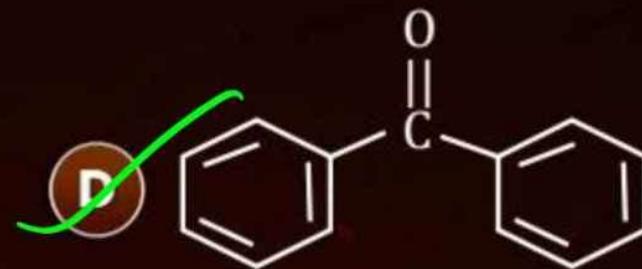
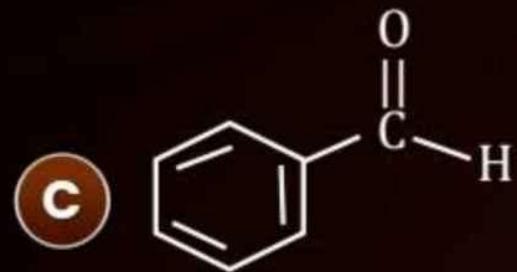


A



B

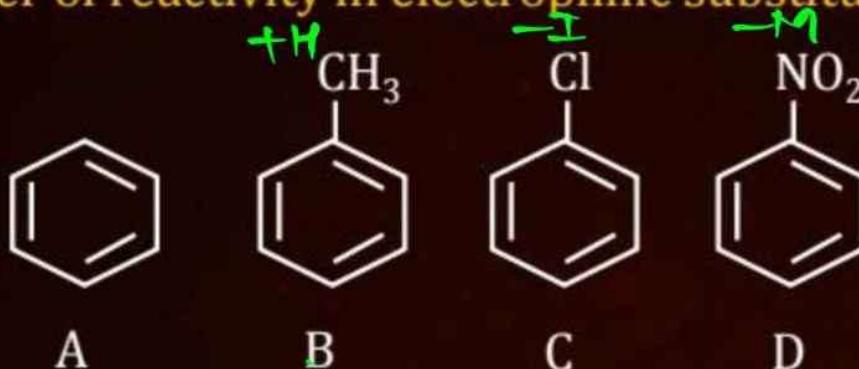




QUESTION (JEE Mains 31 January 2024, Evening Shift)



The correct order of reactivity in electrophilic substitution reaction of the following compounds is:



- A** B > C > A > D
- B** D > C > B > A
- C** A > B > C > D
- D** B > A > C > D

QUESTION (NCERT Exemplar)

Arrange the halogens F_2 , Cl_2 , Br_2 , I_2 in order of their increasing reactivity with alkanes.

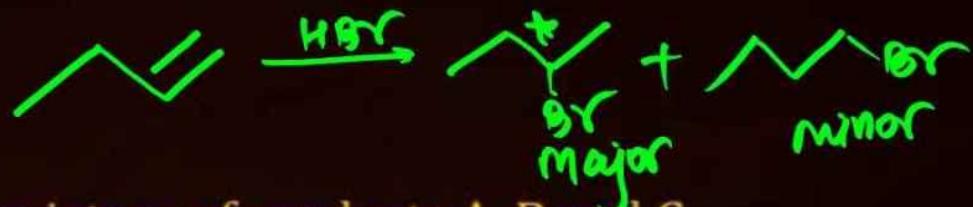
- A** $I_2 < Br_2 < Cl_2 < F_2$ 
- B** $Br_2 < Cl_2 < F_2 < I_2$
- C** $F_2 < Cl_2 < Br_2 < I_2$
- D** $Br_2 < I_2 < Cl_2 < F_2$

QUESTION (NCERT Exemplar)

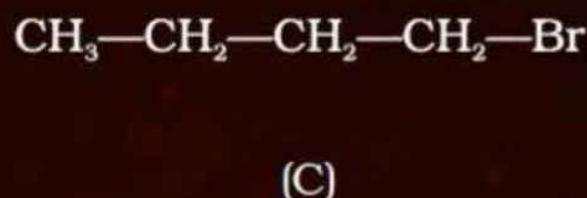
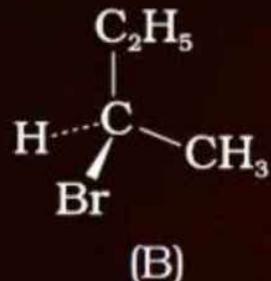
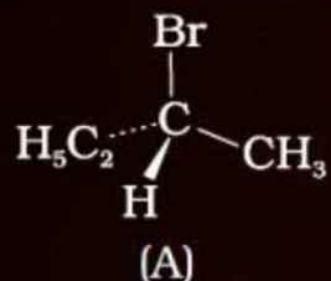
The increasing order of reduction of alkyl halides with zinc and dilute HCl is:

- A** R-Cl < R-I < R-Br
- B** R-Cl < R-Br < R-I ✓
- C** R-I < R-Br < R-Cl
- D** R-Br < R-I < R-Cl

QUESTION (NCERT Exemplar)



The addition of HBr to 1-butene gives a mixture of products A, B and C



The mixture consists of

- A** A and B as major and C as minor products. ✓
- B** B as major, A and C as minor products.
- C** B as minor, A and C as major products.
- D** A and B as minor and C as major products.

QUESTION (NCERT Exemplar)

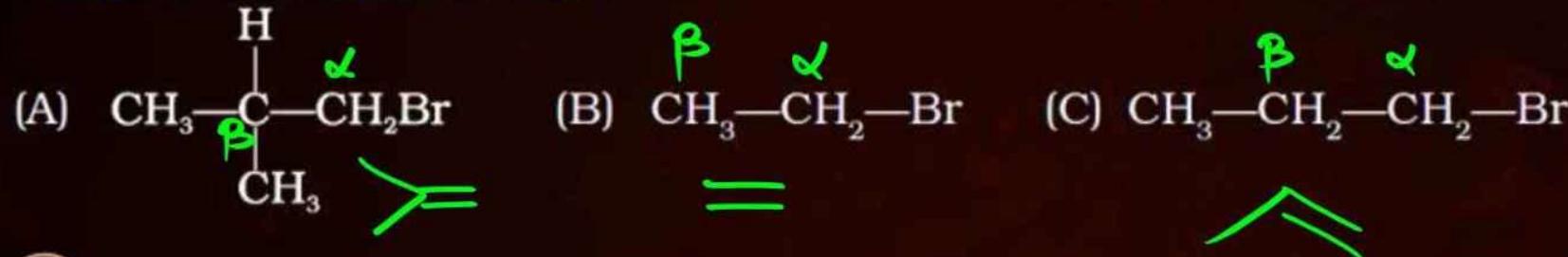
Arrange the following hydrogen halides in order of their decreasing reactivity with propene.

- A** HCl > HBr > HI
- B** HBr > HI > HCl
- C** HI > HBr > HCl
- D** HCl > HI > HBr



QUESTION (NCERT Exemplar)

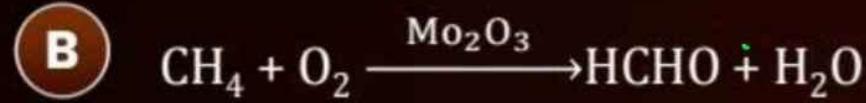
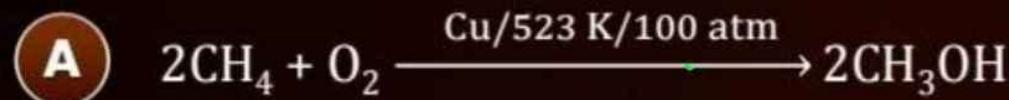
Arrange the following alkyl halides in decreasing order of the rate of β -elimination reaction with alcoholic KOH.



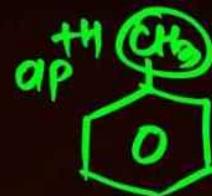
- A $A > B > C$
- B $C > B > A$
- C $B > C > A$
- D $A > C > B$

QUESTION (NCERT Exemplar)

Which of the following reactions of methane is incomplete combustion:



QUESTION (NCERT Exemplar)



Assertion (A): Toluene on Friedal Crafts methylation gives o- and p-xylene.

Reason (R): CH_3- group bonded to benzene ring increases electron density at o- and p- position.

- A Both A and R are correct and R is the correct explanation of A.
- B Both A and R are correct but R is not the correct explanation of A.
- C Both A and R are not correct.
- D A is not correct but R is correct.

QUESTION (NCERT Exemplar)

Assertion (A): Nitration of benzene with nitric acid requires the use of concentrated sulphuric acid.

Reason (R): The mixture of concentrated sulphuric acid and concentrated nitric acid produces the electrophile, NO_2^+ .

- A** Both A and R are correct and R is the correct explanation of A. ✓
- B** Both A and R are correct but R is not the correct explanation of A.
- C** Both A and R are not correct.
- D** A is not correct but R is correct.

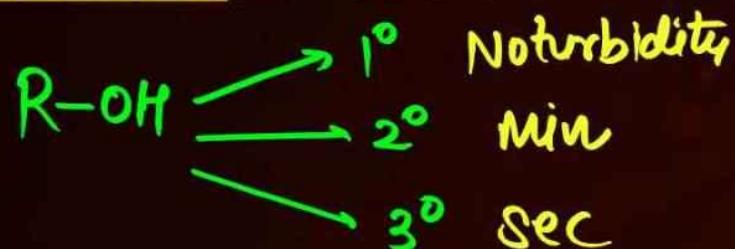


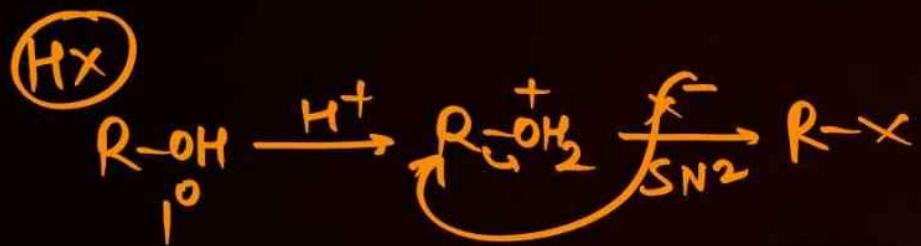
Haloalkanes & Haloarenes



Methods of Preparation of Haloalkanes

1. From Alcohols: A. Reaction with HX/ZnCl₂





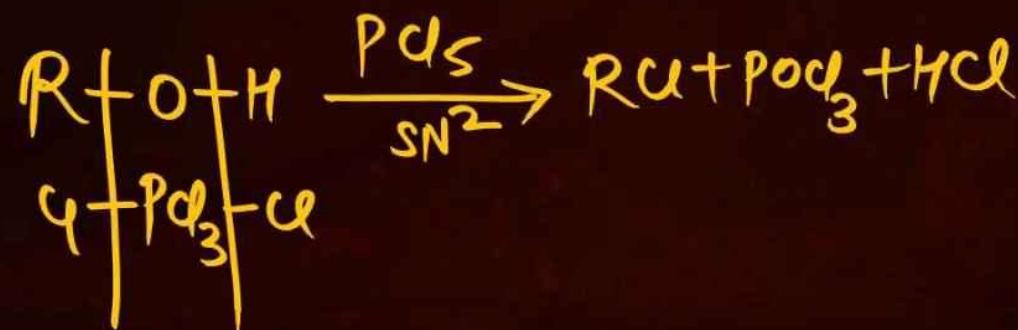
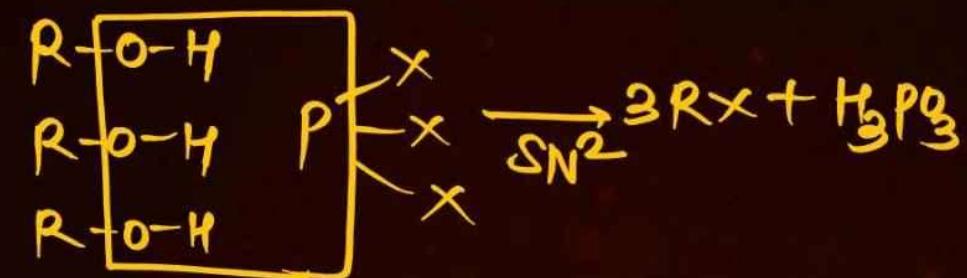
or
 $\text{NaI} + \text{H}_3\text{PO}_4$
 or
 $\text{NaBr} + \text{H}_2\text{SO}_4$

2. From Alcohol without rearrangement:

A. Darzen's Reaction:



B. Reaction with $\underline{PX_3}$, $\underline{PX_5}$ and Red P/X_2 :



3. From Hydrocarbons:

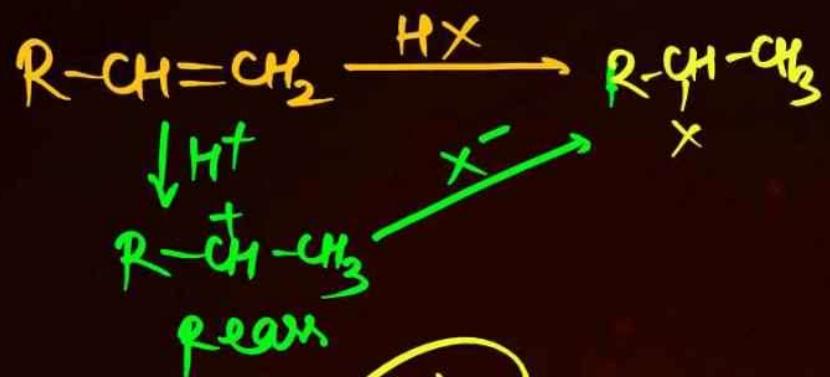
A. From alkanes by free radical halogenation:



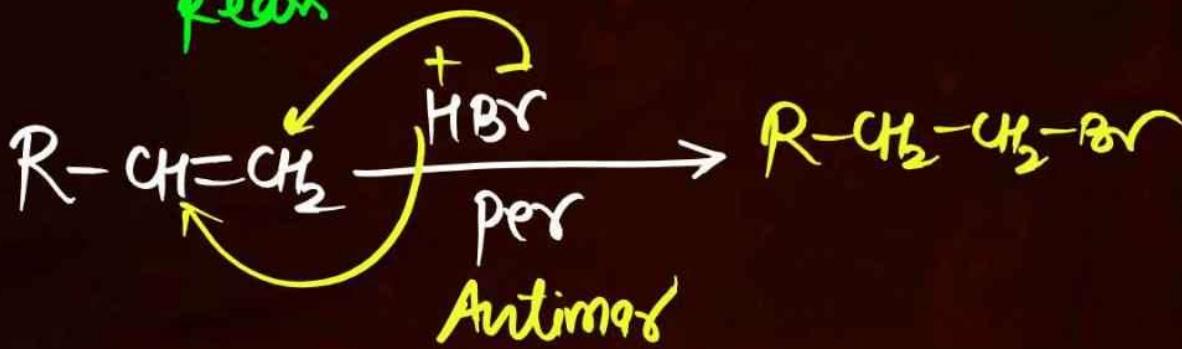
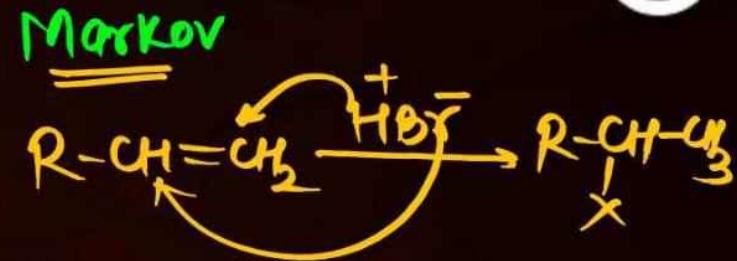
B. From Halogenation of Alkenes:



C. From Hydrohalogenation of Alkenes:

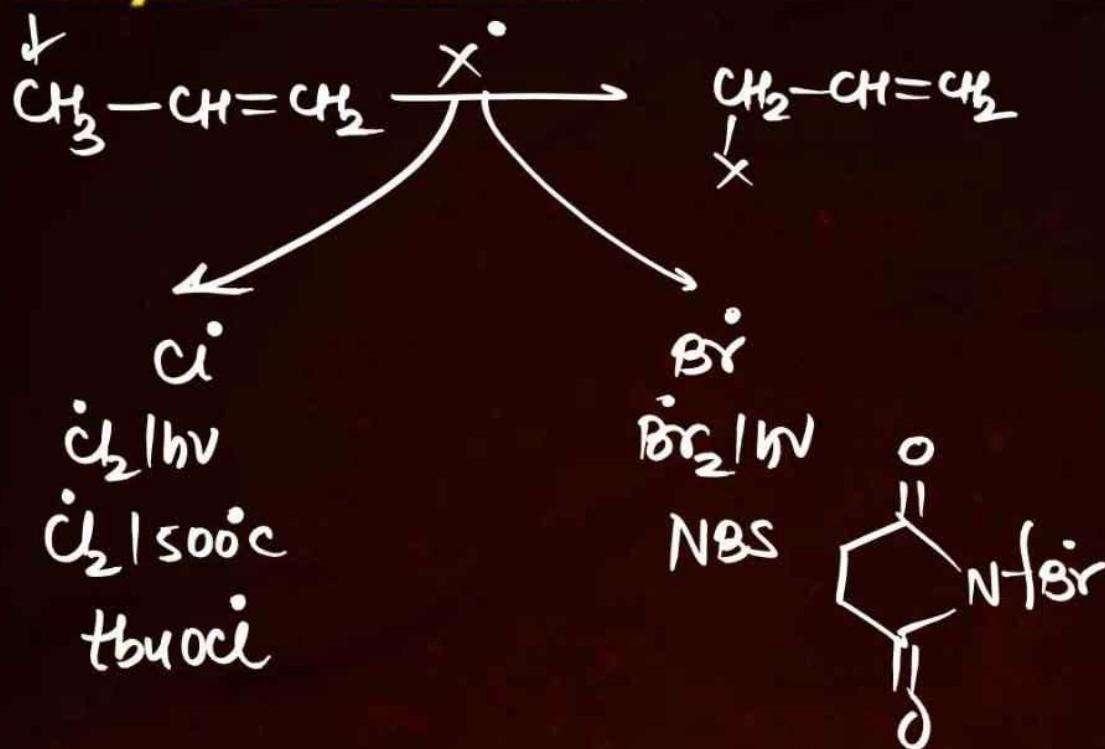


$\downarrow \text{H}^+$
 $R-\overset{+}{\text{CH}}-\text{CH}_3$
rear

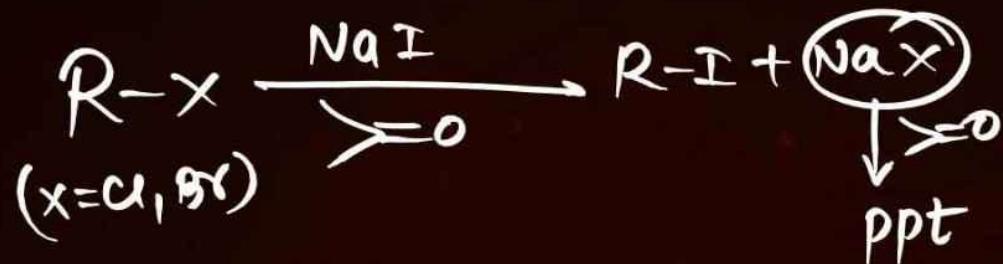


Antim.

4. Allylic & Benzylic Substitution



4. From Halogen Exchange: A. Finkelstein reaction

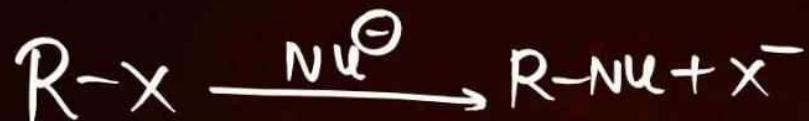


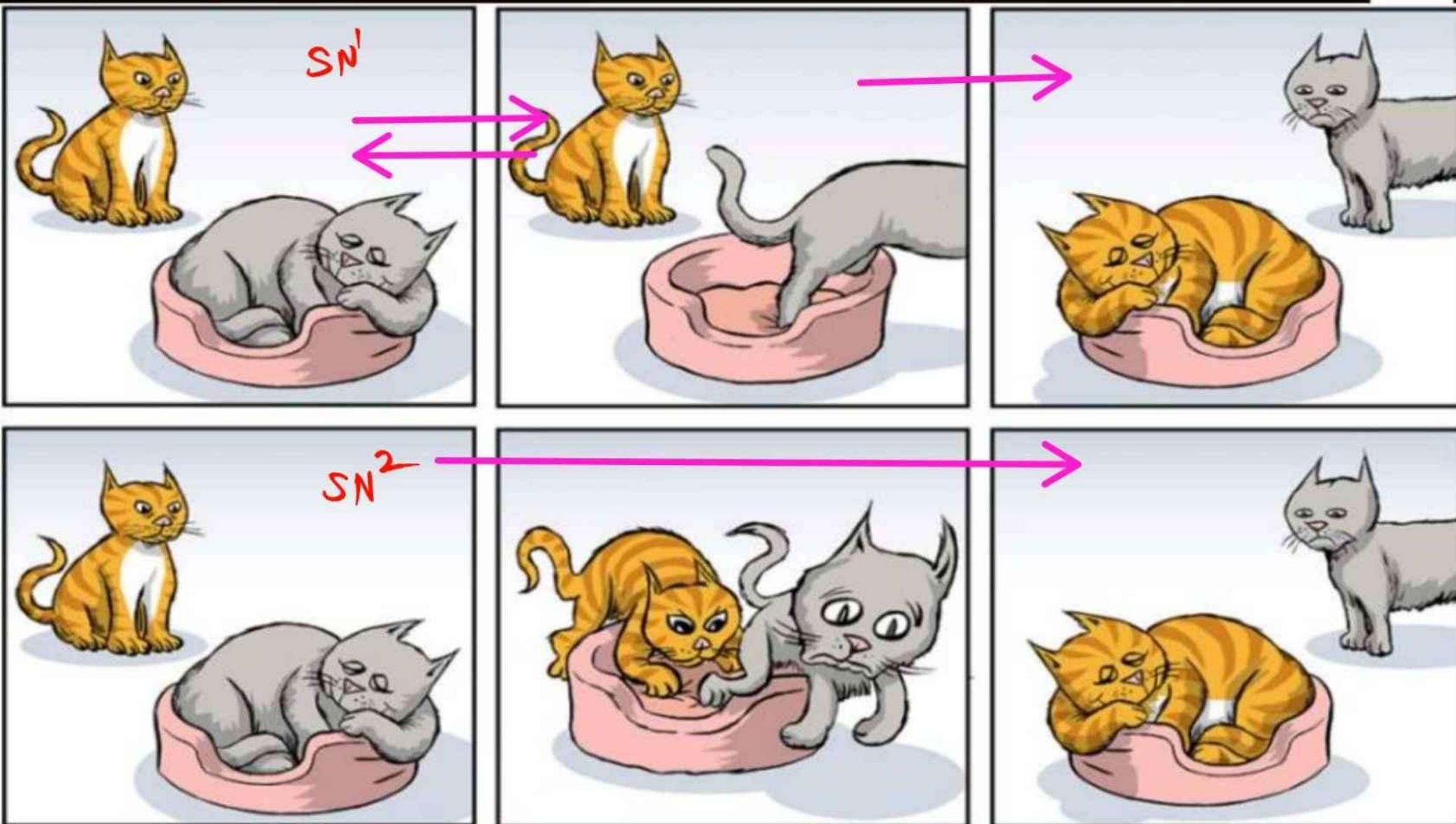
B. Swarts reaction



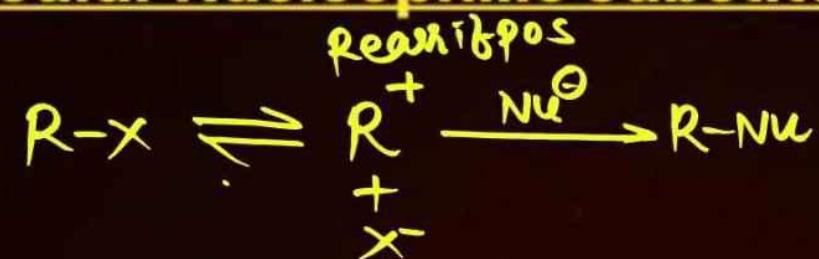
Chemical Properties of Haloalkanes

1. Nucleophilic Substitution Reactions:

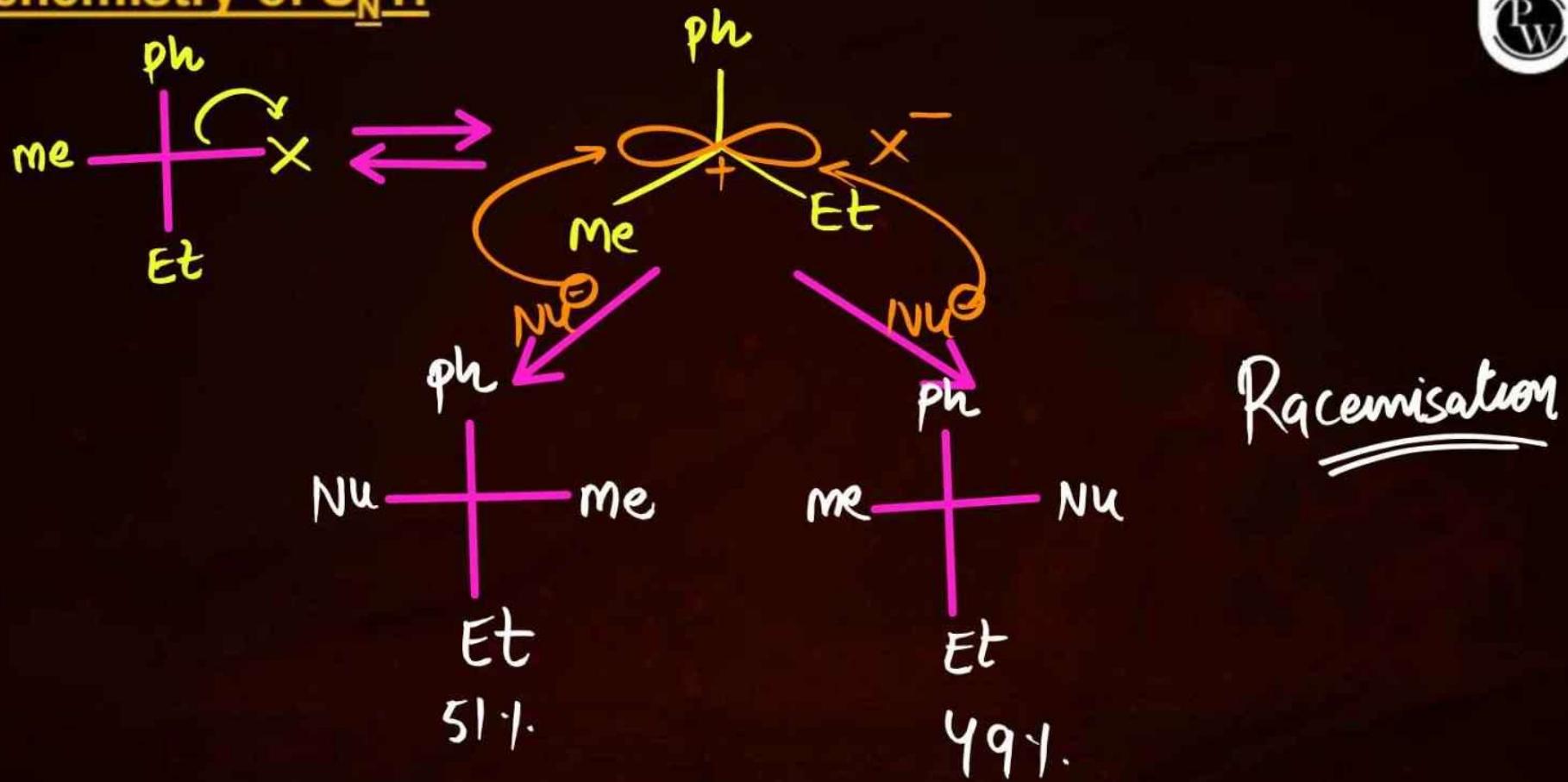




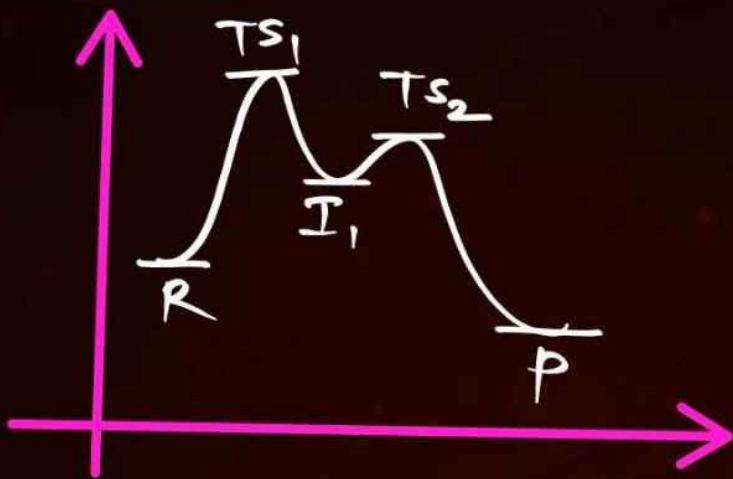
A. Unimolecular Nucleophilic Substitution Reaction S_N1:



Stereochemistry of S_N1:



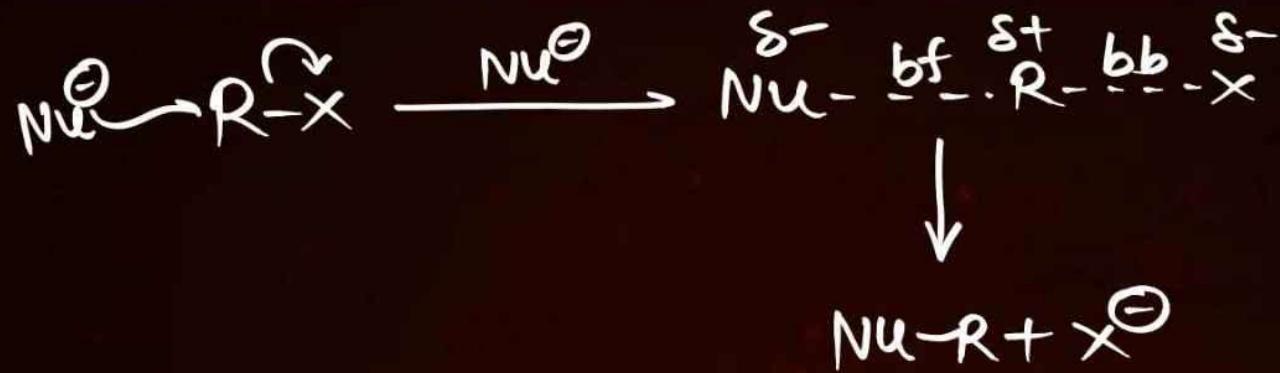
Energy Profile Diagram:



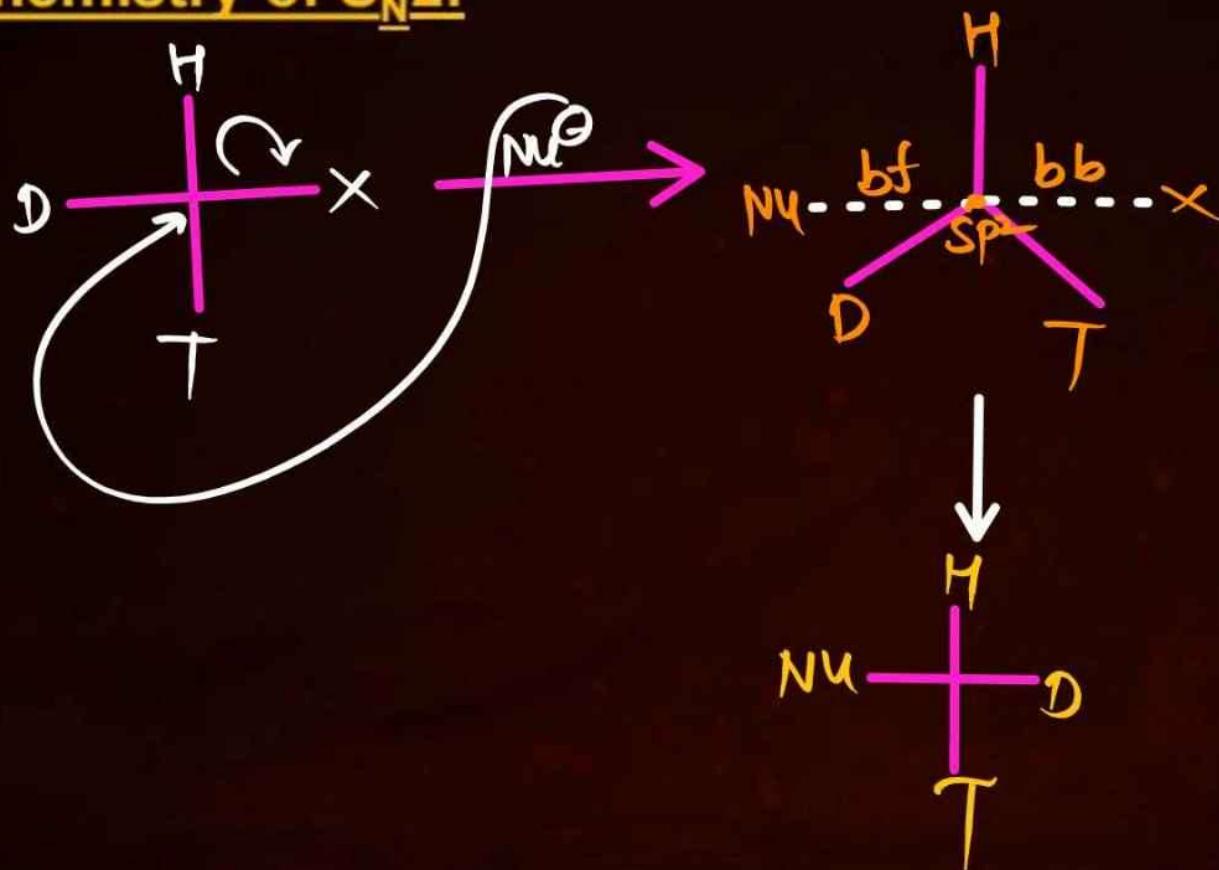
OP Points of S_N1:

1. Usually two step reaction & Carbocation intermediate formation
2. 1st step is the R.D.S (slow step)
3. R.O.R w.r.t. Halogen $R - F < R - Cl < R - Br < R - I$
R.O.R w.r.t. Alkyl ROR \propto Stability of 1st carbocation
4. Rate r = k[R-X]¹
5. Order = 1 & Molecularity = 1
6. PPS (Polar Protic Solvent)
7. Weak nucleophile
8. Incomplete Racemization occurs (more inversion & less retention)
Retention < Inversion
49% 51%

B. Bimolecular Nucleophilic Substitution Reaction S_N2:

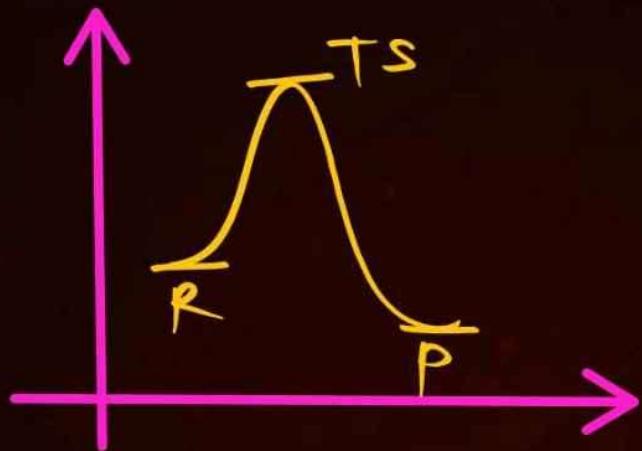


Stereochemistry of S_N2:



$$\frac{100\% \text{ Inv}}{\text{Walden Inv}}$$

Energy Profile Diagram:



OP Points of S_N2:

1. One step Reaction & Transition state formation

2. 1st step is the R.D.S (slow step)

3. R.O.R w.r.t. Halogen R - F < R - Cl < R - Br < R - I

R.O.R w.r.t. Alkyl ROR $\propto \frac{1}{S.H}$ (S.H = Steric Hindrance) ($1^\circ > 2^\circ > 3^\circ$)

4. Rate $r = k[R-X]^1 [Nu^-]^1$

α ewg α 1/edg

5. Order = 2 & Molecularity = 2

6. PAS (Polar Aprotic Solvent)

7. Strong nucleophile

8. Inversion (Walden Inversion), Stereo specific reaction

Effect of Solvent:

PPS

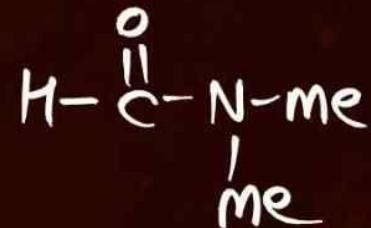
O se H juda ho

R OH H₂O

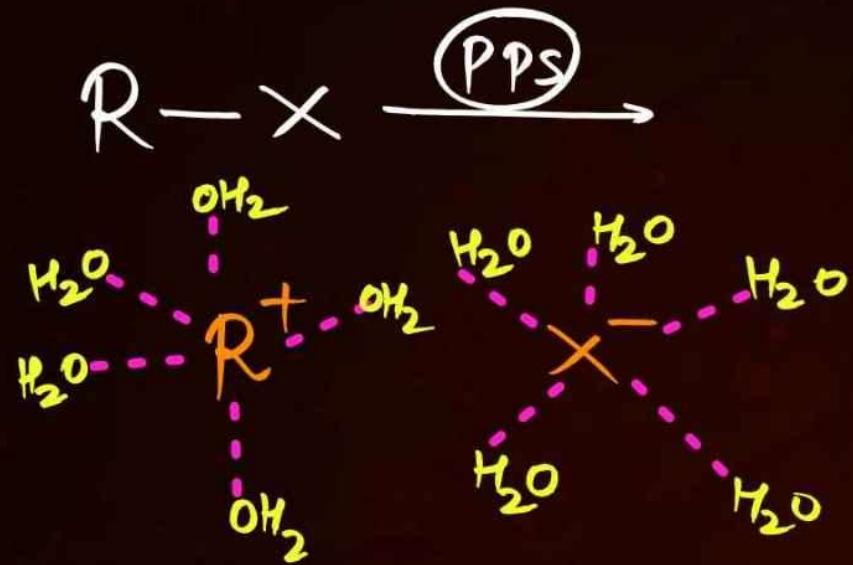
RCOOH

PAS

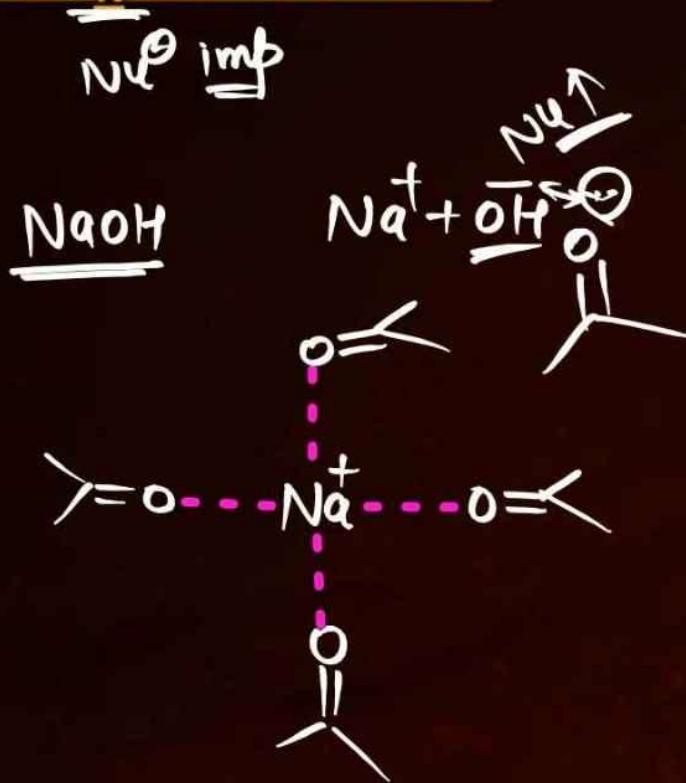
O se H na jyda ho



PPS favours S_N1 Reactions:



PAS favours S_N2 Reactions:



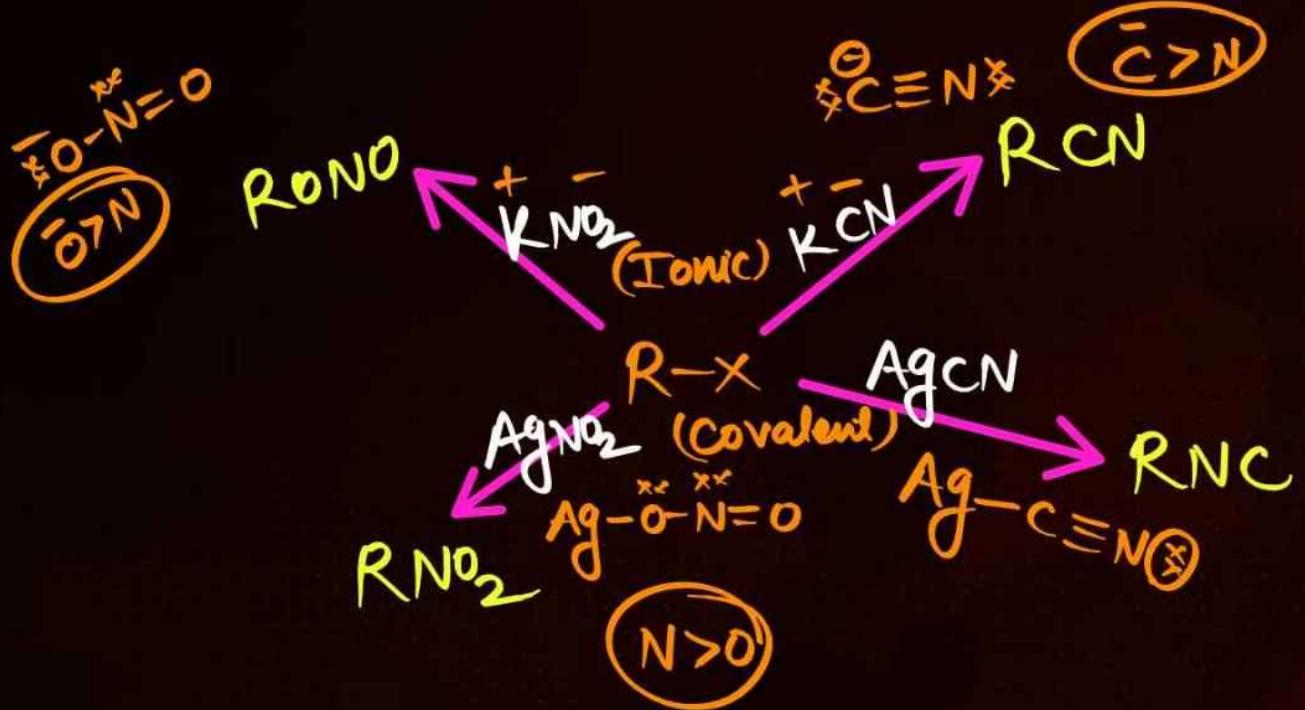
Compounds which do not show S_N1 & S_N2:



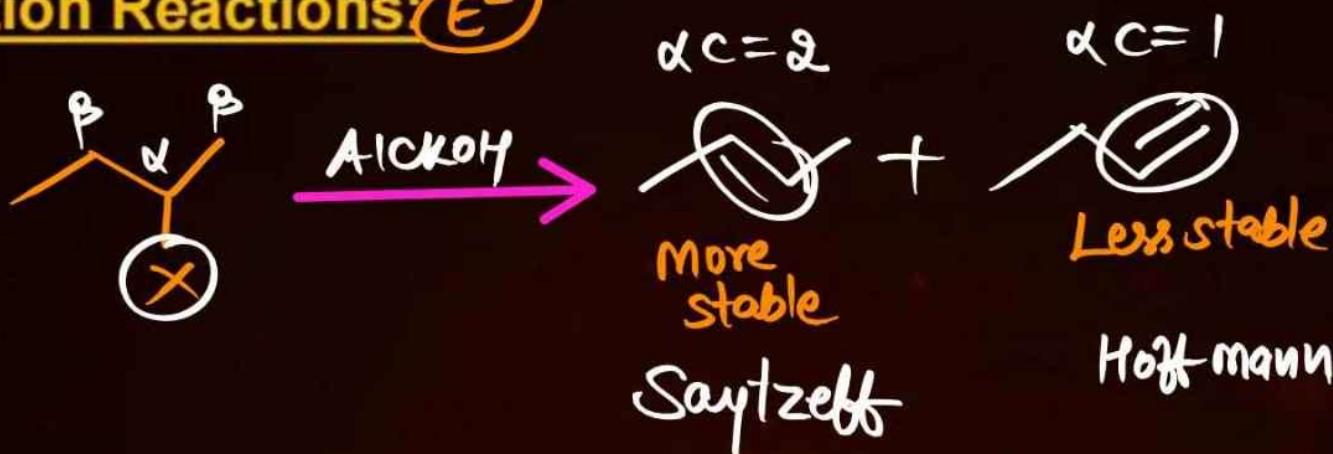
Bredt's rule



Reagent	Nucleophile (Nu ⁻)	Substitution product R-Nu	Class of main product
$NaOH (KOH)$	HO^-	ROH	Alcohol
H_2O	H_2O	ROH	Alcohol
$NaOR'$	$R'O^-$	ROR'	Ether
NaI	I^-	$R-I$	Alkyl iodide
NH_3	NH_3	RNH_2	Primary amine
$R'NH_2$	$R'NH_2$	$RNR'R'$	Sec. amine
$R'R''NH$	$R'R''NH$	$RNR'R''$	Tert. amine
KCN	$\bar{C}\equiv N:$	RCN	Nitrile (cyanide)
$AgCN$	$Ag-CN:$	RNC (isocyanide)	Isonitrile
KNO_2	$O=N-O$	$R-O-N=O$	Alkyl nitrite
$AgNO_2$	$Ag-\ddot{O}-N=O$	$R-NO_2$	Nitroalkane
$R'COOAg$	$R'COO^-$	$R'COOR$	Ester
$LiAlH_4$	H	RH	Hydrocarbon
$R^- M^+$	R'^-	RR'	Alkane



2. Elimination Reactions: E^2



3. Reaction with metals:

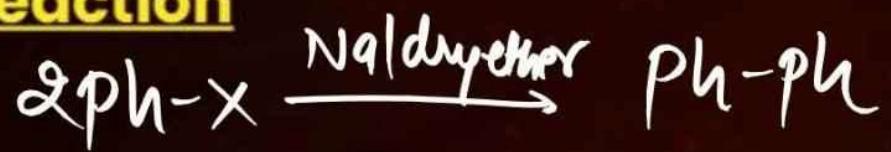
A. Wurtz Reaction:

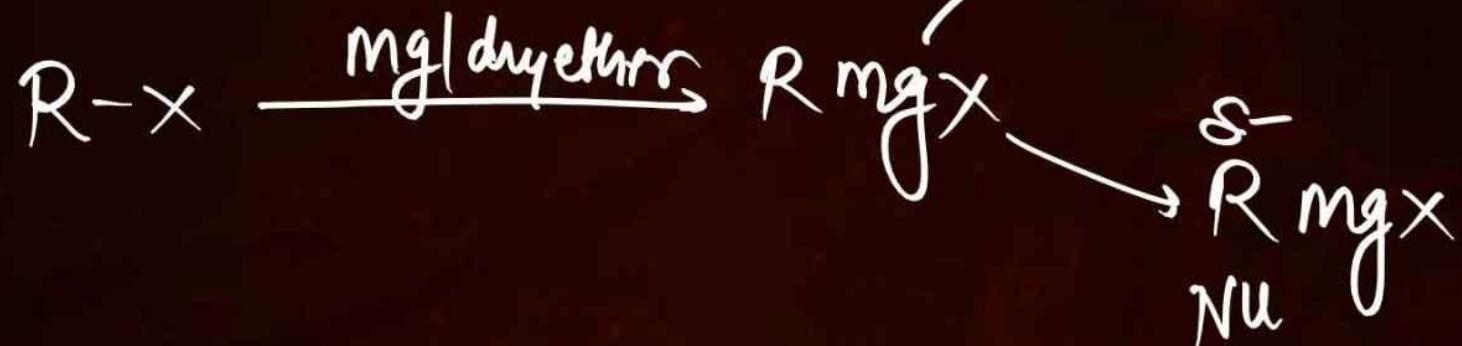


B. Wurtz-Fittig Reaction



C. Fittig Reaction



 Grignard Reagent

OP Points:

1. $\text{ROR} \longrightarrow \text{R}-\text{F} < \text{R}-\text{Cl} < \text{R}-\text{Br} < \text{R}-\text{I}$ ✓
2. In moist condition, alkane will be formed. ✓



3. Grignard Reagent is an Organometallic compound.
4. Dry ether stabilizes G.R & decreases the reactivity of G.R.





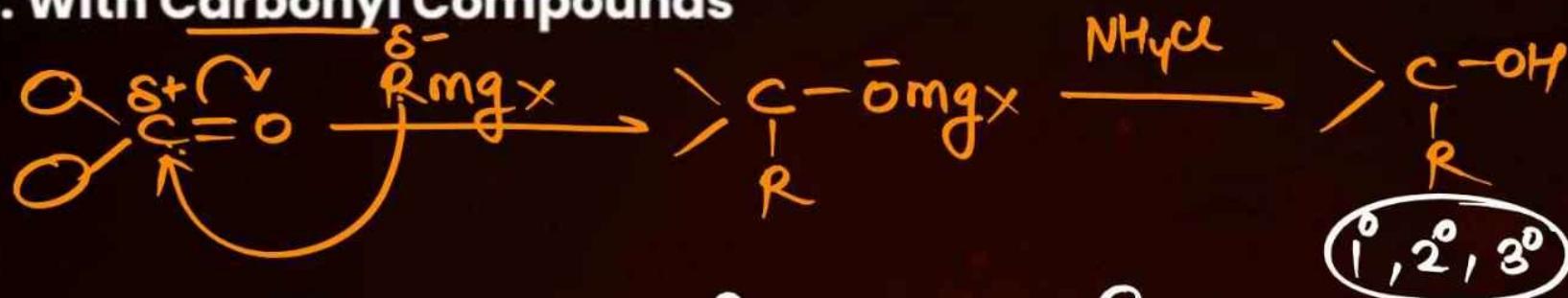
Chemical Reactions of Grignard Reagent

1. Acid base reactions or Zerewitinoff's reactions:



2. Nucleophilic Addition Reaction:

1. With Carbonyl Compounds

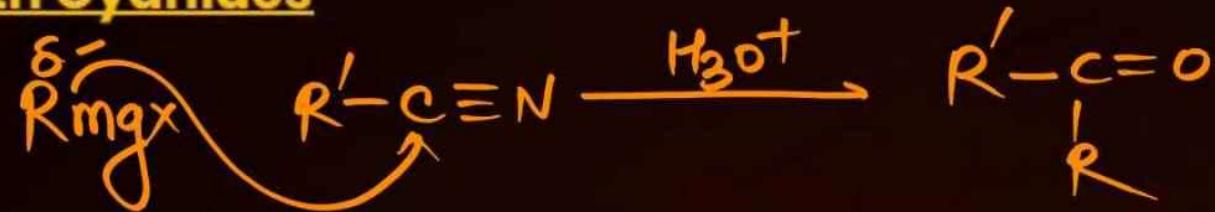


ROR in NAR ① $\text{ROR} \propto \frac{1}{\text{SH}}$ $\text{HCHO} > \text{RCHO} > \text{RCOR}$

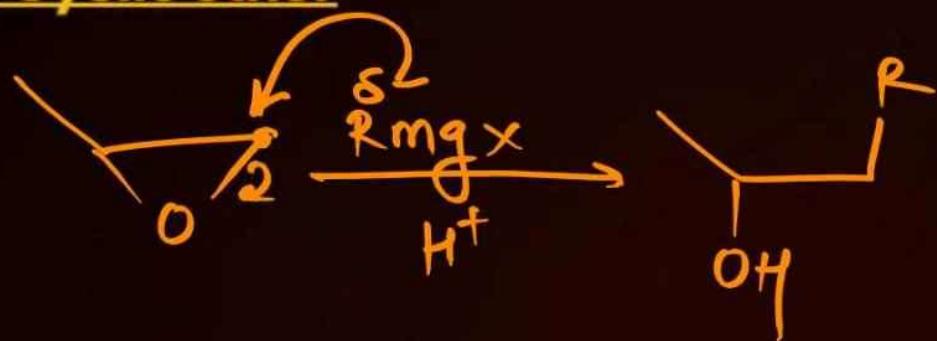
② $\text{ROR} \propto$ Electrophilicity, $\alpha - \text{M}, -\text{H}, -\text{I}$ $\text{HCHO} > \text{RCHO} > \text{RCOR}$

$\alpha \propto \frac{1}{-\text{M}, -\text{H}, -\text{I}}$

2. With Cyanides



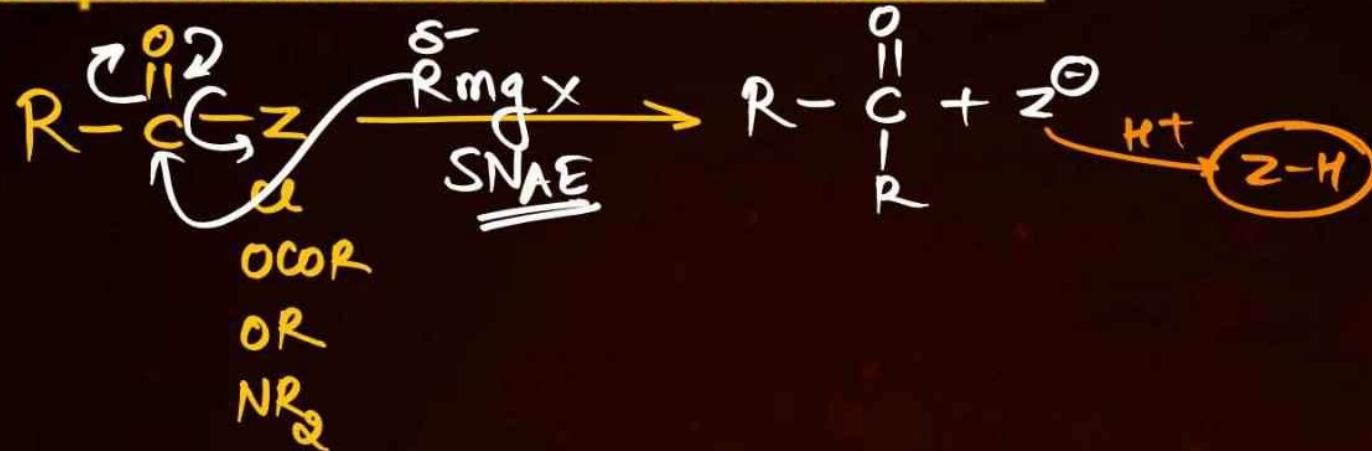
3. With Cyclic ether



OP Points:

1. Acyclic ether does not react with G.R.
2. 3 and 4 membered cyclic ether can react with G.R.
3. 5 membered and beyond do not react with G.R.

3. Nucleophilic Addition Elimination Reaction



OCOR

OR

NR₂

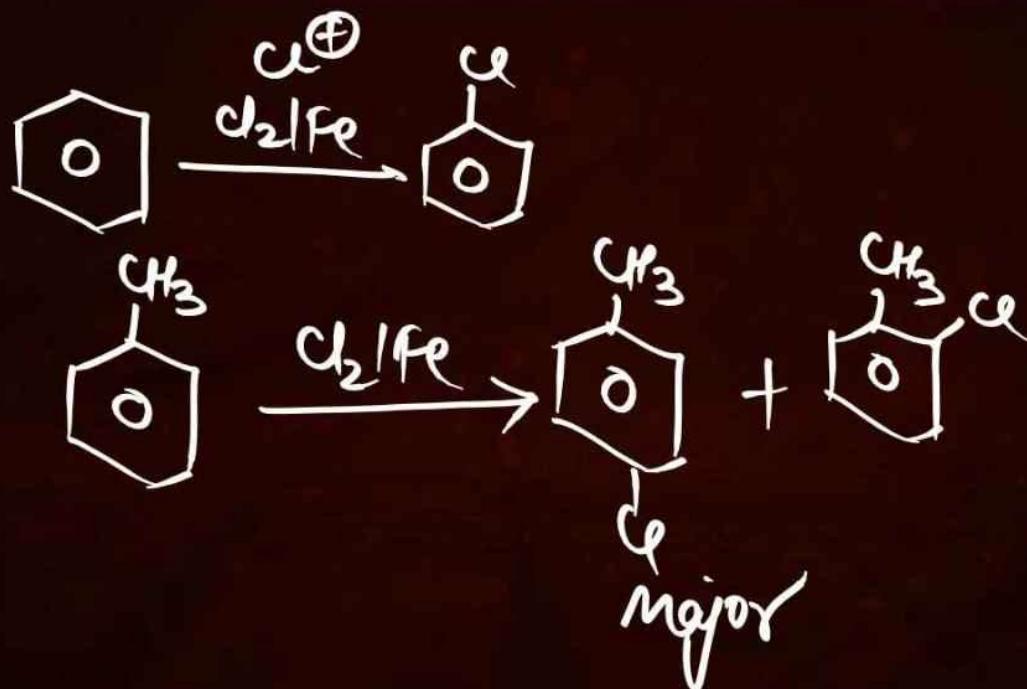
leaving ability strong carboxylic acid better L.G

RCOCl > RCOOCOR > RCOOR > RCONR₂

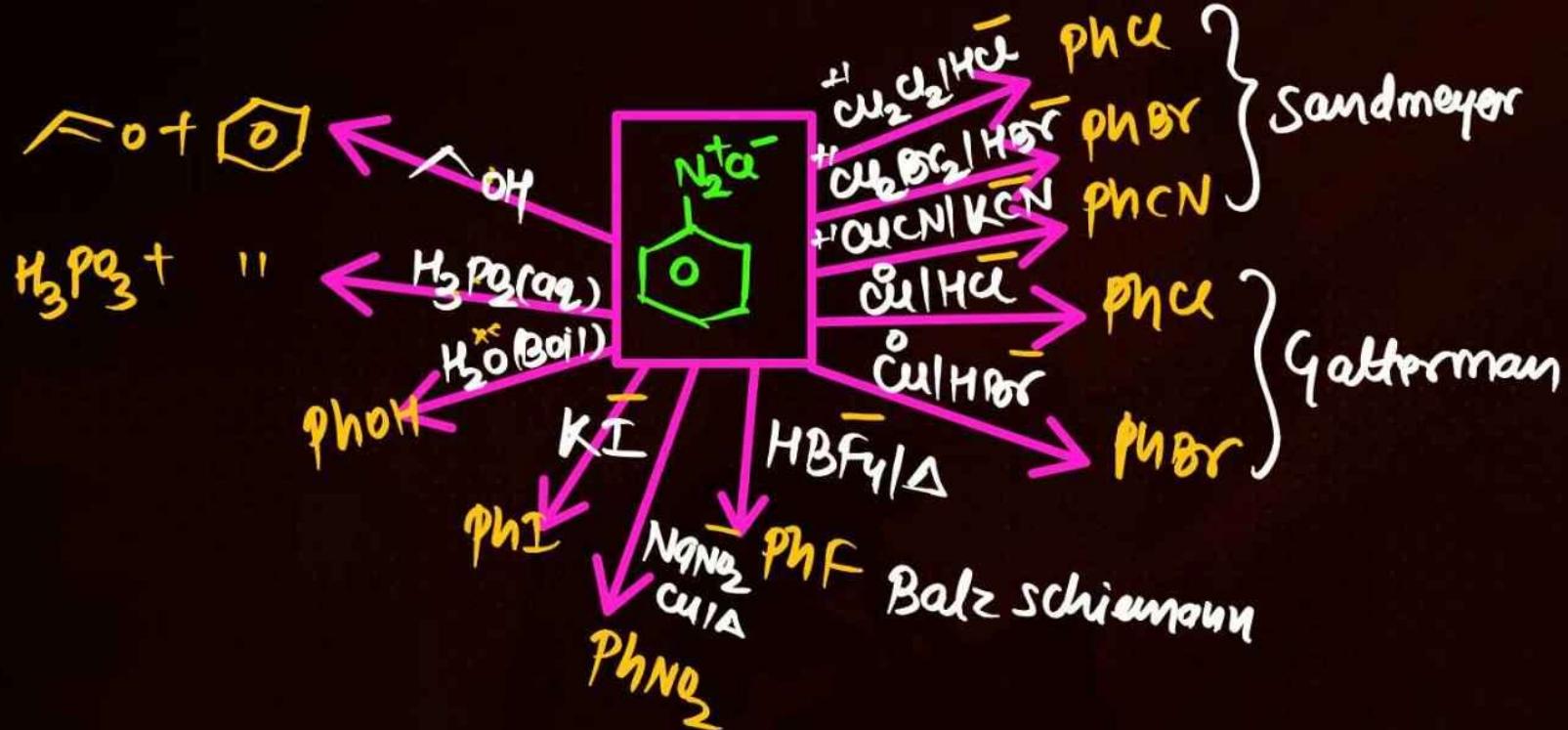
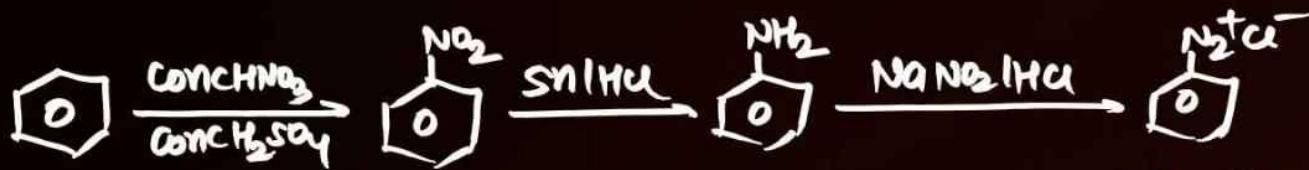


Methods of Preparation of Haloarenes

1. From hydrocarbons by electrophilic substitution:



②

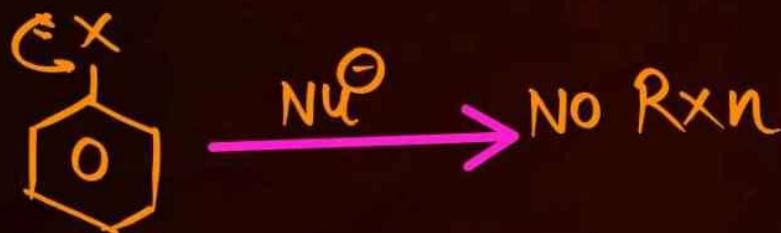




Chemical Properties of Haloarenes

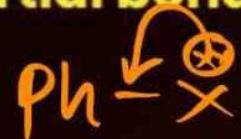
1. Nucleophilic Substitution Reactions:

Generally Aromatic N.S.R do not occurs why?



Reasons

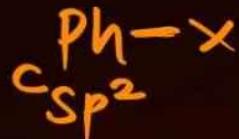
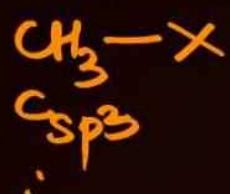
1. Due to partial bond character b/w C and X



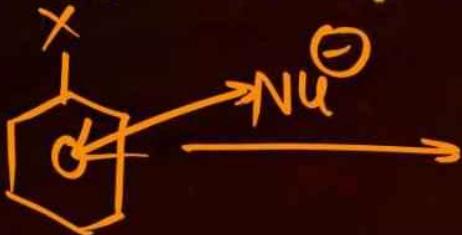
2. Due to instability of phenyl cations



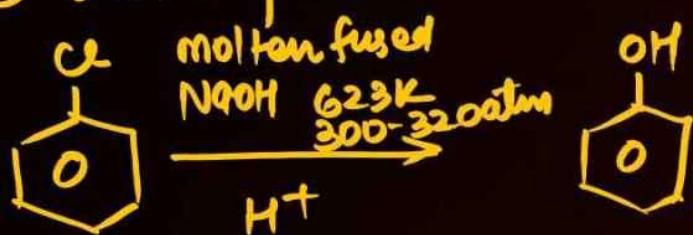
3. Due to difference in hybridization of carbon of C-X bond



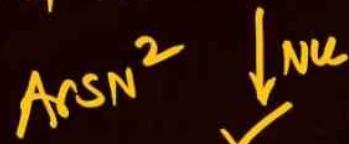
4. Due to repulsion b/w Nucleophile and electron rich haloarenes



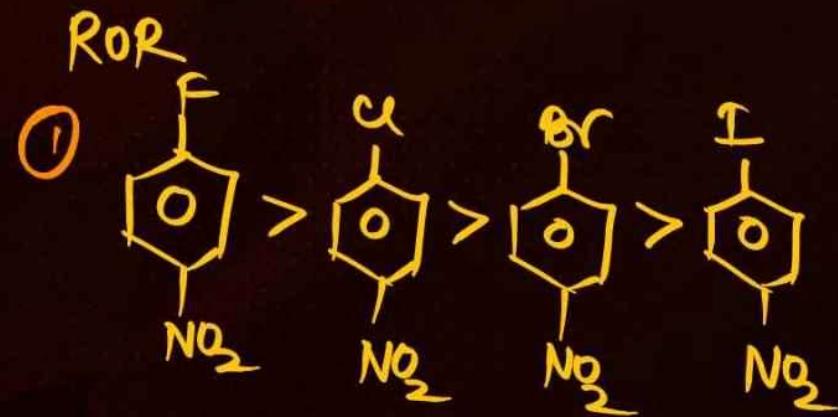
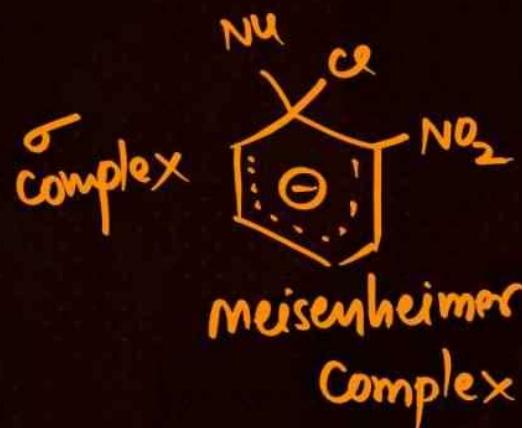
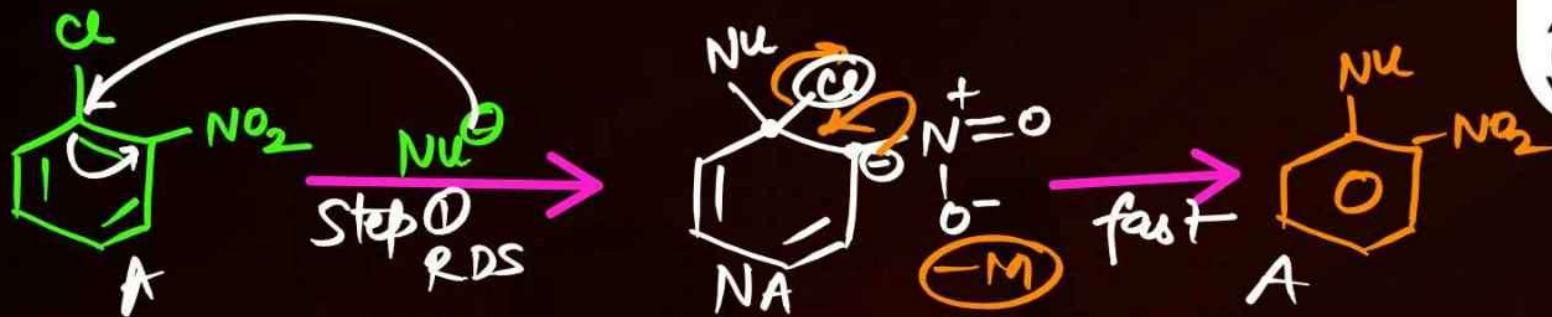
① Dow's process



② OIP nitro halobenzene



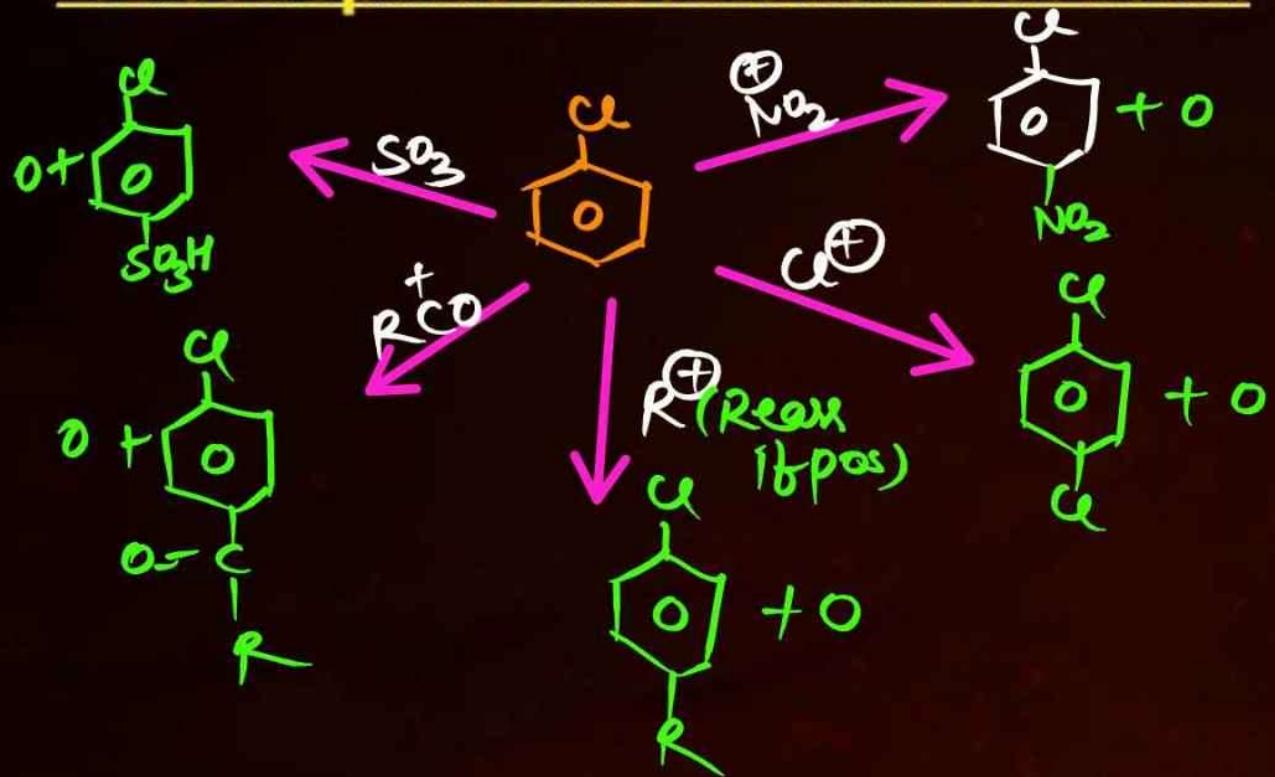
ArSN^2
mech



② ROR' & NO₂ group o/p



2. Electrophilic Substitution reactions: Always 1 major



QUESTION (JEE Mains 1st Feb 2024, Morning Shift)



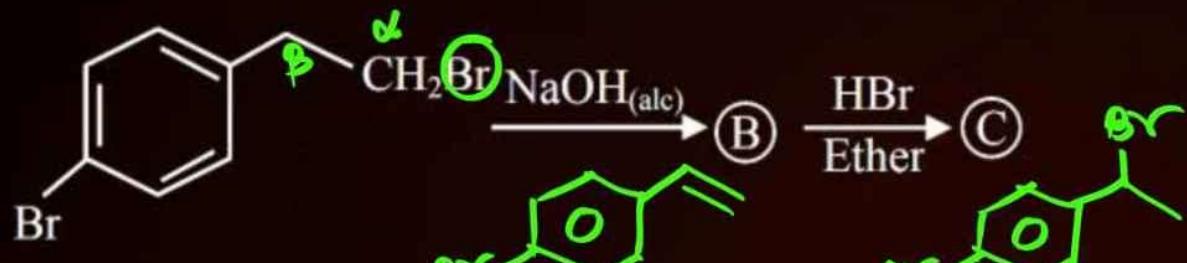
Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): Haloalkanes react with KCN to form alkyl cyanides as a main product while with AgCN form isocyanide as the main product.

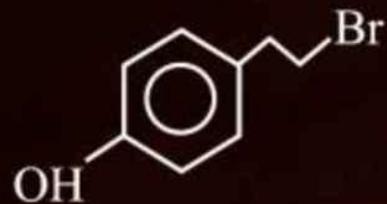
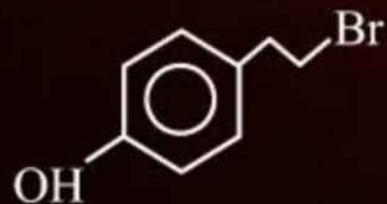
Reason (R): KCN and AgCN both are highly ionic compounds.

In the light of the above statement, choose the most appropriate answer from the options given below:

- A** (A) is correct but (R) is not correct.
- B** Both (A) and (R) are correct but (R) is not the correct explanation of (A).
- C** (A) is not correct but (R) is correct.
- D** Both (A) and (R) are correct and (R) is the correct explanation of (A).

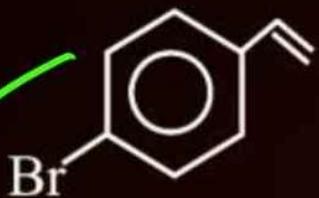
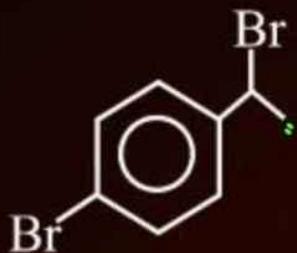
QUESTION (JEE Mains 4th April 2024, Morning Shift)

Identify (B) and (C) and how are (A) and (C) related?

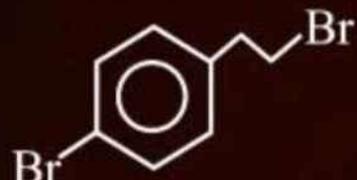
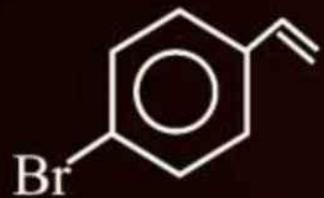
(B)**(C)****A****B**

Functional group isomers

Derivative

(B)**(C)**

Position isomers

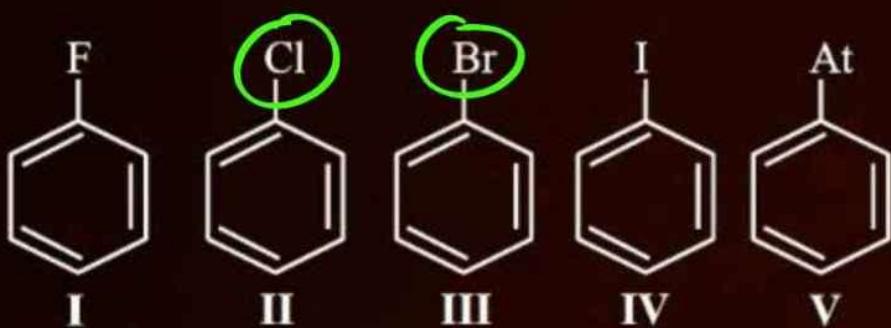
D

Chain isomers

QUESTION (JEE Mains 5th April 2024, Morning Shift)

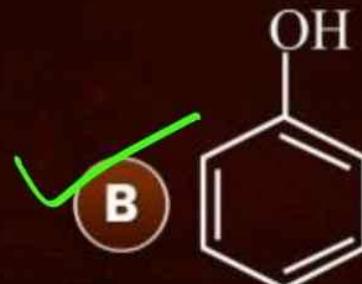
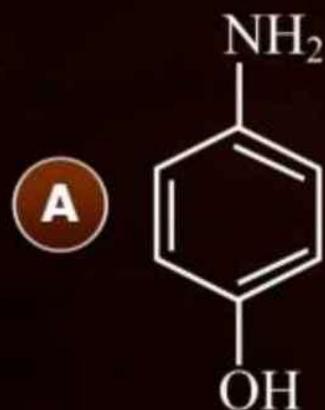
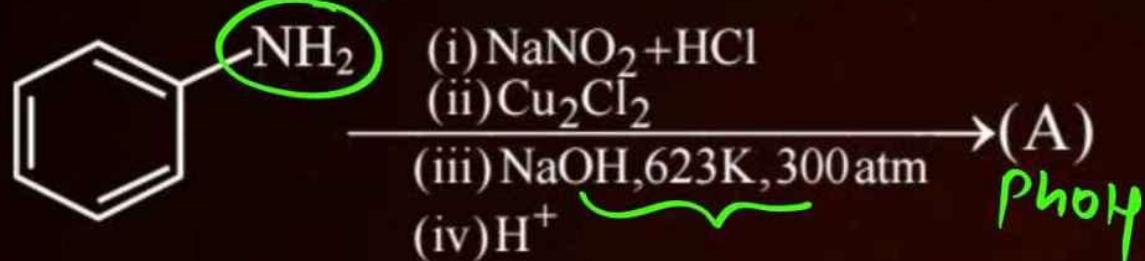


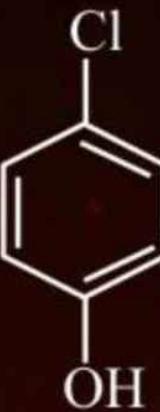
The number of halobenzenes from the following that can be prepared by Sandmeyer's reaction is ... 2



QUESTION (JEE Mains 6th April 2024, Evening Shift)

Identify the product (A) in the following reaction.





QUESTION (JEE Mains 8th April 2024, Evening Shift)



Given below are two statements:

Statement (I): S_N2 reactions are 'stereospecific', indicating that they result in the formation only one stereo-isomers as the product.

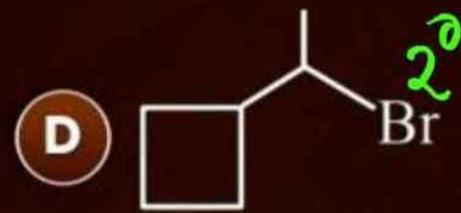
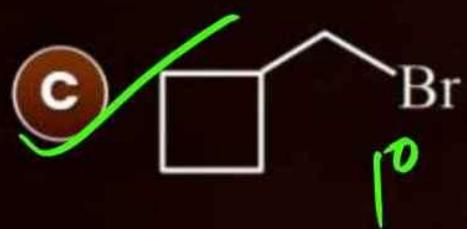
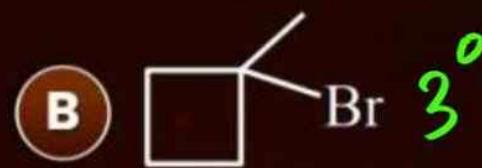
Statement (II): S_N1 reactions generally result in formation of product as racemic mixtures. In the light of the above statements, choose the correct answer from the options given below:

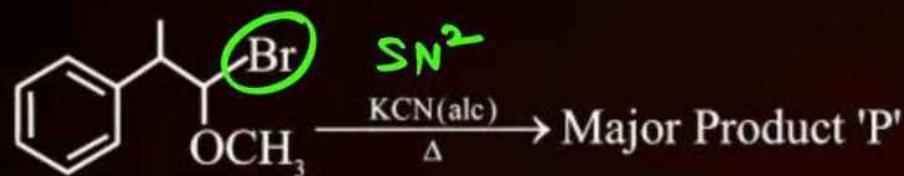
- A Statement I is true but Statement II is false.
- B Statement I is false but Statement II is true.
- C Both Statement I and Statement II is true.
- D Both Statement I and Statement II is false.

QUESTION (JEE Mains 8th April 2024, Morning Shift)

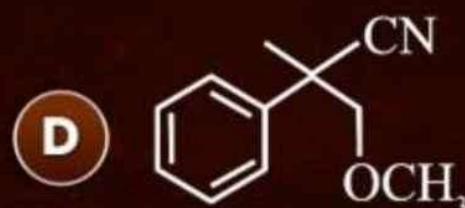
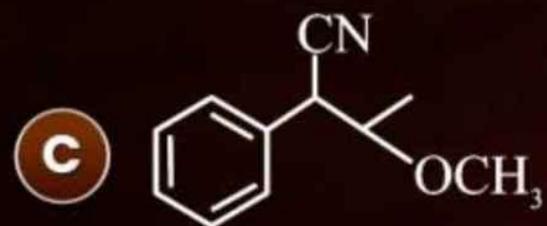
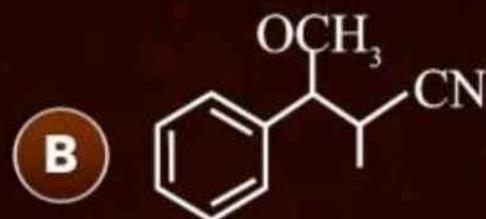
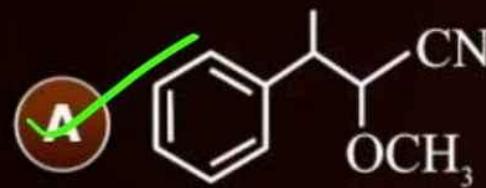


Which among the following compounds will undergo fastest S_N2 reaction?



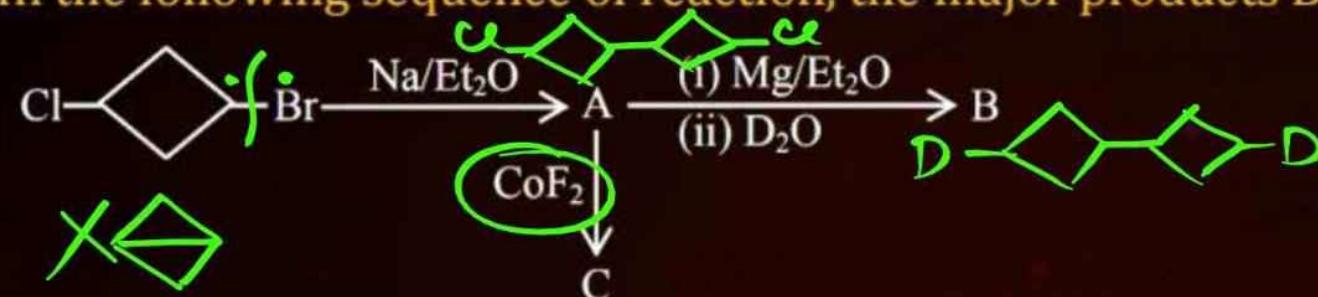
QUESTION (JEE Mains 9th April 2024, Evening Shift)

In the above reaction product 'P' is:



QUESTION (JEE Mains 9th April 2024, Morning Shift)

In the following sequence of reaction, the major products B and C respectively are:



- A** and
- B** and
- C** and
- D** and

QUESTION (JEE Mains 9th April 2024, Morning Shift)



Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R):

Assertion (A): S_N2 reaction of $C_6H_5CH_2Br$ occurs more readily than the S_N2 reaction of CH_3CH_2Br .

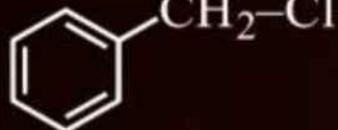
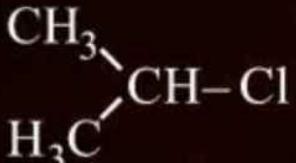
Reason (R): The partially bonded unhybridized p-orbital that develops in the trigonal bipyramidal transition state is stabilized by conjugation with the phenyl ring.

In the light of the above statements, choose the most appropriate answer from the options given below:

- A** (A) is not correct but (R) is correct.
- B** Both (A) and (R) are correct but (R) is not the correct explanation of (A).
- C** Both (A) and (R) are correct and (R) is the correct explanation of (A). 
- D** (A) is correct but (R) is not correct.

QUESTION (JEE Mains 27th January 2024, Evening Shift)

Which among the following halide/s will not show S_N1 reaction:

- A. $H_2C = CH - CH_2Cl$
- B. $CH_3 - CH = CH - Cl$ 
- C. 
- D. 

Choose the **most appropriate** answer from the options given below:

- A** (A), (B) and (D) only
- C** (B) and (C) only

- B** (A) and (B) only
- D** (B) only



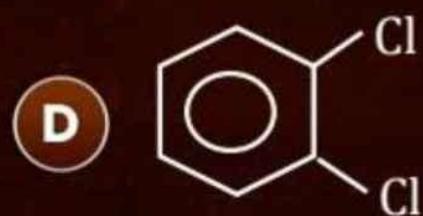
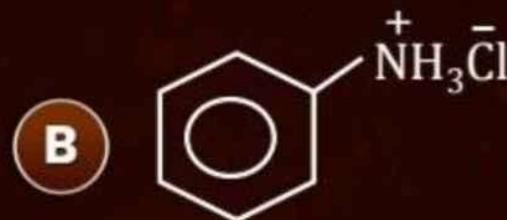
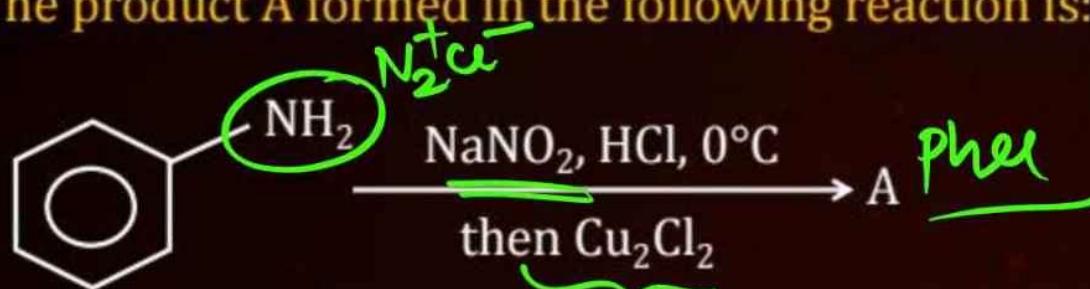
QUESTION (JEE Mains 27th January 2024, Morning Shift)

The correct statement regarding nucleophilic substitution reaction in a chiral alkyl halide is:

- A Retention occurs in S_N1 reaction and inversion occurs in S_N2 reaction.
- B Racemisation occurs in S_N1 reaction and retention occurs in S_N2 reaction.
- C Racemisation occurs in both S_N1 and S_N2 reactions.
- D Racemisation occurs in S_N1 reaction and inversion occurs in S_N2 reaction.

QUESTION (JEE Mains 29 January 2024, Evening Shift)

The product A formed in the following reaction is:



QUESTION (JEE Mains 30 January 2024, Evening Shift)



3°SN^1 1°SN^2
 2°SN^1 SN^2
weak Strong

Given below are two statements:

Statement-I: High concentration of strong nucleophilic reagent with secondary alkyl halides which do not have bulky substituents will follow S_N2 mechanism.

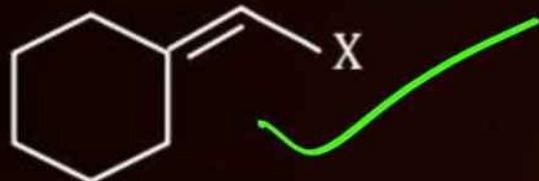
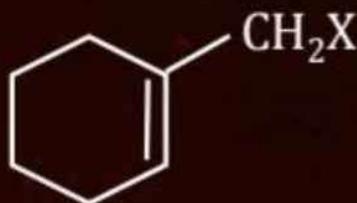
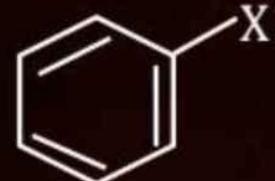
Statement-II: A secondary alkyl halide when treated with a large excess of ethanol follows S_N1 mechanism.

In the light of the above statements, choose the most appropriate from the questions given below:

- A Statement I is true but Statement II is false.
- B Statement I is false but Statement II is true.
- C Both statement I and Statement II are false.
- D Both statement I and Statement II are true.

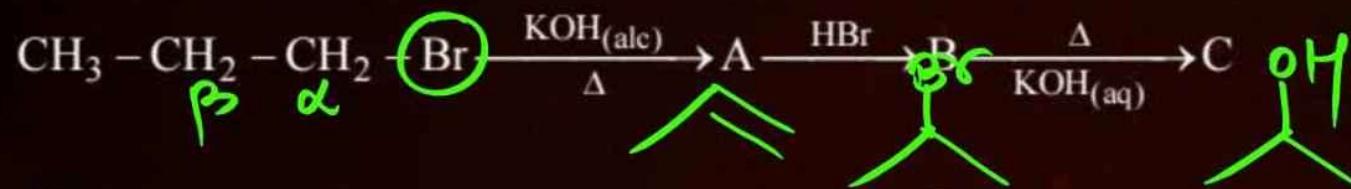
QUESTION (JEE Mains 30 January 2024, Morning Shift)

Example of vinylic halide is:

A**B****C****D**

QUESTION (JEE Mains 31 January 2024, Morning Shift)

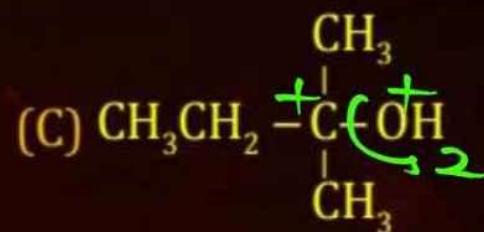
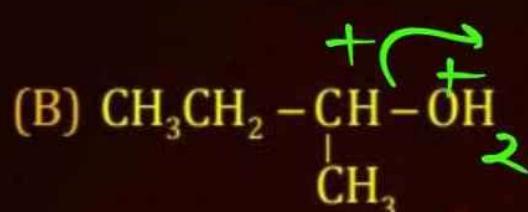
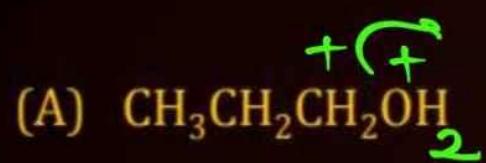
The product (C) in the below mentioned reaction is:



- A** Propan-1-ol
- B** Propene
- C** Propyne
- D** Propan-2-ol

QUESTION (NCERT Exemplar)

The order of reactivity of following alcohols with halogen acids is _____

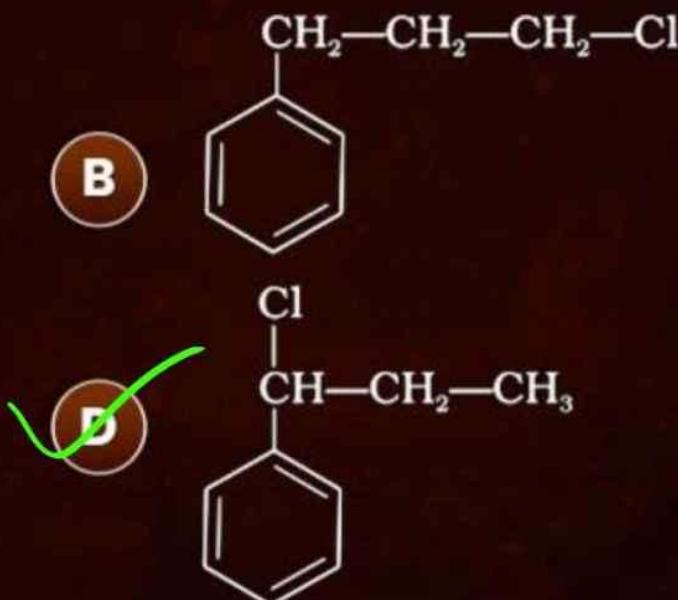
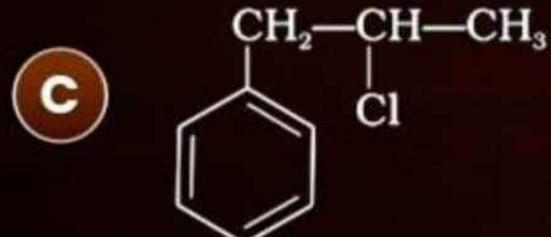
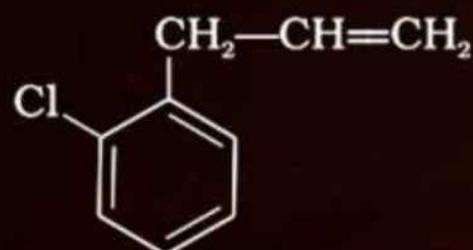
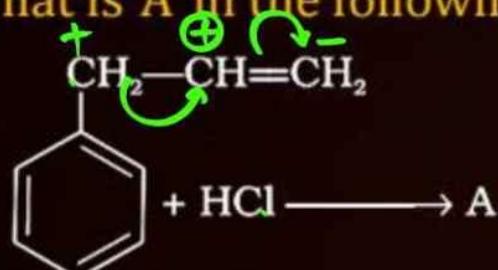


- A** (A) > (B) > (C)
- C** (B) > (A) > (C)

- B** (C) > (B) > (A)
- D** (A) > (C) > (B)

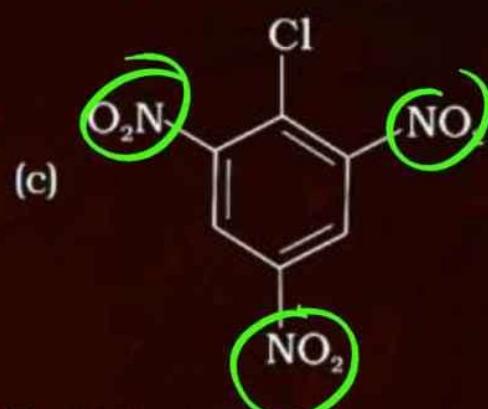
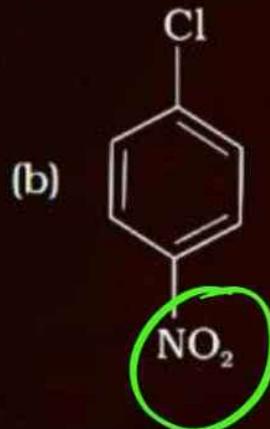
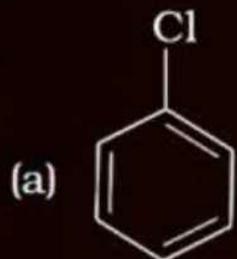
QUESTION (NCERT Exemplar)

What is 'A' in the following reaction?



QUESTION (NCERT Exemplar)

In the given question arrange the compounds in increasing order of rate of reaction towards nucleophilic substitution.



A (c) < (b) < (a)

B (b) < (c) < (a)

C (a) < (c) < (b)

D (a) < (b) < (c)

QUESTION (NCERT Exemplar)



Assertion: Phosphorus chlorides (tri and penta) are preferred over thionyl chloride for the preparation of alkyl chlorides from alcohols.

Reason: Phosphorus chlorides give pure alkyl halides.

- A** Assertion and reason both are correct and reason is correct explanation of assertion.
- B** Assertion and reason both are wrong statements
- C** Assertion is correct but reason is wrong statements
- D** Assertion is wrong but reason is correct statement.

QUESTION (NCERT Exemplar)

Assertion: KCN reacts with methyl chloride to give methyl ~~isocyanide~~.

Reason: CN^- is an ambident nucleophile.

- A** Assertion and reason both are correct and reason is correct explanation of assertion.
- B** Assertion and reason both are wrong statements.
- C** Assertion is correct but reason is wrong statement.
- D** Assertion is wrong but reason is correct statement.

QUESTION (NCERT Exemplar)

Assertion: Presence of a nitro group at ortho or para position increases the reactivity of haloarenes towards nucleophilic substitution.

Reason: Nitro group, being an electron withdrawing group decreases the electron density over the benzene ring.

- A** Assertion and reason both are correct and reason is correct explanation of assertion. ✓
- B** Assertion and reason both are wrong statements.
- C** Assertion is correct but reason is wrong statement.
- D** Assertion is wrong but reason is correct statement.



Alcohols,
Phenols
&
Ethers



Methods of Preparation of Alcohols

From Alkenes:

A. By Acid Catalyzed Hydration: H_3O^+ dil H_2SO_4

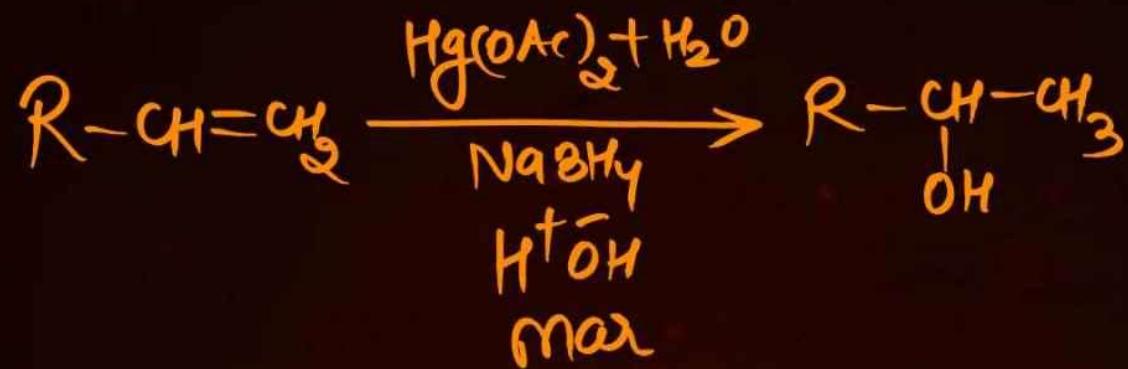


B. By Hydroboration-Oxidation (HBO):

OP Points:

1. 4 MCTS is formed.
2. ROR \propto Nucleophilicity of alkene
3. No rearrangement occurs
4. Product appears like addition of H₂O on alkene by Anti Markovnikov's Rule
5. Syn addition of BH₃

C. By Oxymercuration-Demercuration (OMDM):

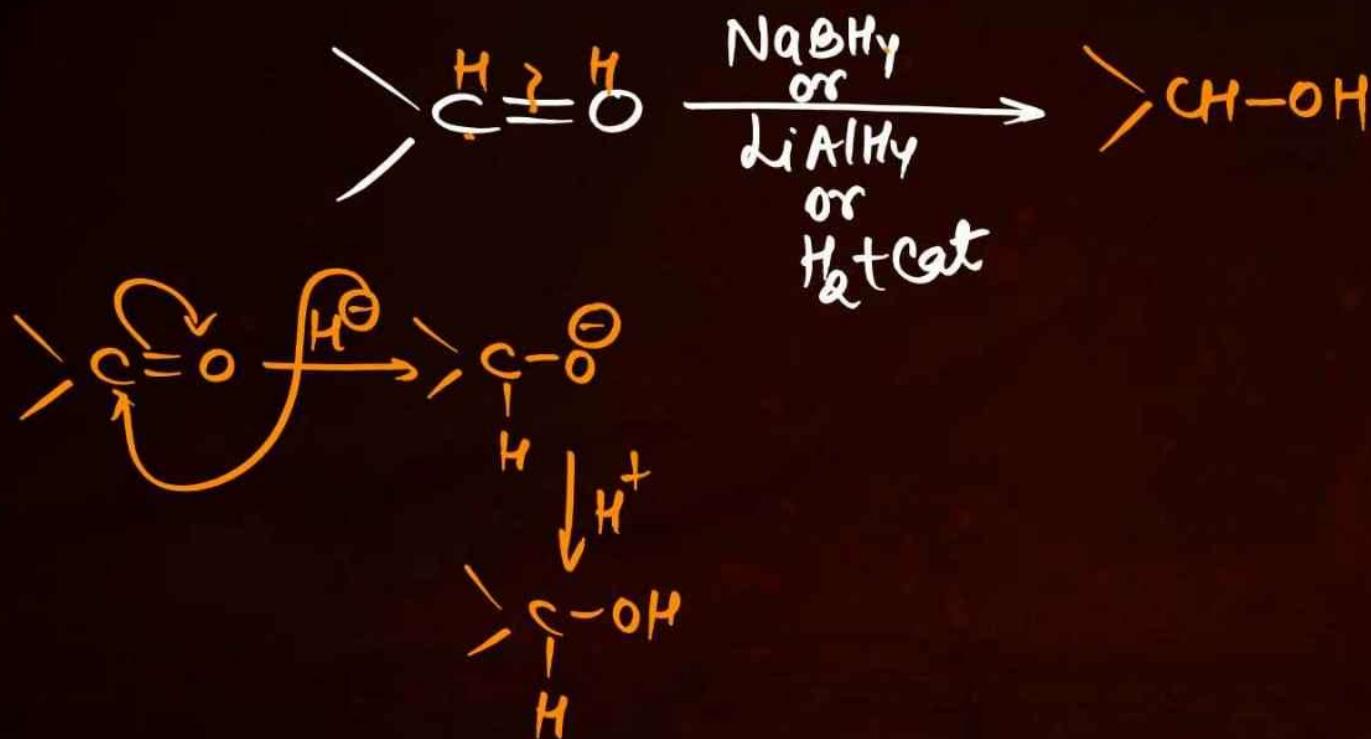


OP Points:

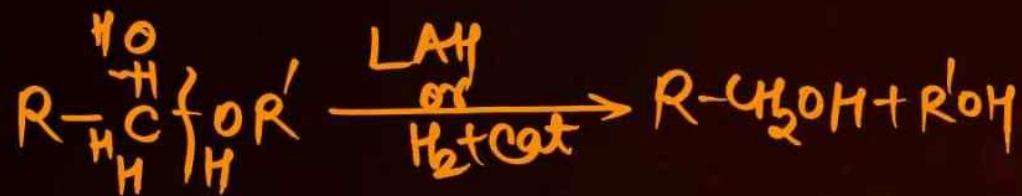
1. Non classical Carbocations formation is RDS.
2. ROR α Nucleophilicity of alkene α Stability of partial positive C
3. No rearrangement occurs
4. Cyclic mercuranium ion formation
5. Anti addition

2. Reduction reactions:

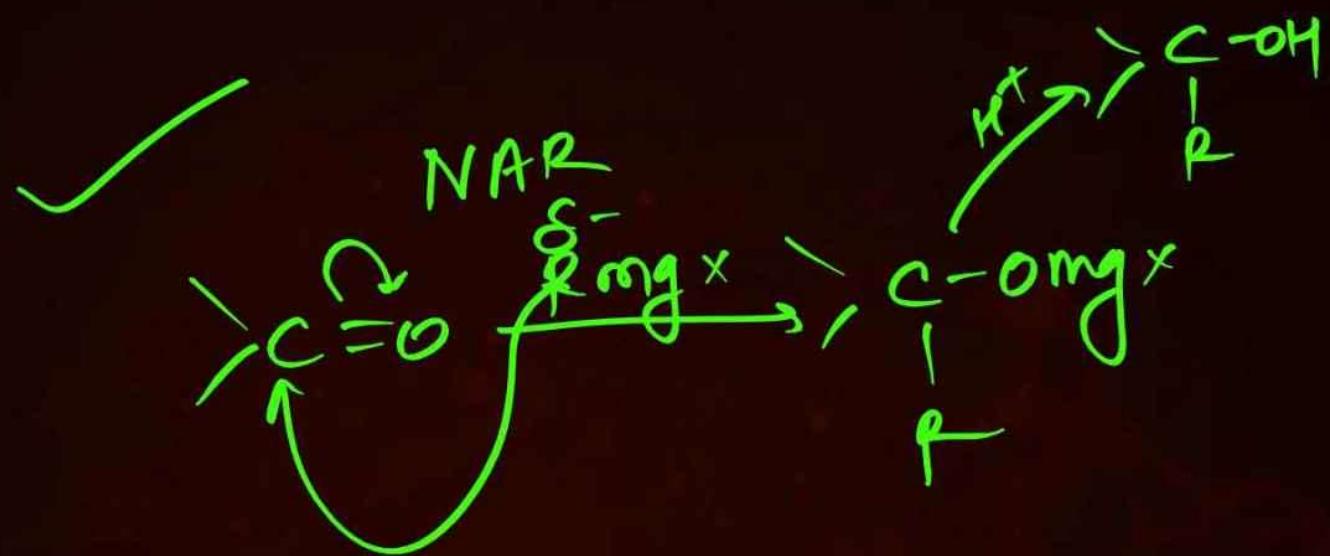
A. By reduction of carbonyl compounds:



B. By reduction of carboxylic acid, ester and Acid chlorides:



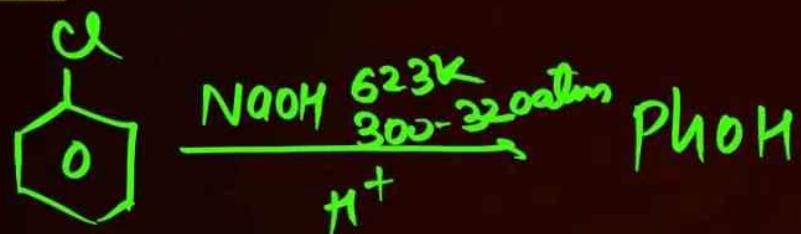
3. By Grignard Reagent:



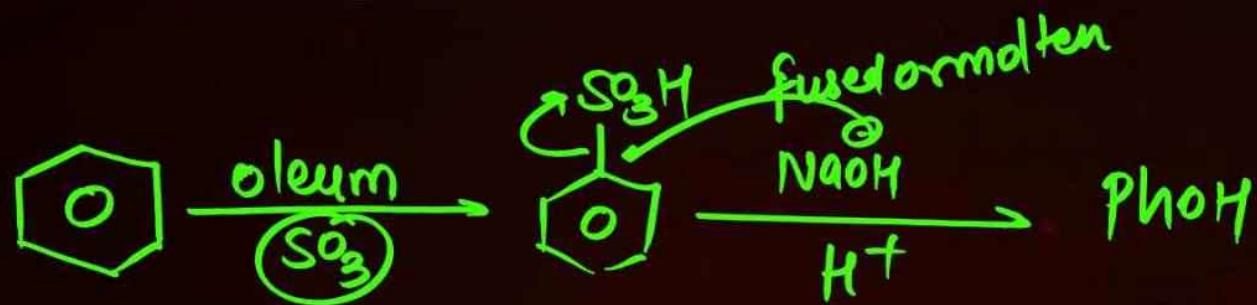


Methods of Preparation of Phenols

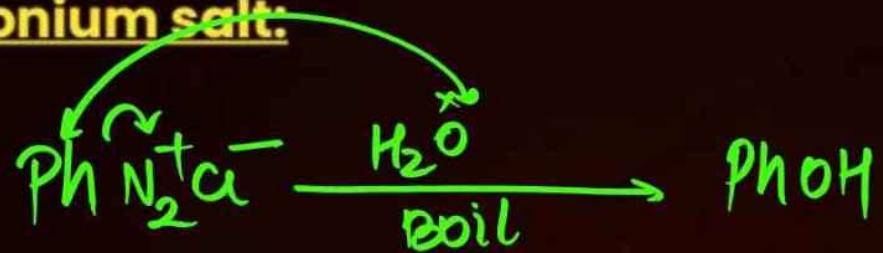
1. Dows Process:

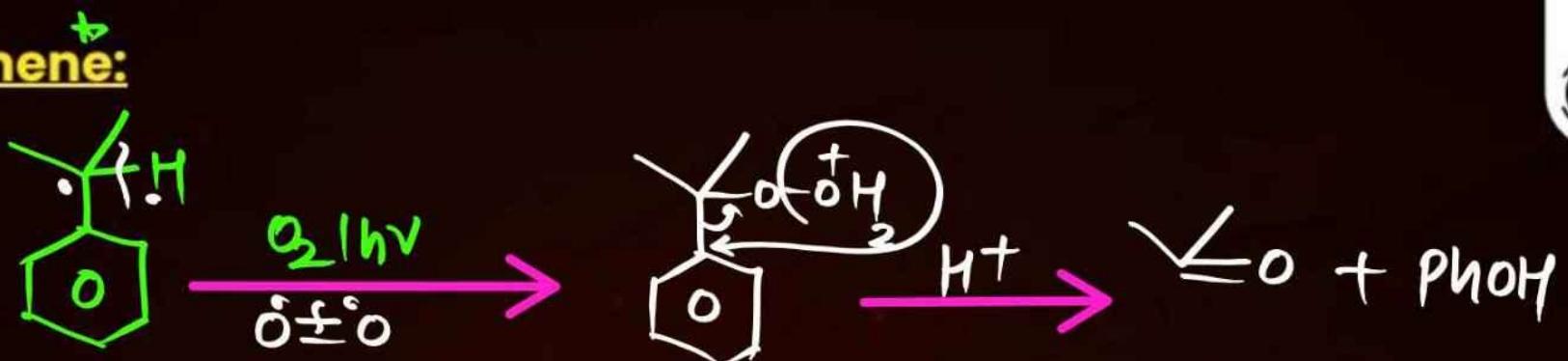


2. From Benzene Sulphonic Acid:



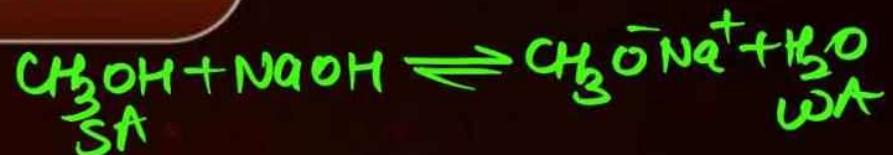
3. From Diazonium salt:



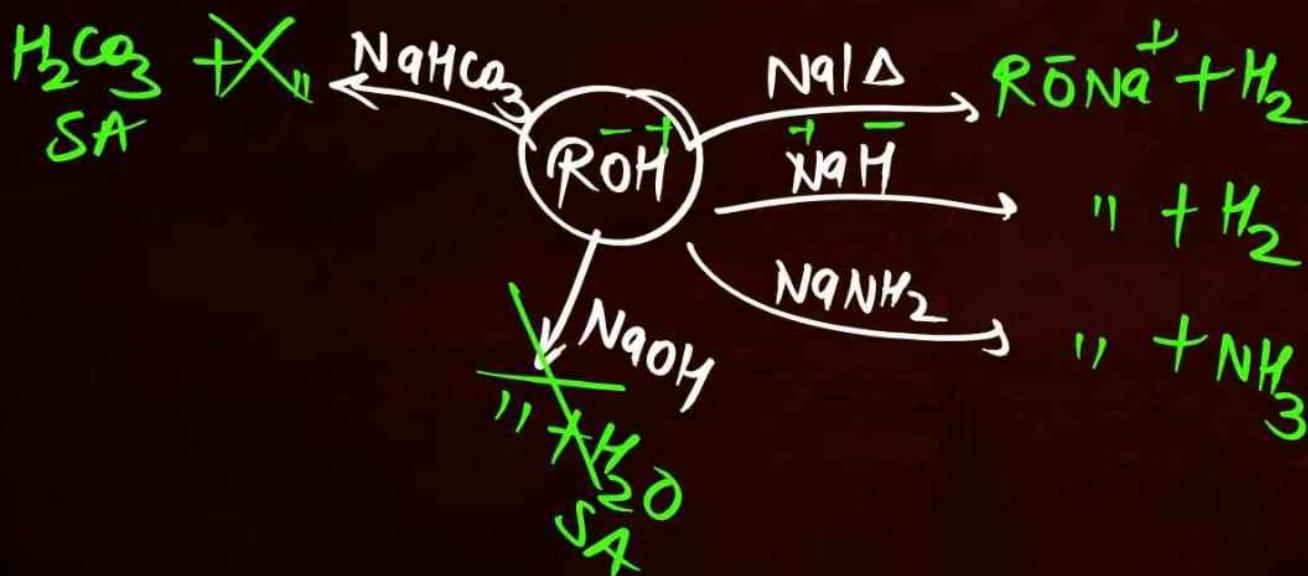
4. From cumene:



Chemical Properties of Alcohols



1. Acidic Nature of alcohol:



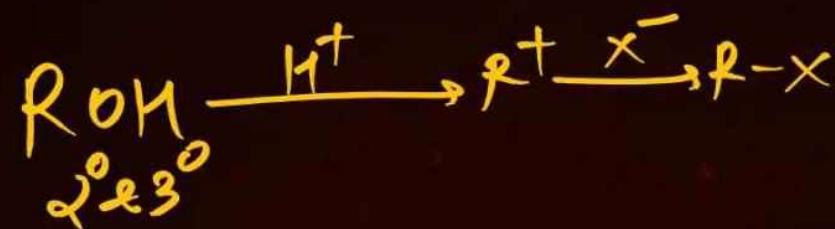
2. Esterification:



3. Reaction with PX_3 , PX_5 & SOX_2 :

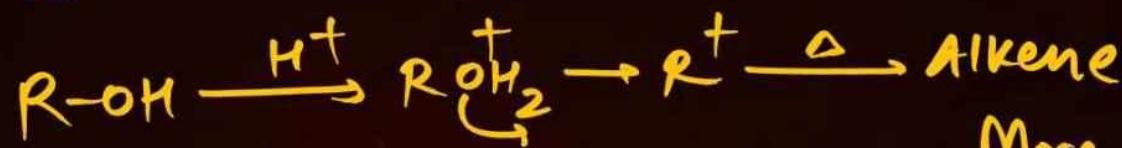


4. Reaction with HX:



5. Dehydration: E^I

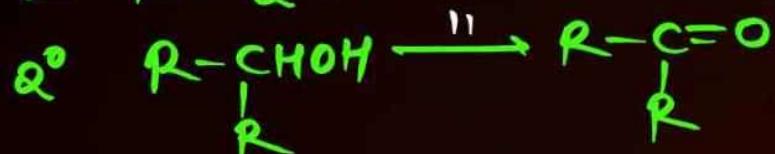
H⁺/Δ conc H₂SO₄ conc H₃PO₄ 443K



More stable
major

6. Oxidation:

MOA



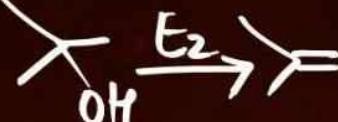
3° → NO Oxi

MOA



⑤ Cu or Ag

300°C



OH



Allyl & Benzylic
MnO₂
MOA



3° → NO Rxn

SOA ① KMnO₄ / H⁺ or Hot

or K₂Cr₂O₇ / H⁺ or Hot

(Alk KMnO₄ / Δ + H⁺)

② Con CHNO₃

③ CrO₃ + H₂SO₄

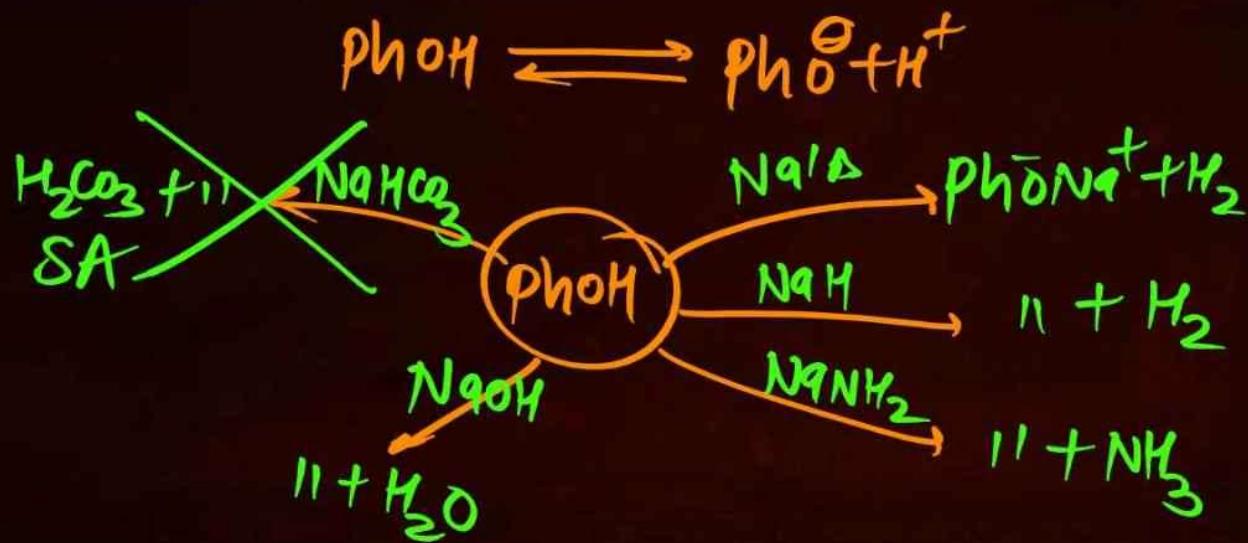
④ aq CrO₃ or H₂O₂



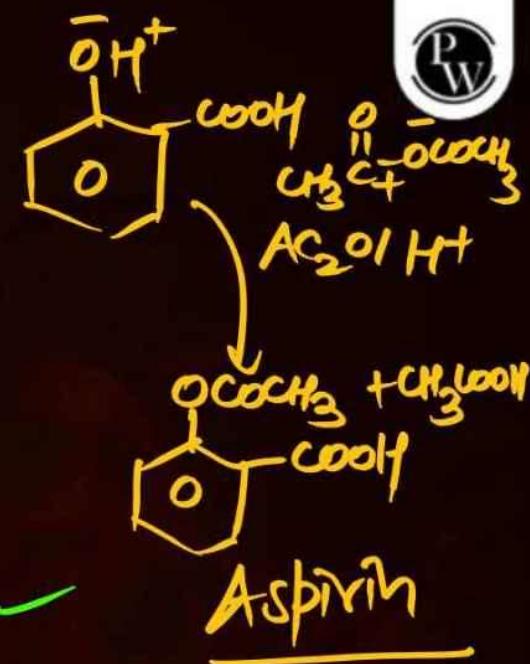


Chemical Properties of Phenols

1. Acidic Nature of Phenol:



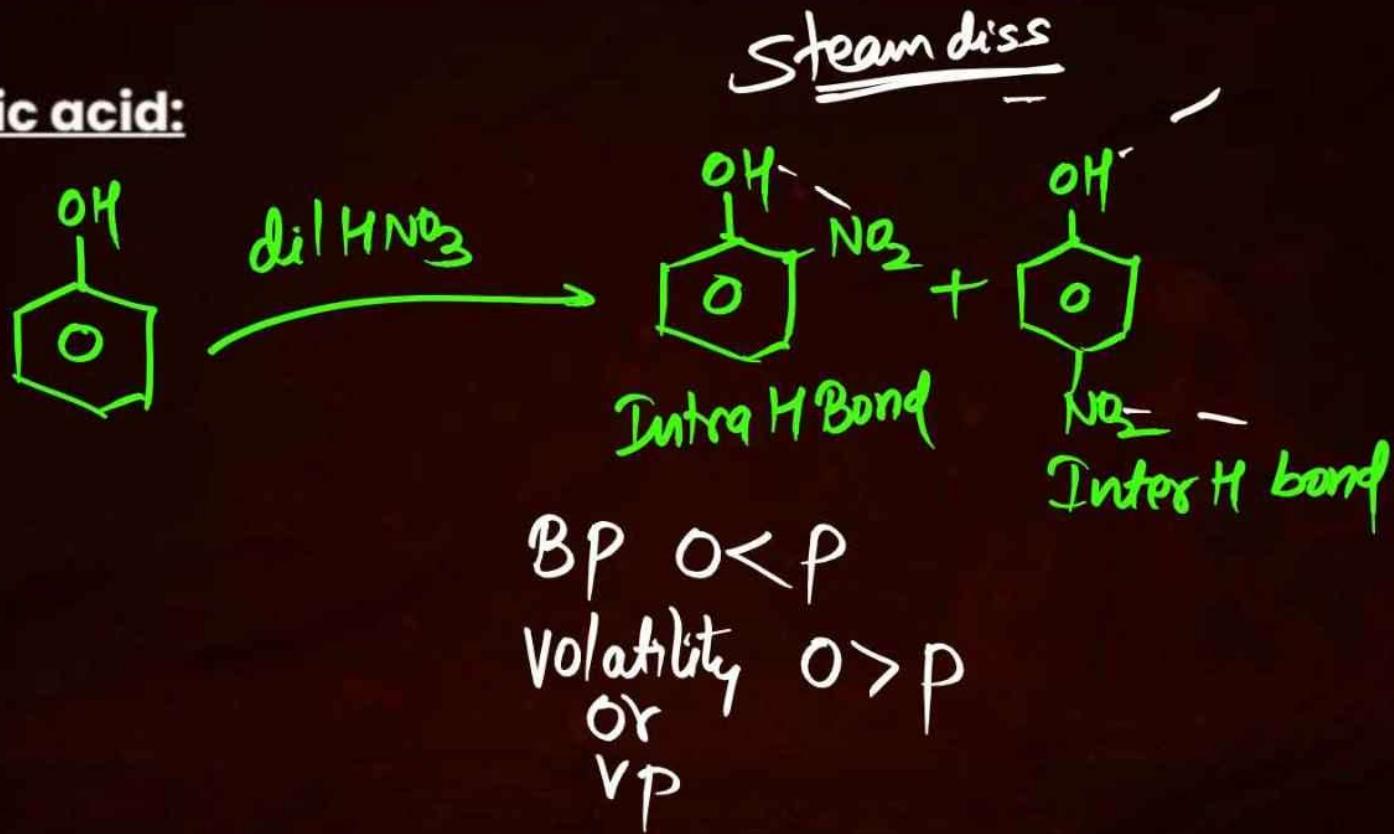
2. Esterification:



3. Electrophilic Aromatic Substitution reactions:

A. Nitration:

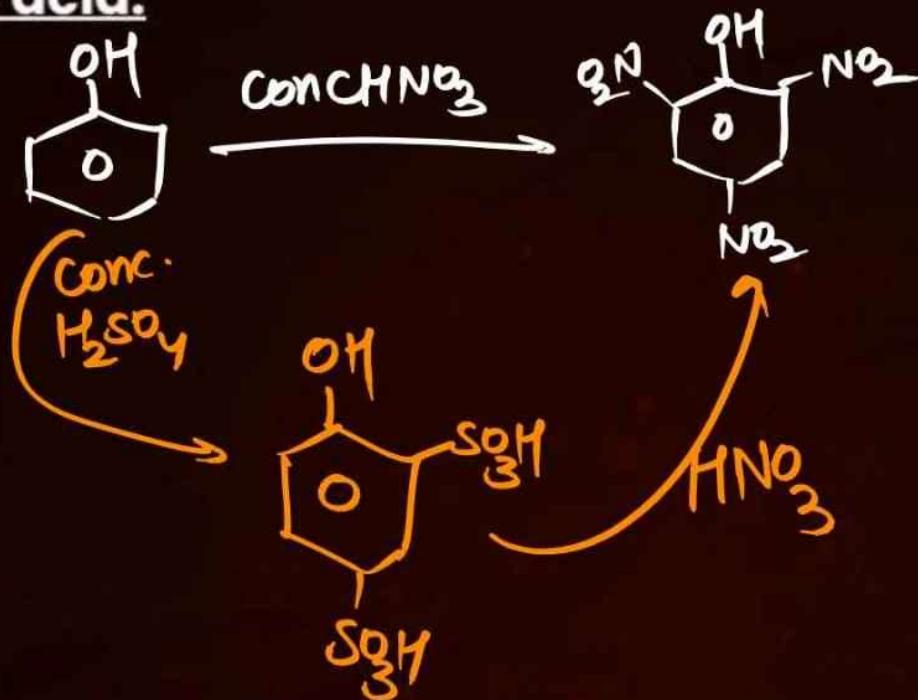
With dilute nitric acid:



OP Points:

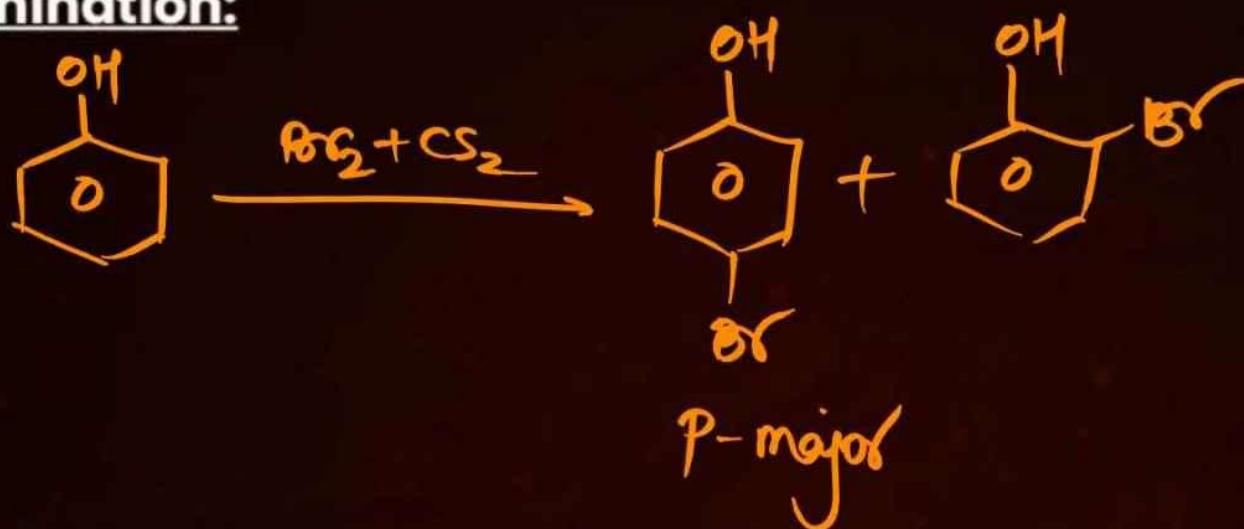
1. The ortho and para isomers can be separated by steam distillation.
2. o-Nitrophenol is steam volatile due to intramolecular hydrogen bonding while p-nitrophenol is less volatile due to intermolecular hydrogen bonding which cause the association of molecules.

With Conc. nitric acid:



B. Halogenation:

Mono bromination:



OP Points:

1. The usual halogenation of benzene takes place in the presence of a Lewis acid, such as FeBr_3 which polarises the halogen molecule.
2. In case of phenol, the polarization of bromine molecule takes place even in the absence of Lewis acid.
3. It is due to the highly activating effect of -OH group attached to the benzene ring.

Tri bromination:

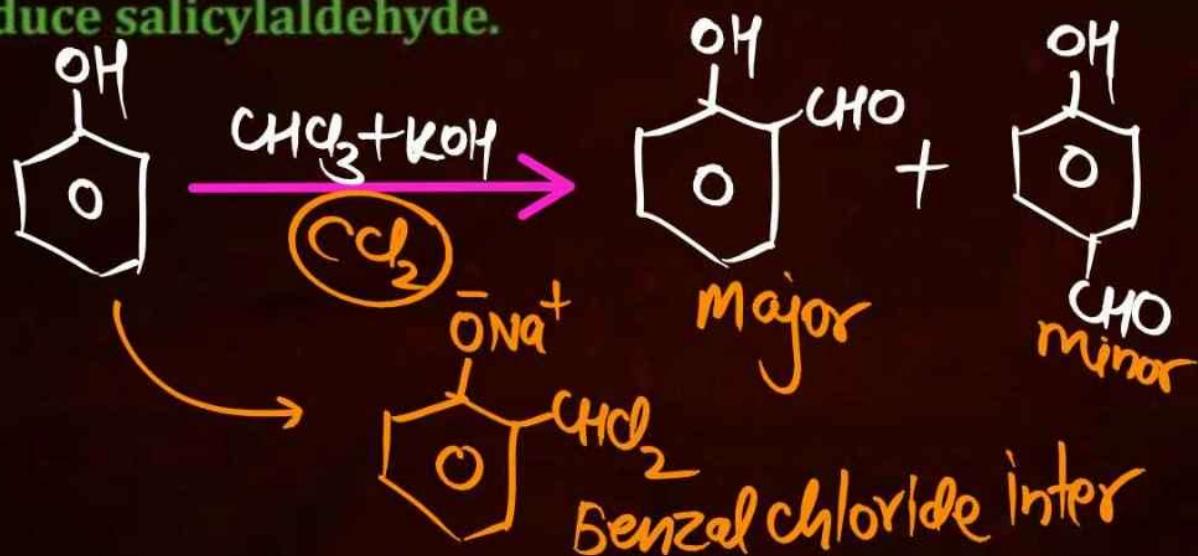
4. Kolbe's reaction:

1. Phenoxide ion generated by treating phenol with sodium hydroxide is even more reactive than phenol towards electrophilic aromatic substitution.

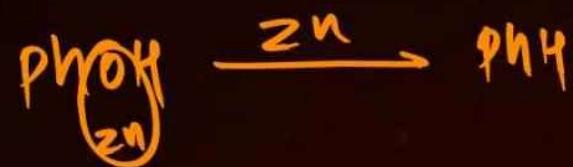


5. Reimer-Tiemann Reaction:

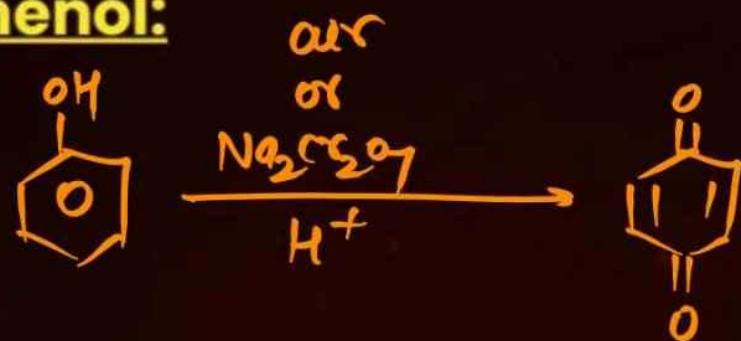
1. On treating phenol with chloroform in the presence of sodium hydroxide, - CHO group is introduced at ortho position of benzene ring.
2. This reaction is known as Reimer-Tiemann reaction.
3. The intermediate substituted benzal chloride is hydrolyzed in the presence of alkali to produce salicylaldehyde.



6. Reaction with zinc dust:



7. Oxidation of Phenol:

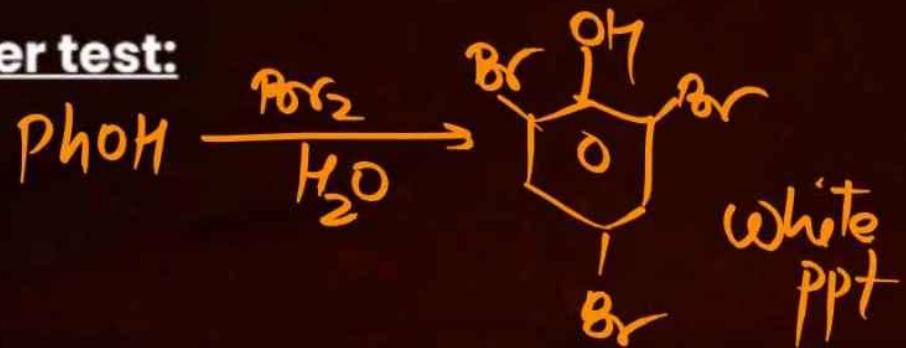


8. Test of phenol:

1. Neutral FeCl_3 Test:



2. Bromine water test:

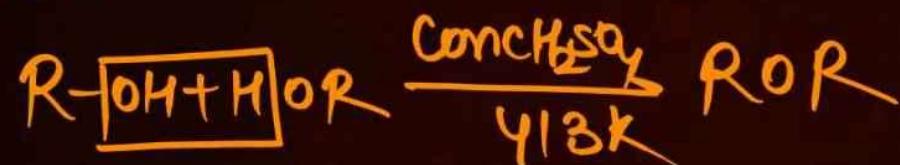




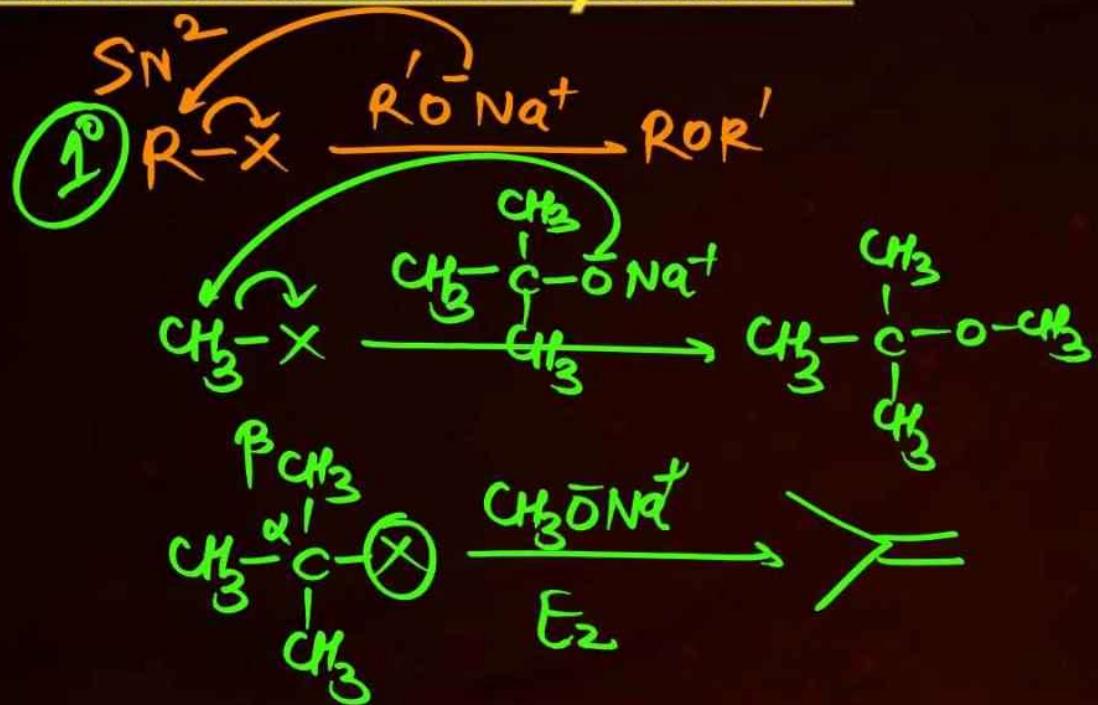
Methods of Preparation of Ethers

1. By Dehydration of Alcohols:

413K



2. Williamson-Ether Synthesis:

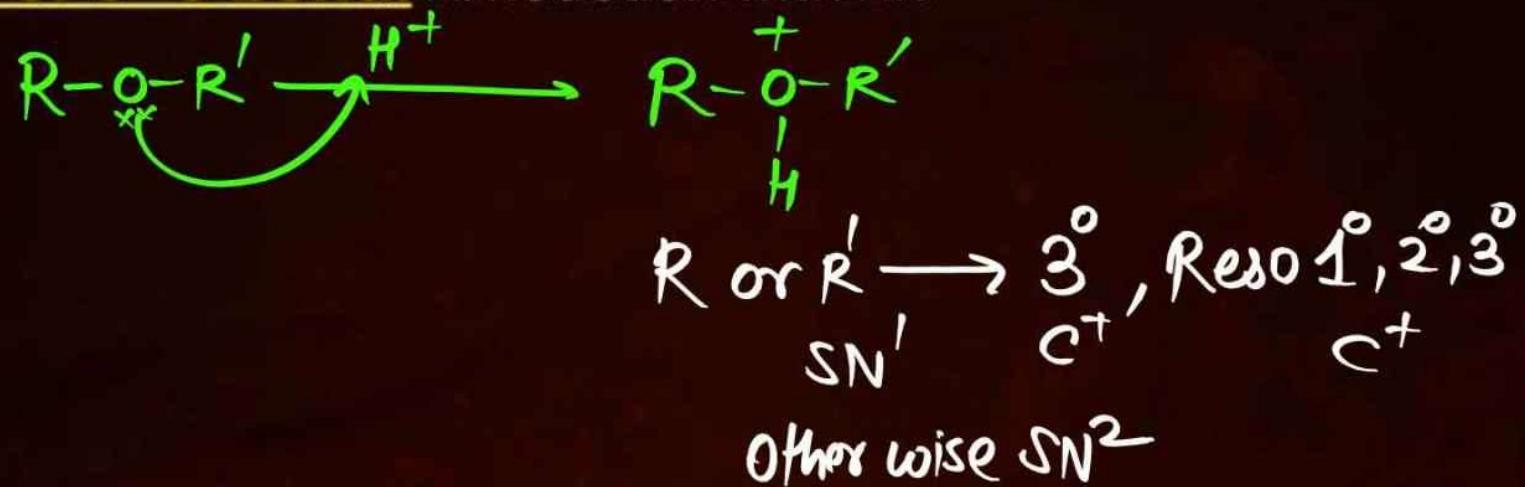


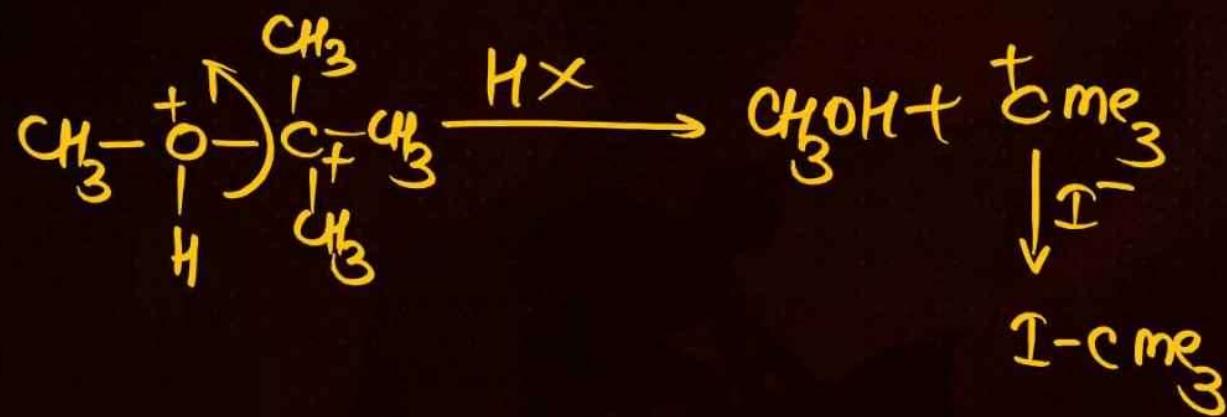
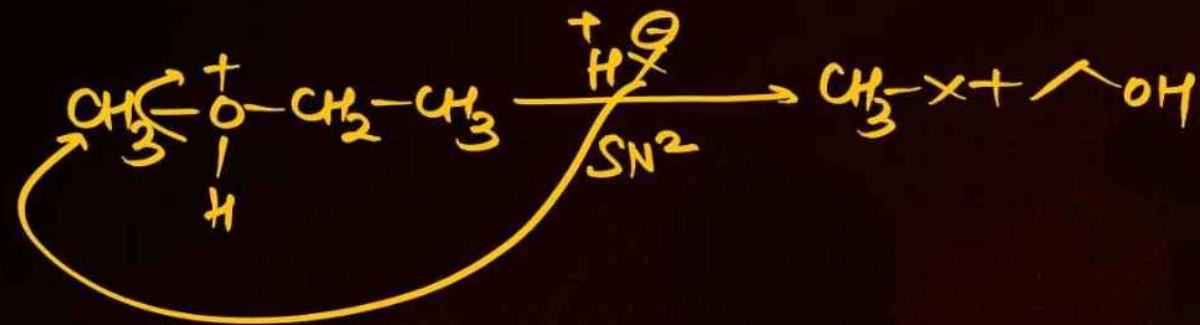


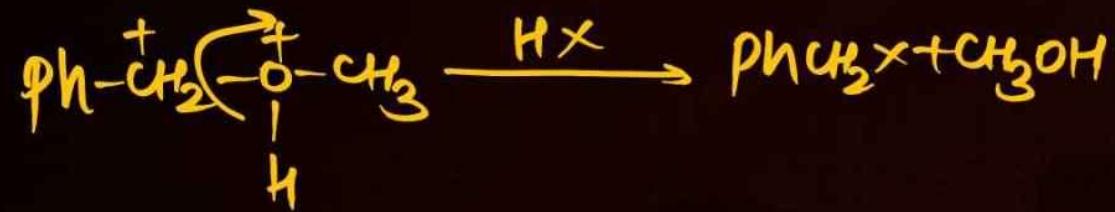
Chemical Properties of Ethers

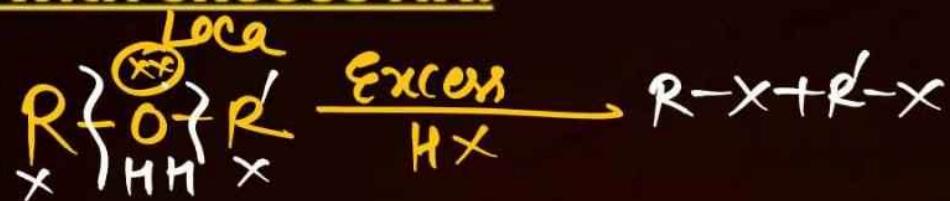
1. Cleavage of C-O bond:

A. Reaction with HX

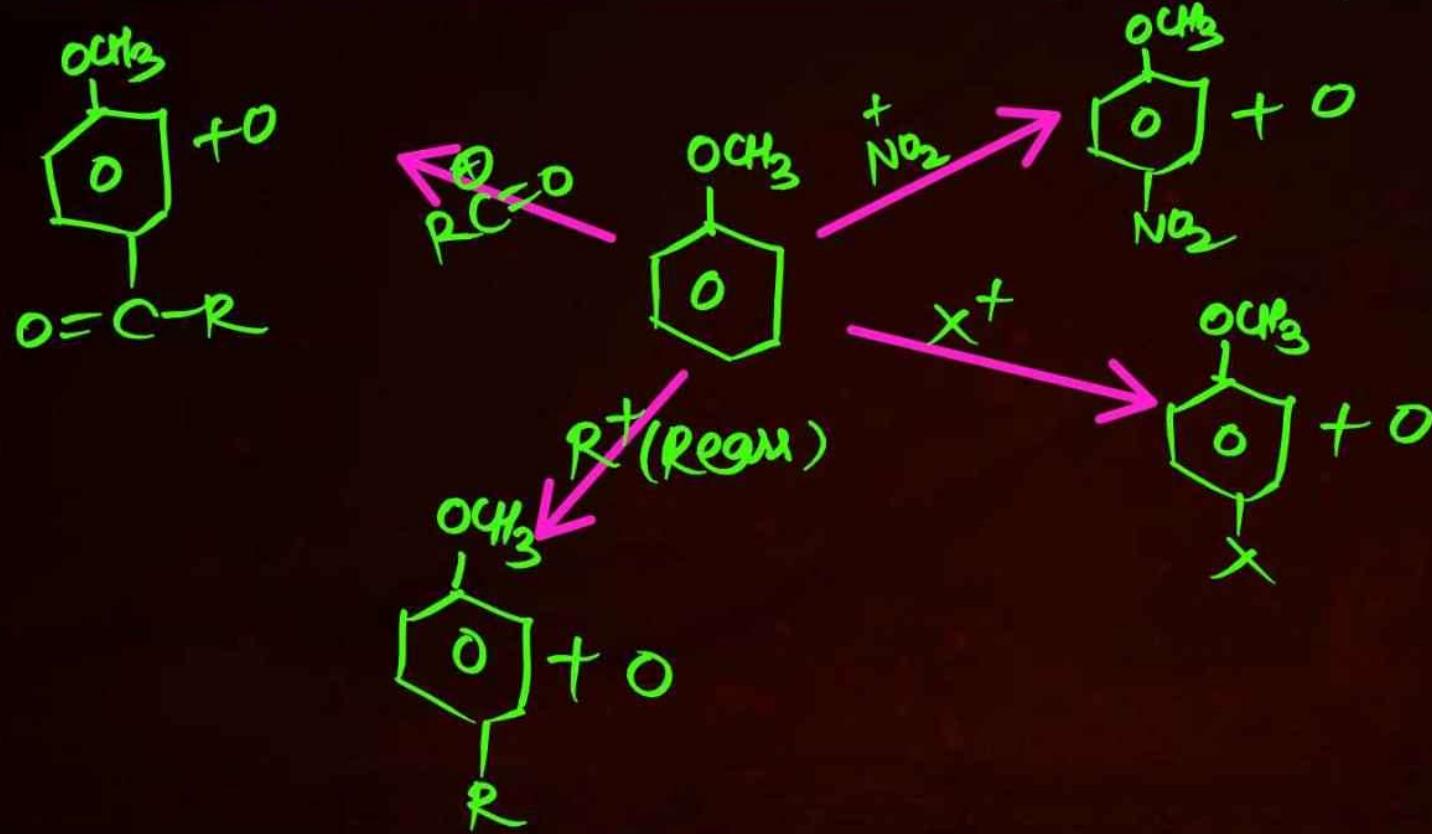






B. Reaction with excess HX:

2. Electrophilic Substitution reactions: Always ρ major



QUESTION (JEE Mains 1st Feb 2024, Evening Shift)



Match List-I with List-II.

List-I (Reactants)	List-II Products
(A) Phenol, Zn/ Δ	(I) Salicylaldehyde
(B) Phenol, CHCl_3 , NaOH, HCl	(II) Salicylic acid
(C) Phenol, CO_2 , NaOH, HCl	(III) Benzene
(D) Phenol, Conc. HNO_3	(IV) Picric acid

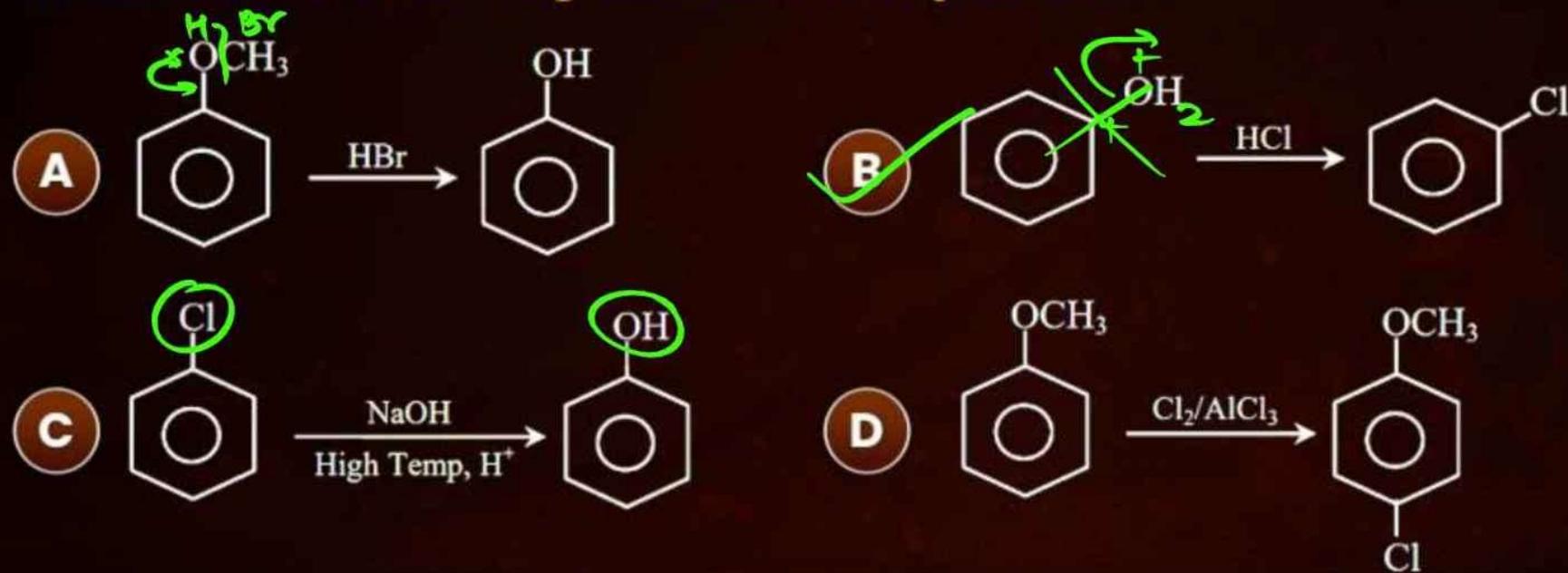
Choose the correct answer from the options given below.

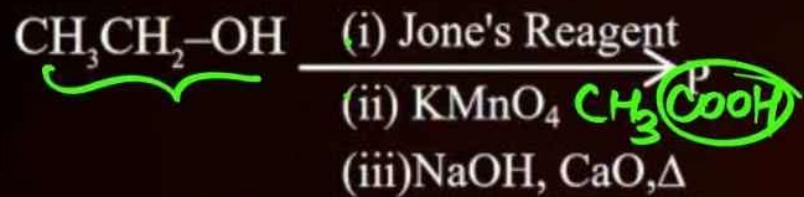
- A** (A)-(IV), (B)-(II), (C)-(I), (D)-(III) **B** (A)-(IV), (B)-(I), (C)-(II), (D)-(III)
- C** (A)-(III), (B)-(I), (C)-(II), (D)-(IV) **D** (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

QUESTION (JEE Mains 5th April 2024, Evening Shift)



Which one of the following reactions is NOT possible?



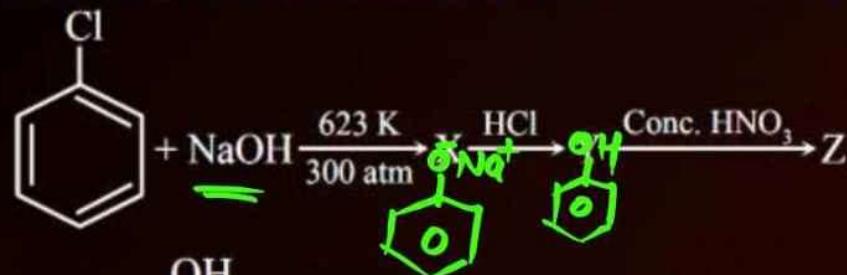
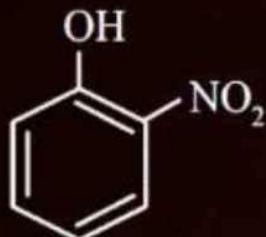
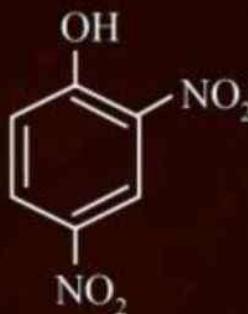
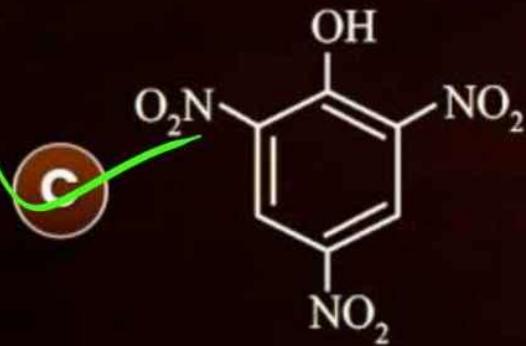
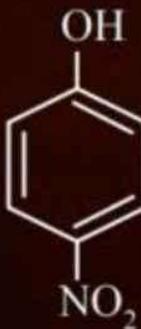
QUESTION (JEE Mains 5th April 2024, Evening Shift)

Consider the above reaction sequence and identify the major product P.

- A Methane
- B Methanal
- C Methoxymethane
- D Methanoic acid

QUESTION (JEE Mains 5th April 2024, Morning Shift)

Identify compound (Z) in the following reaction sequence.

**A****B****C****D**

QUESTION (JEE Mains 5th April 2024, Morning Shift)

Given below are two statements:

Statement I: Bromination of phenol in solvent with low polarity such as CHCl_3 or CS_2 requires Lewis acid ~~catalyst~~.

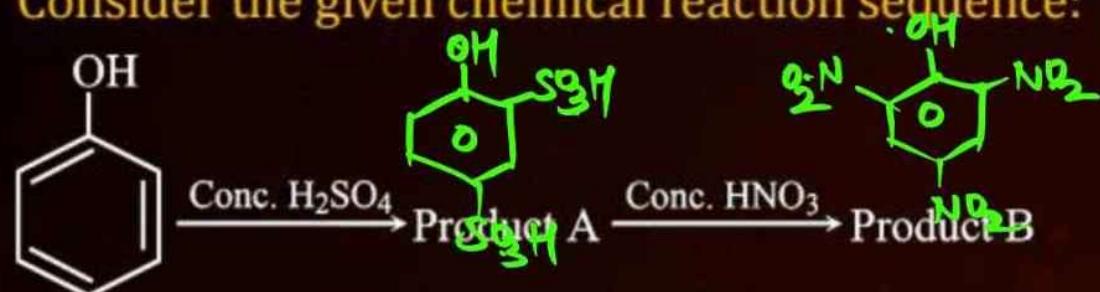
Statement II: The Lewis acid catalyst polarises the bromine to generate Br^+

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

- A** Statement I is true but Statement II is false.
- B** Both Statement I and Statement II are true
- C** Both Statement I and Statement II are false.
- D** Statement I is false but Statement II is true.

QUESTION (JEE Mains 5th April 2024, Morning Shift)

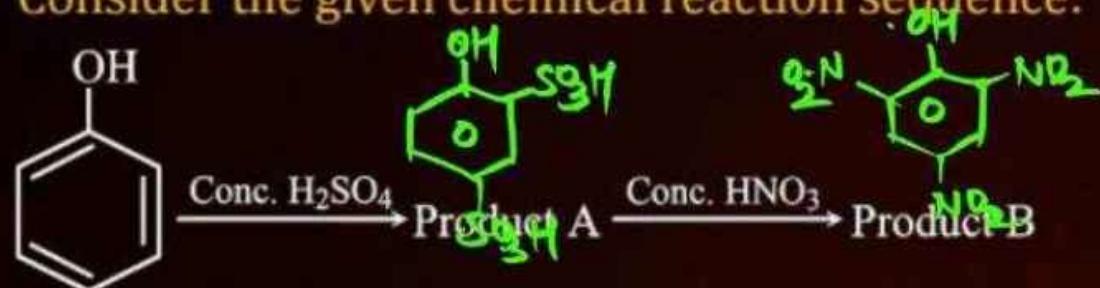
Consider the given chemical reaction sequence:



Total sum of oxygen atoms in Product A and Product B are **14**.....

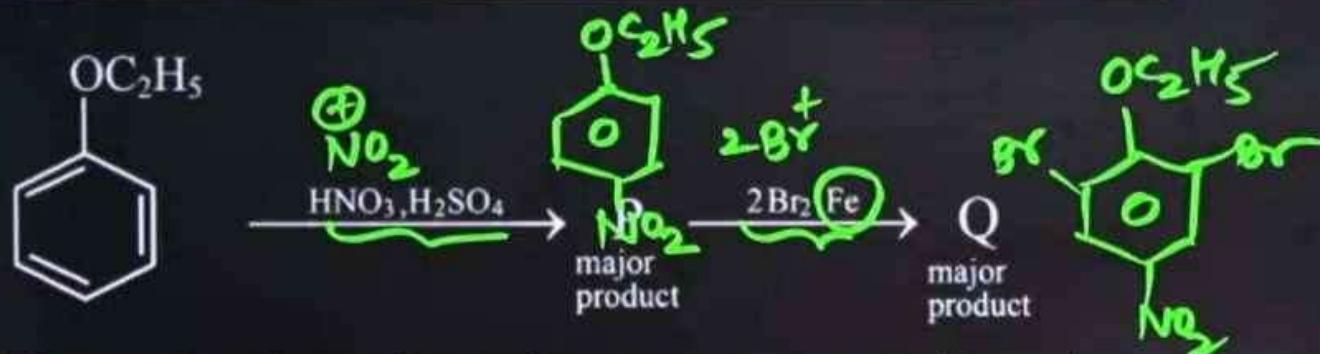
QUESTION (JEE Mains 5th April 2024, Morning Shift)

Consider the given chemical reaction sequence:



Total sum of oxygen atoms in Product A and Product B are **14**.

QUESTION (JEE Mains 6th April 2024, Evening Shift)



The ratio of number of oxygen atoms to bromine atoms in the product Q is $\frac{15}{15} \times 10^{-1}$

$\frac{3}{2}$
1.5



QUESTION (JEE Mains 6th April 2024, Morning Shift)

Given below are two statements:

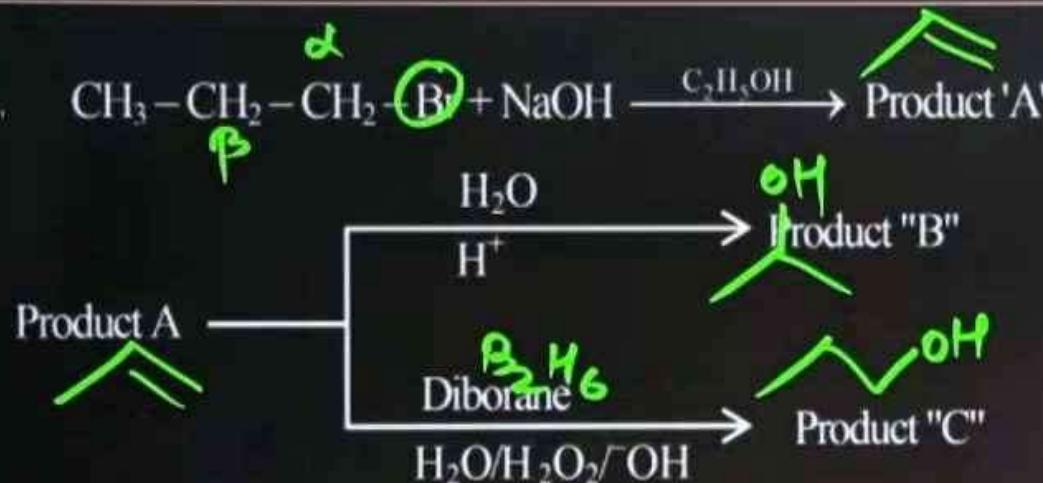
Statement I: Picric acid is 2, 4, 6-trinitrotoluene ~~X~~

Statement II: Phenol-2, 4-disulphuric acid is treated with conc. HNO_3 to get picric acid.

In the light of the above statement, choose the most appropriate answer from the options given below:

- A** Statement I is incorrect but Statement II is correct.
- B** Both Statement I and Statement II are incorrect.
- C** Statement I is correct but Statement II is incorrect.
- D** Both Statement I and Statement II are correct.

QUESTION (JEE Mains 4th April 2024, Evening Shift)



Consider the above reactions, identify product B and product C.

- A** B = C = 2-Propanol
- B** B = 2-Propanol, C = 1-Propanol
- C** B = 1-Propanol, C = 2-Propanol
- D** B = C = 1-Propanol

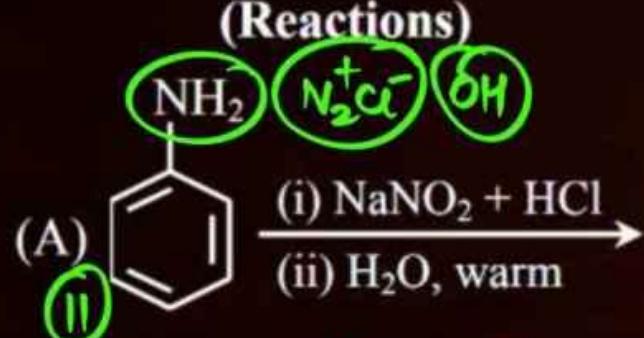
QUESTION (JEE Mains 8th April 2024, Evening Shift)



Match List-I with List-II.

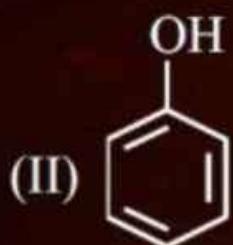
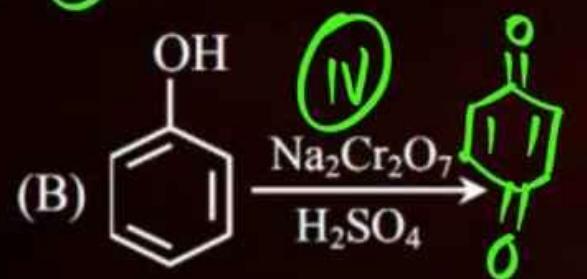
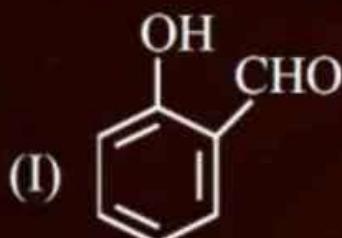
List-I

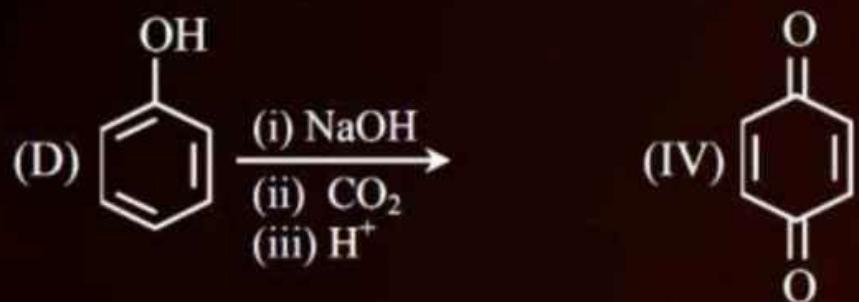
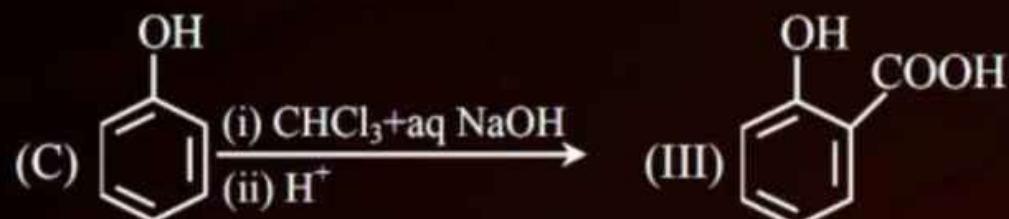
(Reactions)



List-II

(Products)



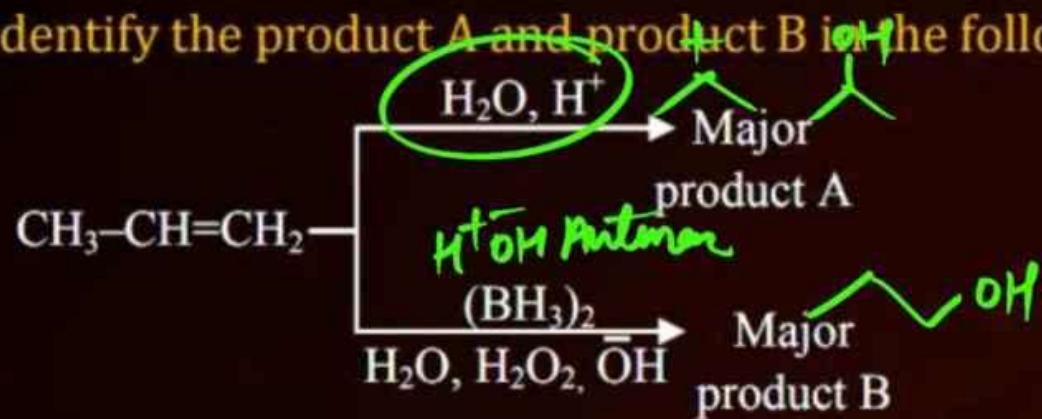


Choose the **correct** answer from the options given below:

- A** (A)-(III), (B)-(II), (C)-(I), (D)-(IV) **B** (A)-(IV), (B)-(II), (C)-(III), (D)-(I)
- C** (A)-(I), (B)-(IV), (C)-(II), (D)-(III) **D** (A)-(II), (B)-(IV), (C)-(I), (D)-(III)

QUESTION (JEE Mains 9th April 2024, Morning Shift)

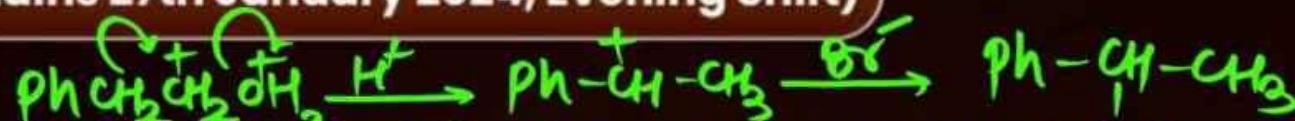
Identify the product A and product B in the following set of reactions.



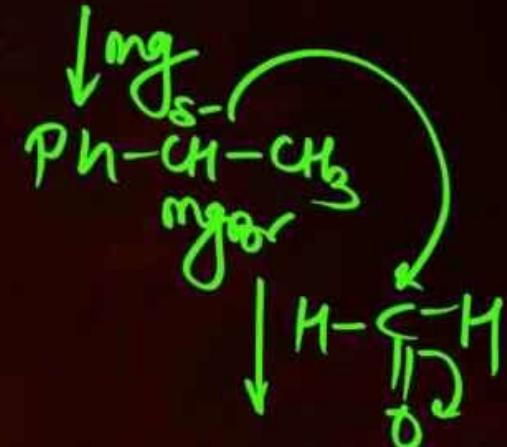
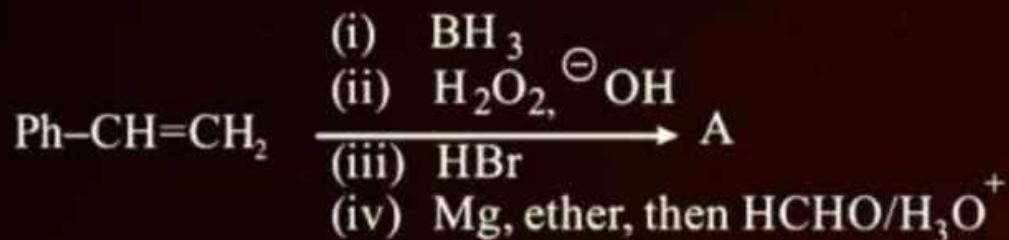
- A** A-CH₃CH₂CH₂-OH, B-CH₃CH₂CH₂-OH
- B** A-CH₃CH₂CH₂-OH, B-CH₃
|
OH
- C** A-CH₃-CH(OH)-CH₃, B-CH₃CH₂CH₂-OH
- D** A-CH₃CH₂CH₃, B-CH₃CH₂CH₃

QUESTION (JEE Mains 27th January 2024, Evening Shift)

PW



The final product A, formed in the following reaction sequence is:



- A Ph-CH₂-CH₂-CH₃
- C Ph-CH(CH₃)₂
|
CH₂OH

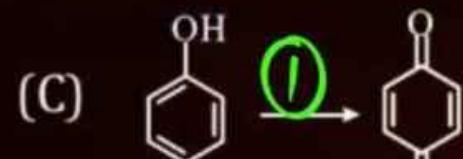
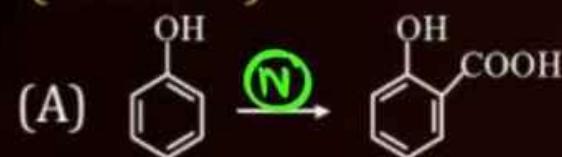
- B Ph-CH(CH₃)₂
- D Ph-CH₂-CH₂-CH₂-OH

QUESTION (JEE Mains 27th January 2024, Evening Shift)

Match List-I with List-II.

List - I

(Reaction)



List - II

(Reagent(s))

(I) $\text{Na}_2\text{Cr}_2\text{O}_7, \text{H}_2\text{SO}_4$

(II) (i) NaOH (ii) CH_3Cl

(III) (i) $\text{NaOH}, \text{CHCl}_3$ (ii) NaOH (iii) HCl

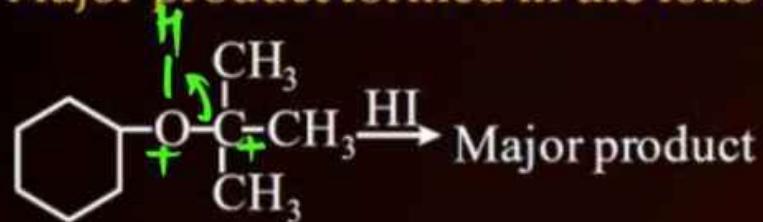
(IV) (i) NaOH (ii) CO_2 (iii) HCl

Choose the correct answer from the options given below:

- A** (A)-(IV), (B)-(I), (C)-(III), (D)-(II)
- B** (A)-(II), (B)-(III), (C)-(I), (D)-(IV)
- C** (A)-(II), (B)-(I), (C)-(III), (D)-(IV)
- D** (A)-(IV), (B)-(III), (C)-(I), (D)-(II)

QUESTION (JEE Mains 27th January 2024, Evening Shift)

Major product formed in the following reaction is a mixture of:



- A**
- B**
- C**
- D**

QUESTION (JEE Mains 30 January 2024, Evening Shift)



Salicylaldehyde is synthesized from phenol, when reacted with

- A  Cl, NaOH
- C CCl₄, NaOH

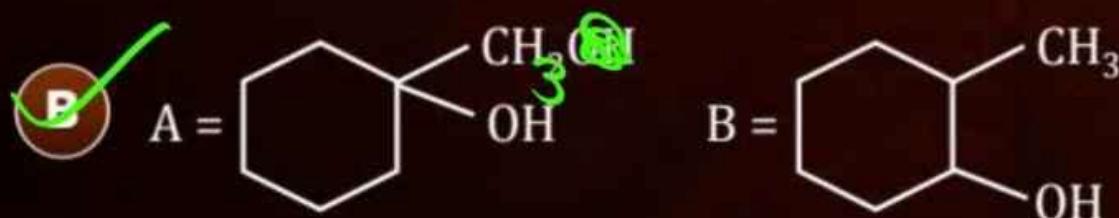
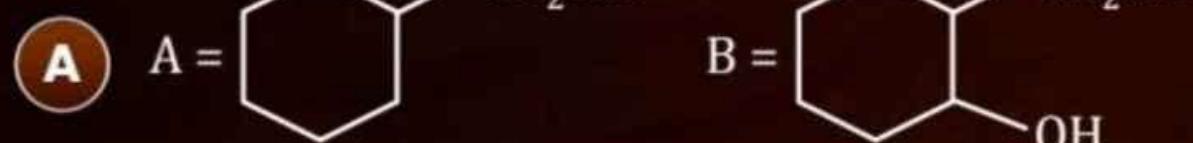
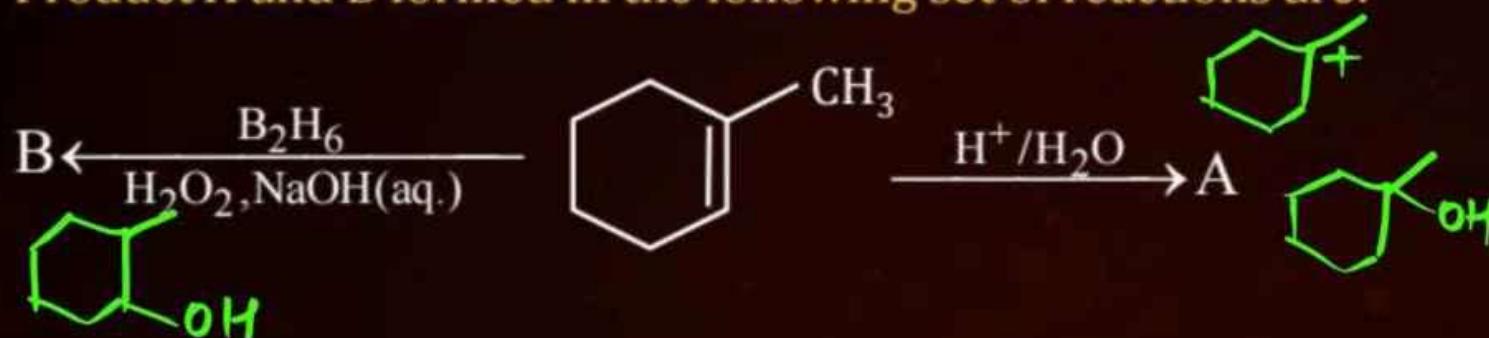
- B CO₂, NaOH
- D CHCl₃, NaOH

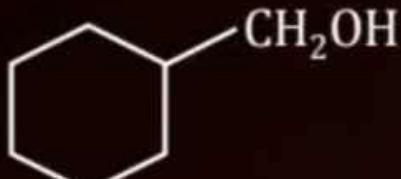
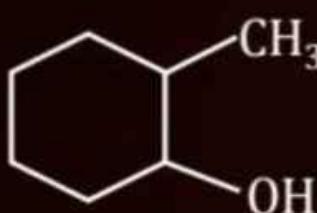
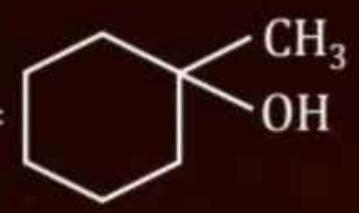


QUESTION (JEE Mains 30 January 2024, Evening Shift)



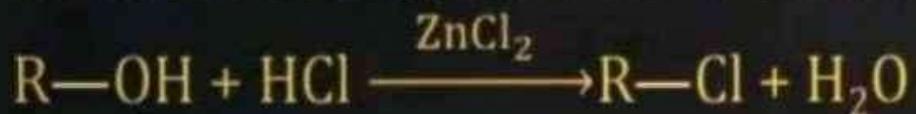
Product A and B formed in the following set of reactions are:



- C A =  CH₂OH
- B =  CH₃
OH
- D A =  CH₃
OH
- B =  CH₃
OH

QUESTION (NCERT Exemplar)

What is the correct order of reactivity of alcohols in the following reaction?



A $1^\circ > 2^\circ > 3^\circ$

C $3^\circ > 2^\circ > 1^\circ$

B $1^\circ < 2^\circ > 3^\circ$

D $3^\circ > 1^\circ > 2^\circ$

QUESTION (NCERT Exemplar)

$\text{CH}_3\text{CH}_2\text{OH}$ can be converted into CH_3CHO by _____.

- A catalytic hydrogenation
- B treatment with LiAlH_4
- C treatment with pyridinium chlorochromate
- D treatment with KMnO_4

QUESTION (NCERT Exemplar)

The process of converting alkyl halides into alcohols involves _____.

- A addition reaction
- B substitution reaction
- C dehydrohalogenation reaction
- D rearrangement reaction

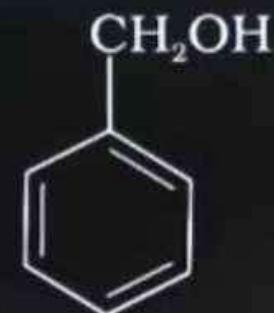
QUESTION (NCERT Exemplar)

$C_{sp^3}-OH$

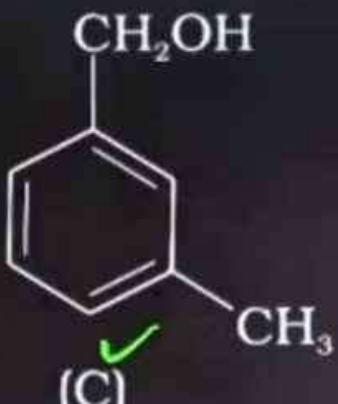
Which of the following compounds is aromatic alcohol?



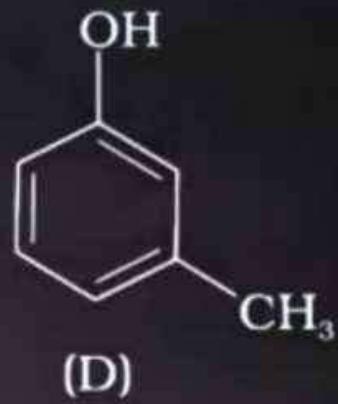
(A)



(B) ✓



(C) ✓



(D)

A A, B, C, D

B A, D

C B, C ✓

D A

QUESTION (NCERT Exemplar)

Which of the following are not used to convert RCHO into RCH₂OH?

A H₂/Pd

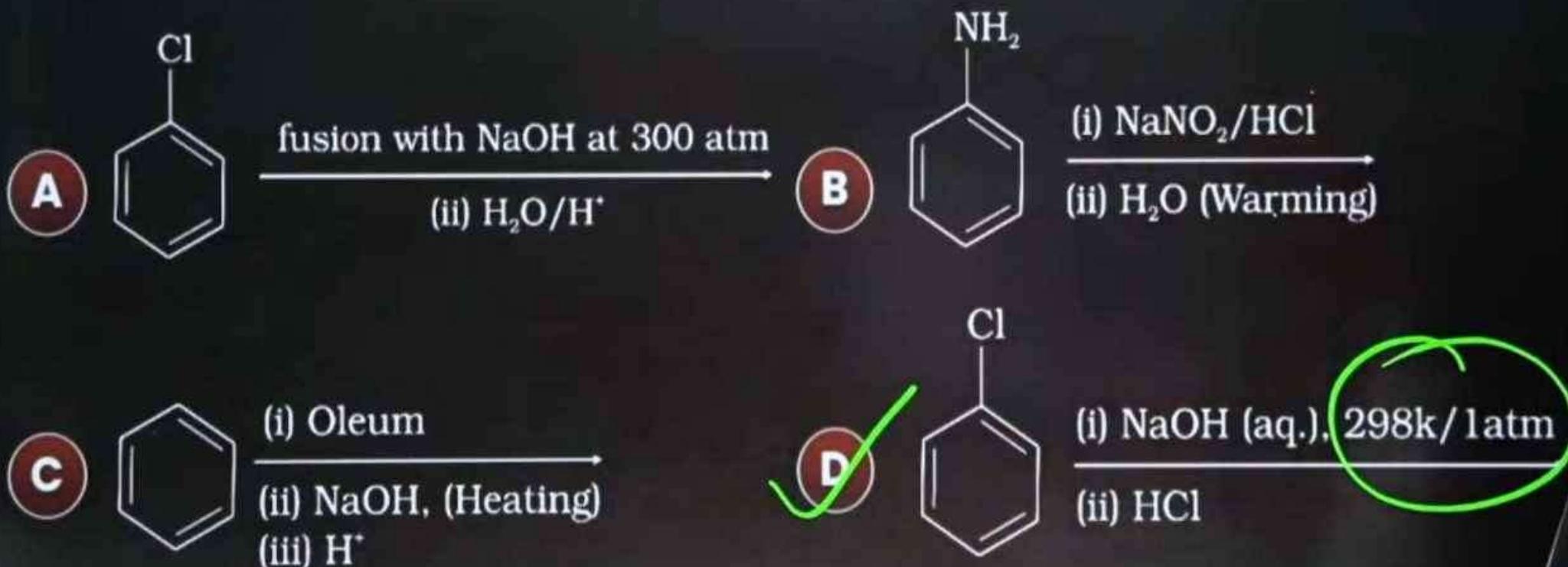
B LiAlH₄

C NaBH₄

D Reaction with RMgX followed by hydrolysis

QUESTION (NCERT Exemplar)

Which of the following reactions will not yield phenol?





QUESTION (NCERT Exemplar)

Assertion: Phenols give o-and p-nitrophenol on nitration with conc. HNO_3 and H_2SO_4 mixture.

Reason: —OH group in phenol is *o-, p-* directing.

- A** Assertion and reason both are correct and reason is correct explanation of assertion.
- B** Assertion and reason both are wrong statements.
- C** Assertion is correct statement but reason is wrong statement.
- D** Assertion is wrong statement but reason is correct statement.



Aldehydes, Ketones

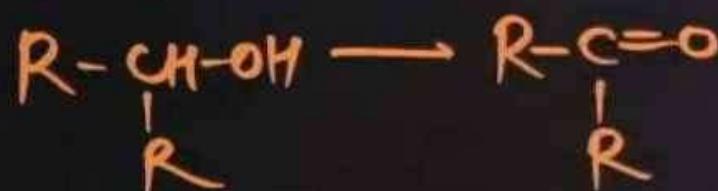
&

Carboxylic Acids



Methods of Preparation of Aldehydes & Ketones

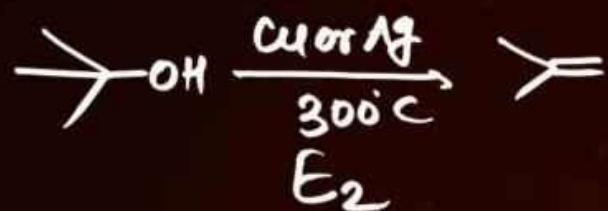
1. By oxidation of alcohols:



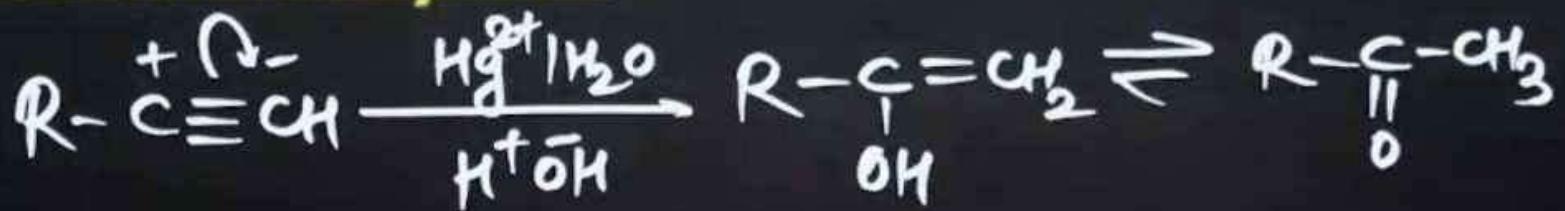
3° \longrightarrow No Oxi

2. By dehydrogenation of alcohols:

O₂
Cu or Ag | 300°C
MoA



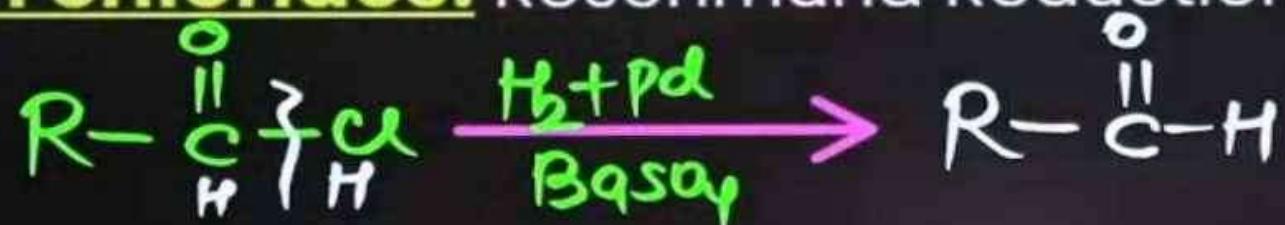
B. By hydration of alkynes:



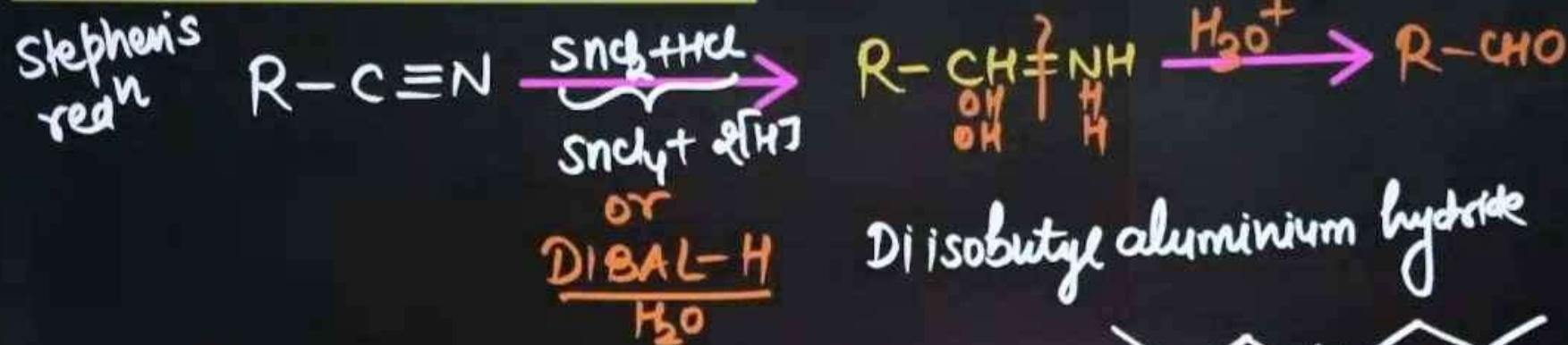


Methods of Preparation of Aldehydes

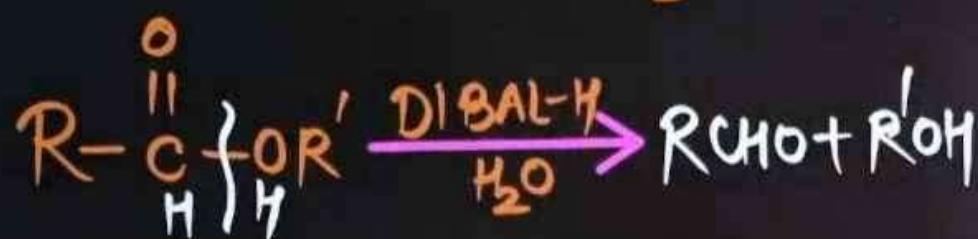
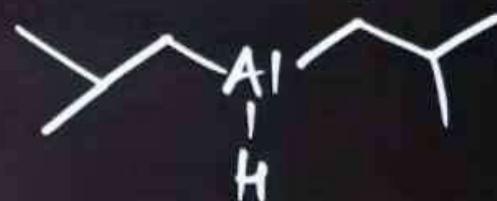
1. From acyl chlorides: Rosenmund Reduction



2. From nitriles and esters:



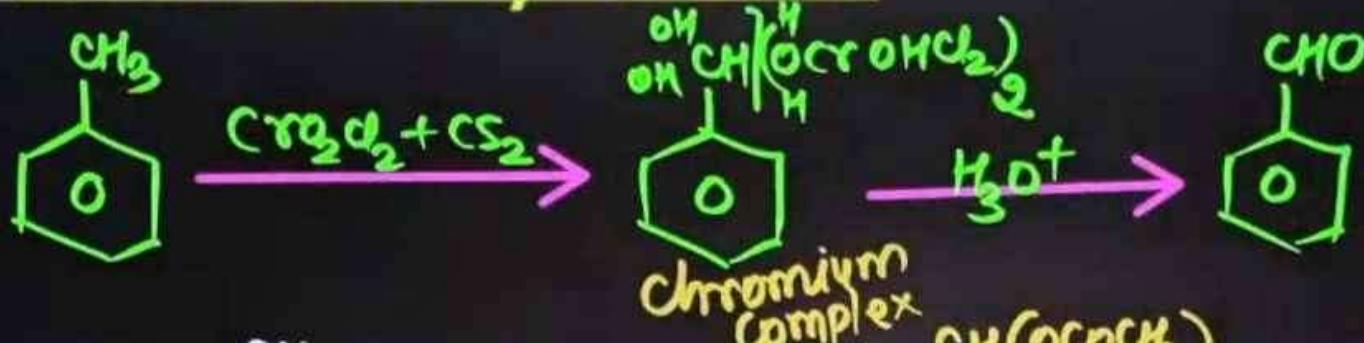
Di isobutyl aluminium hydride



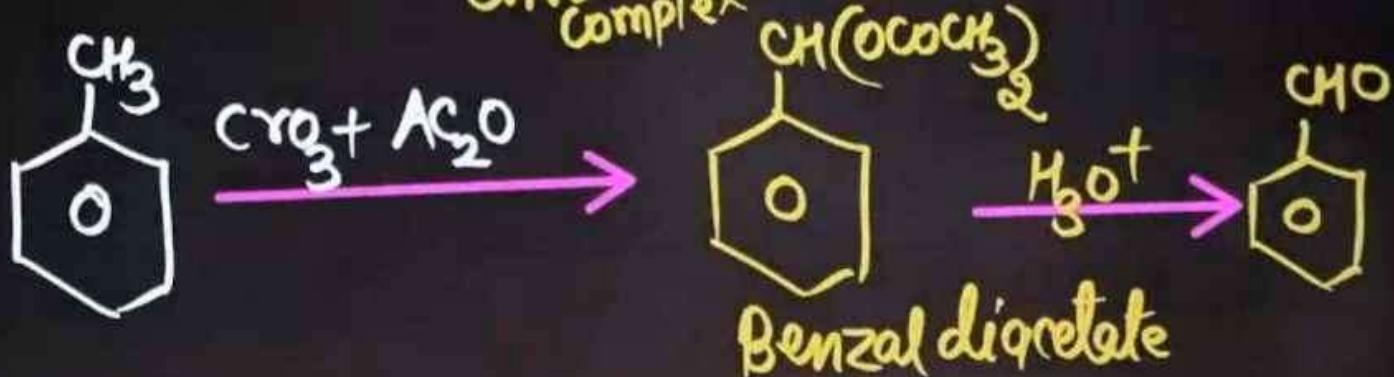
3. From hydrocarbons:

A. By oxidation of methyl benzene:

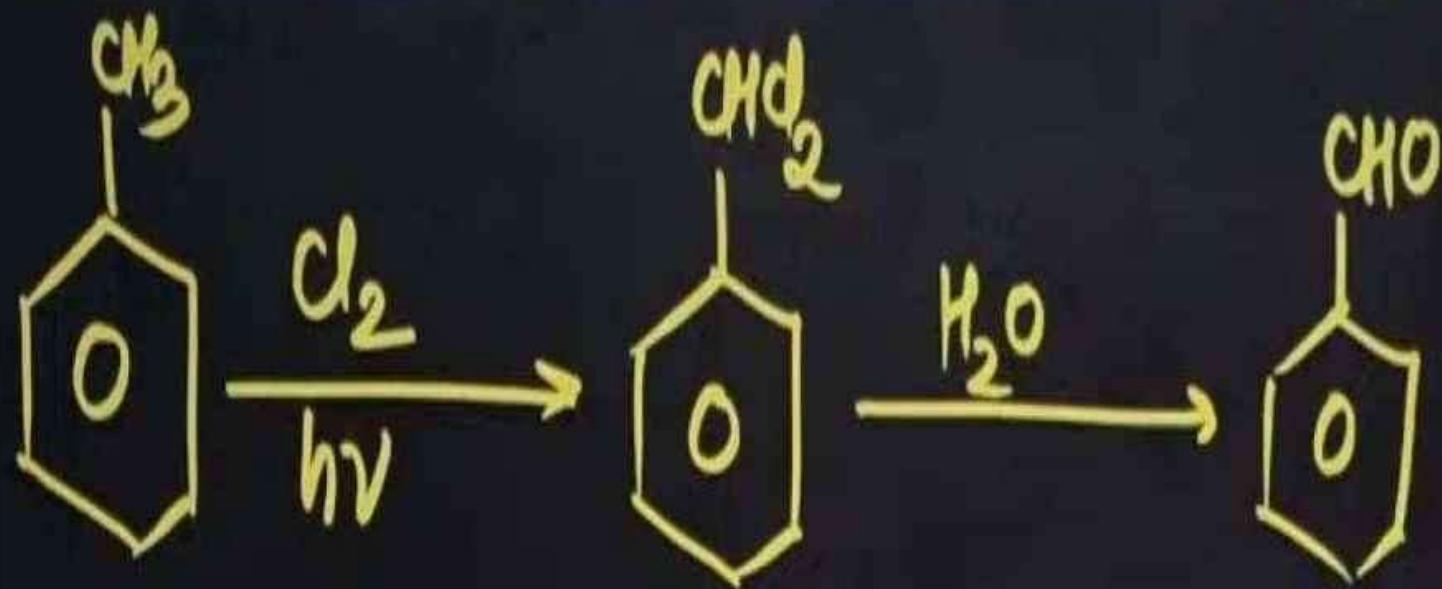
Etard
Reacn



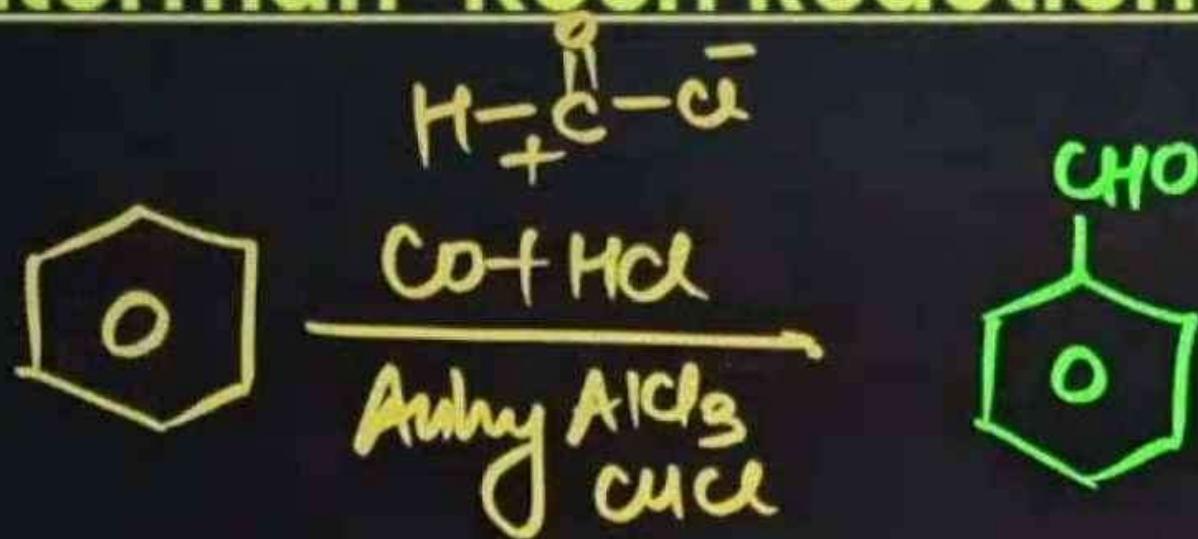
Alternate
method



B. By side chain chlorination followed by hydrolysis:



C. By Gatterman-Koch Reaction:

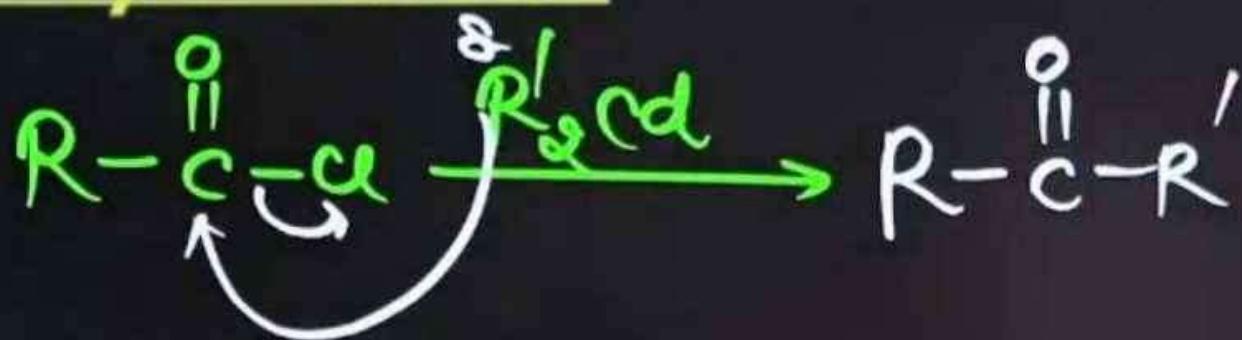




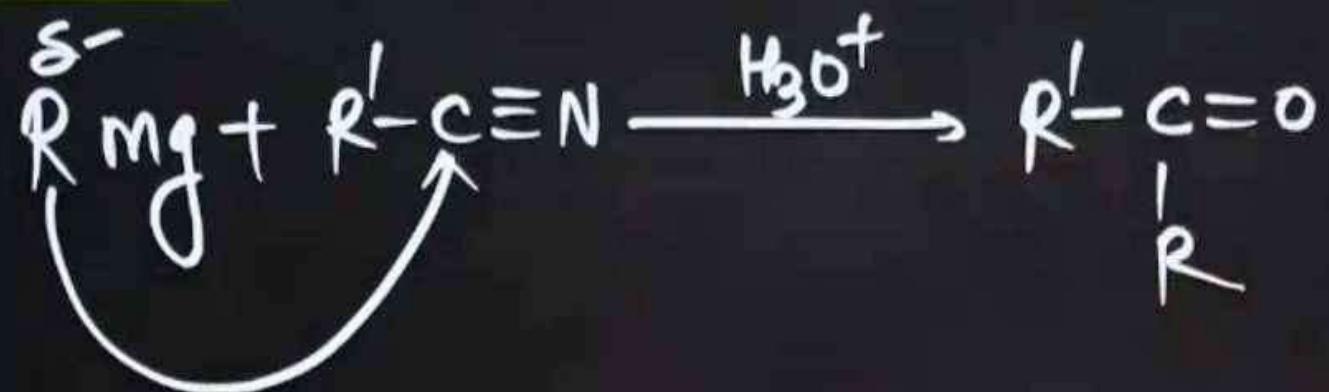
Methods of Preparation of Ketones



1. From acyl chlorides:

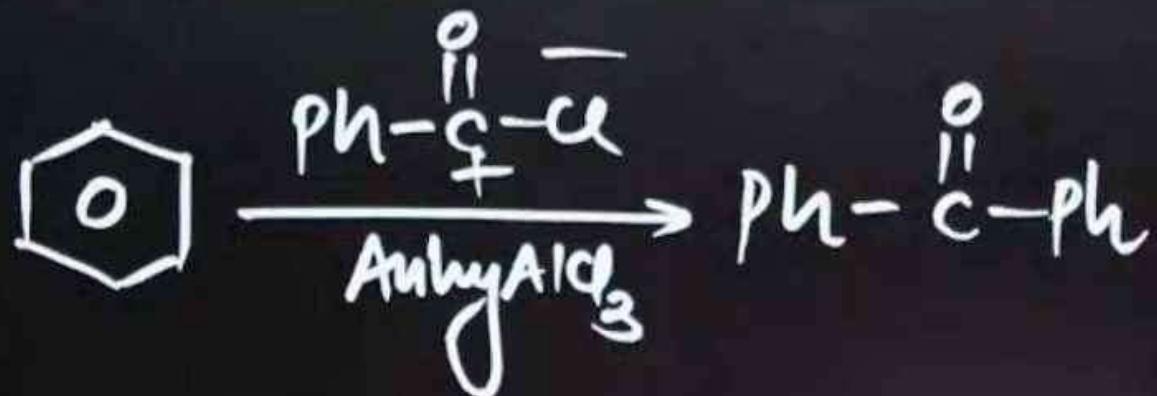


2. From nitriles:



3. From benzene or substituted benzenes:

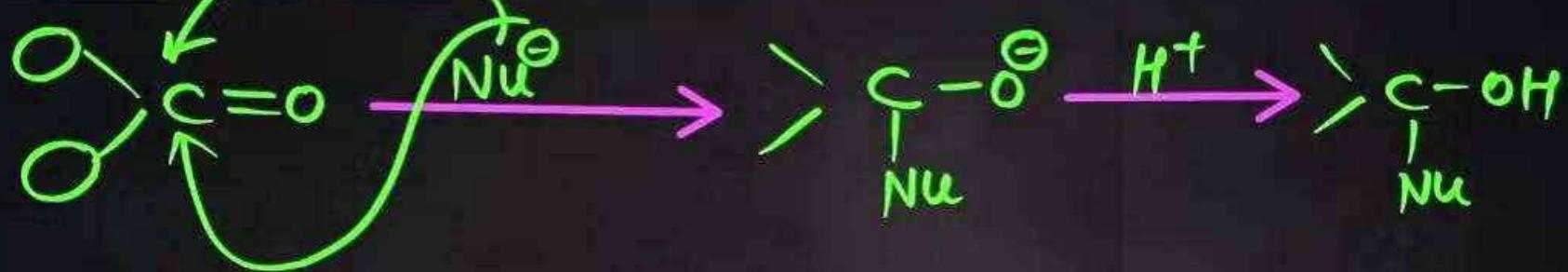
Friedel-Crafts acylation reaction





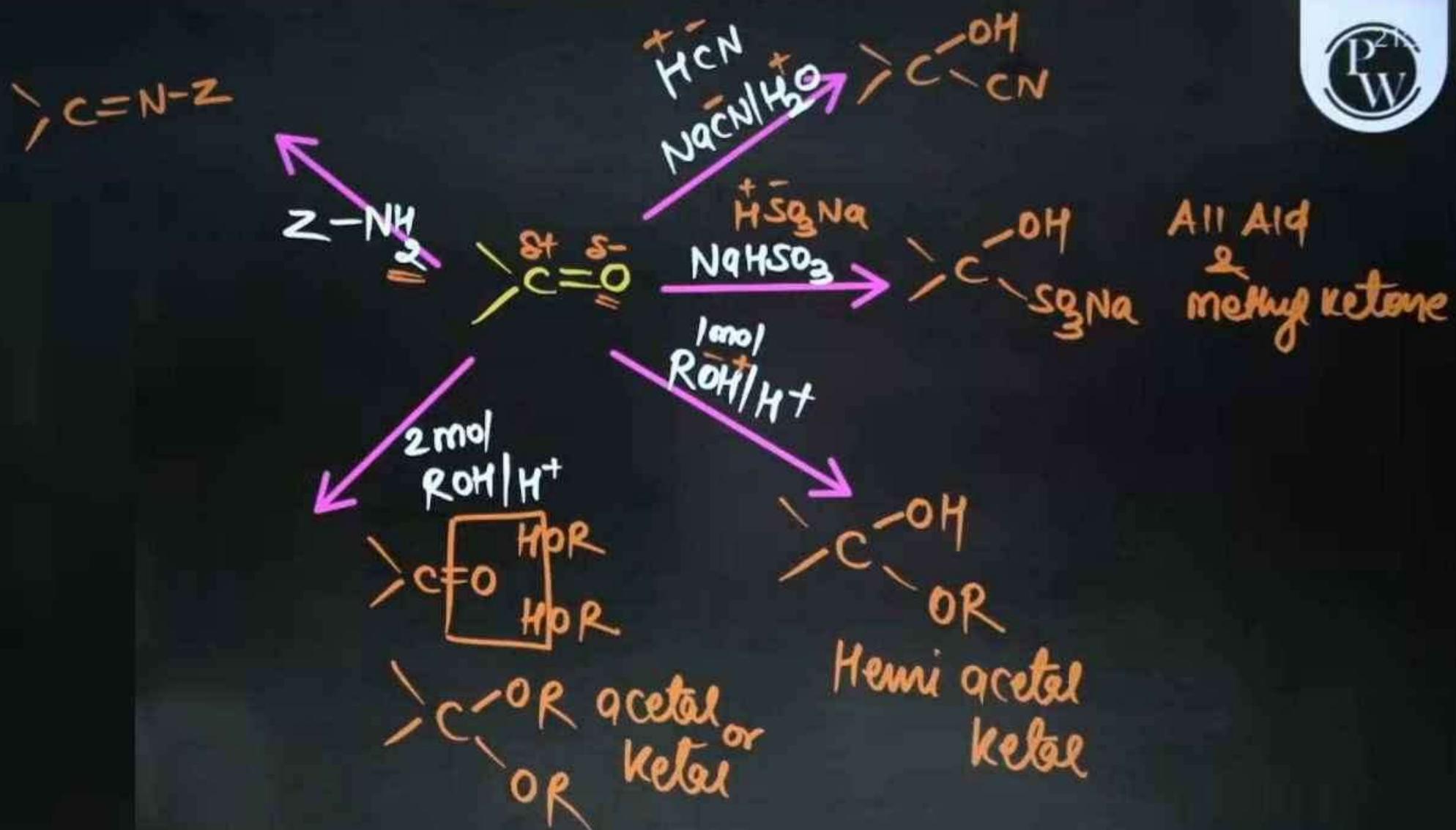
Chemical Properties of Aldehydes & Ketones

1. Nucleophilic Addition Reaction:



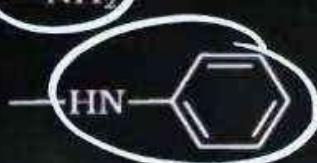
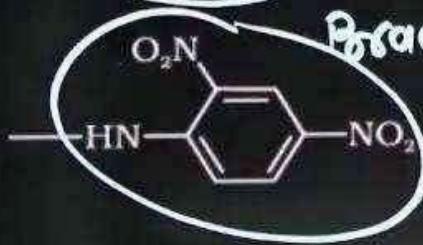
Reactivity:

$$\text{ROR in NAR} \propto \frac{1}{S_H} \propto \text{Electrophilicity}$$



Some N-Substituted Derivatives of Aldehydes and Ketones ($>\text{C}=\text{N}-\text{Z}$)



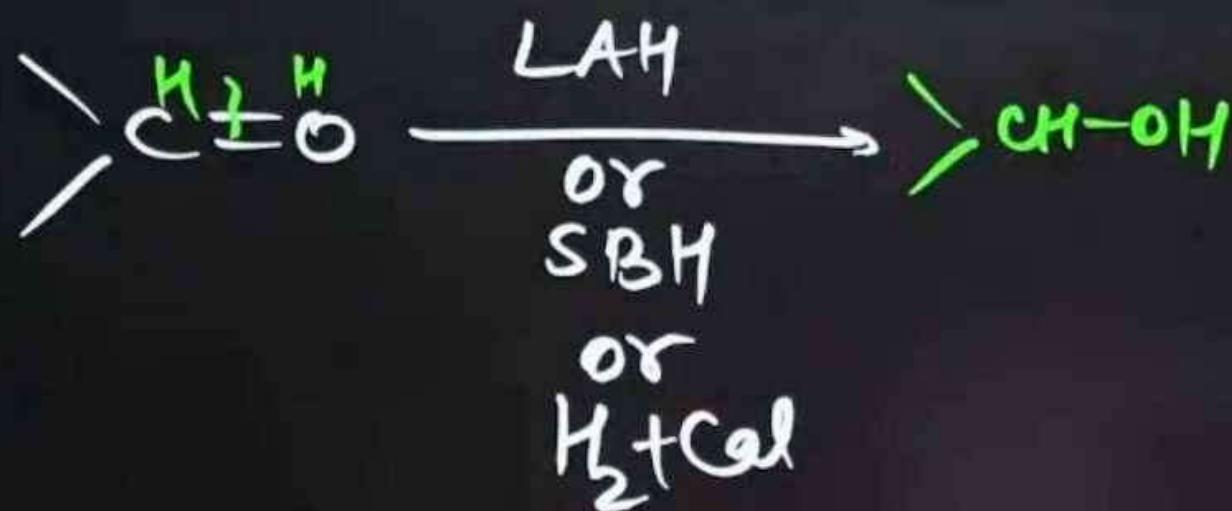
Z	Reagent name	Carbonyl derivative	Product name
-H	Ammonia	>C=NH	Imine
-R	Amine	>C=NR	Substituted imine (Schiff's base)
-OH	Hydroxylamine	>C=N-OH	Oxime
-NH ₂	Hydrazine	>C=N-NH_2	Hydrazone
	Phenylhydrazine	>C=N-NH-phenyl	Phenylhydrazone
	Brady's reagent 2,4-Dinitrophenylhydrazine	$\text{>C=N-NH-2,4-dinitrophenyl}$ <i>ROY</i>	2,4 Dinitrophenylhydrazone
	Semicarbazide	$\text{>C=N-NH-C(=O)-NH}_2$	Semicarbazone



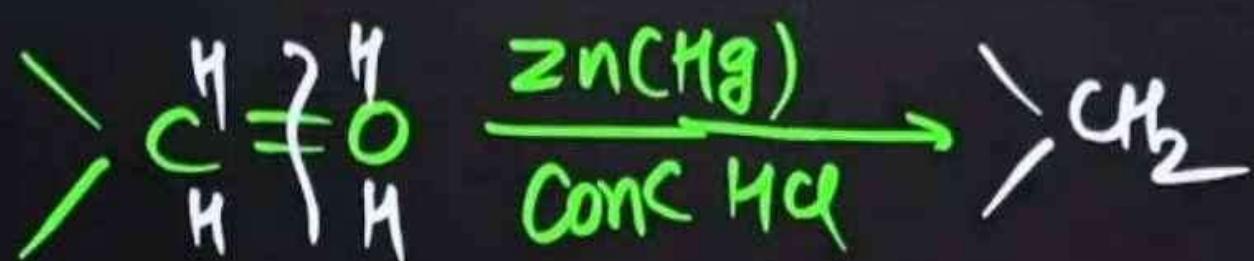
2. Reduction Reaction:



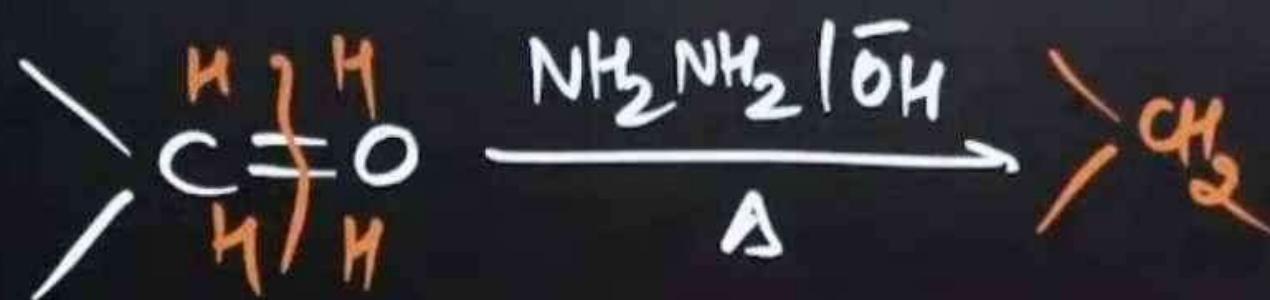
A. Reduction to Alcohols:



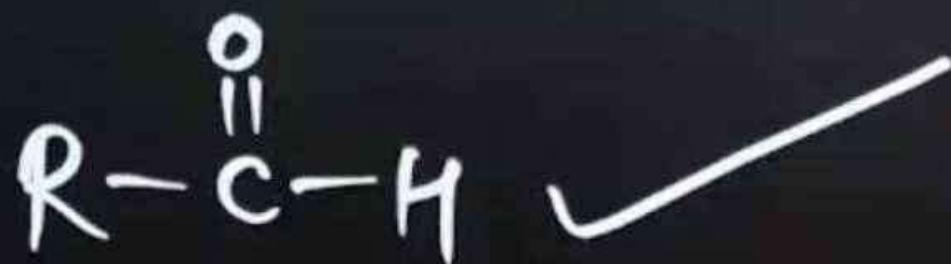
B. Clemmensen Reduction:



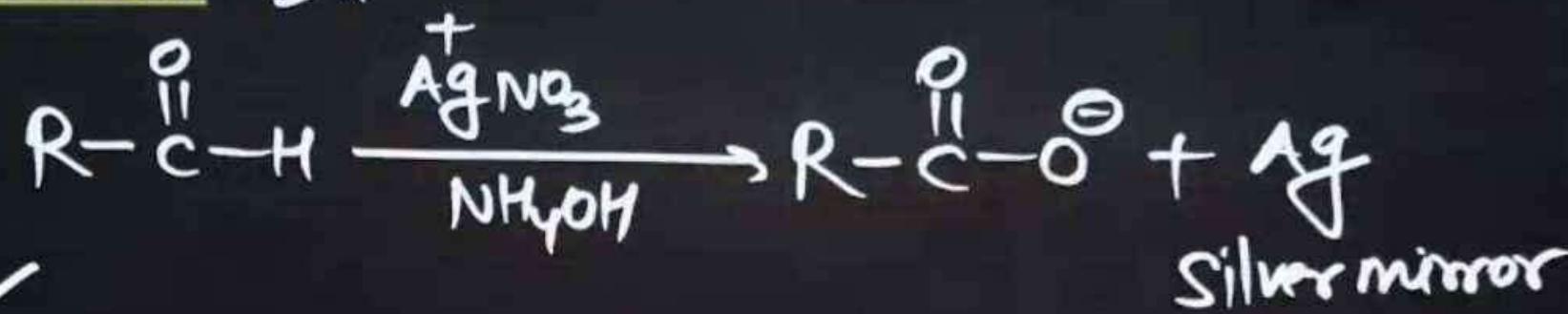
C. Wolff-Kishner Reduction:



3. Oxidation Reaction:



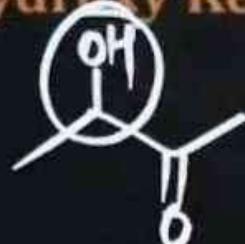
A. Tollen's Test: Silver mirror Test



Ali Ald ✓
Aro Ald ✓
Ket X

Compounds other than Aldehydes & Ketones Perform Tollen's Test

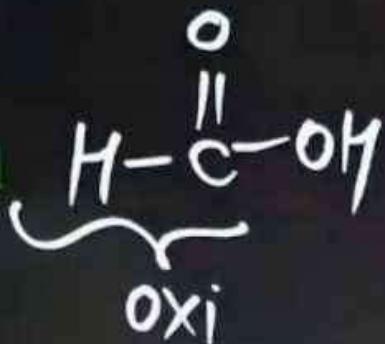
1. α -Hydroxy Ketone



2. R/ArNH₃⁺Cl⁻

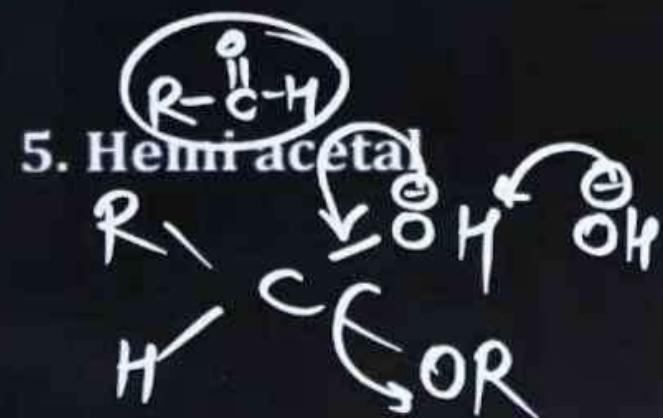
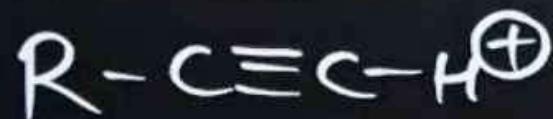


3. Formic Acid



Compounds other than Aldehydes & Ketones Perform Tollen's Test

4. Terminal Alkynes

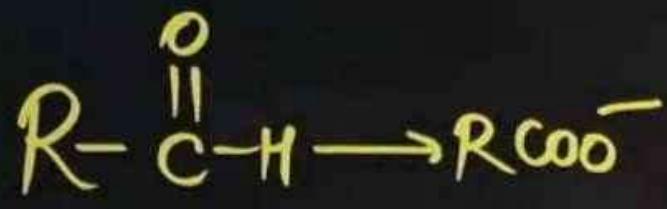


6. Cl⁻, Br⁻, I⁻ Ion



B. Fehling's Test: Al₁ Ald✓ Al₂ Ald X Ket X

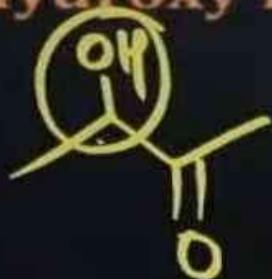
aqueous + NaKT Sodium potassium tartrate
Fehling A Rochelle's salt
COONa
CH₂O⁺
CHOH
COOK



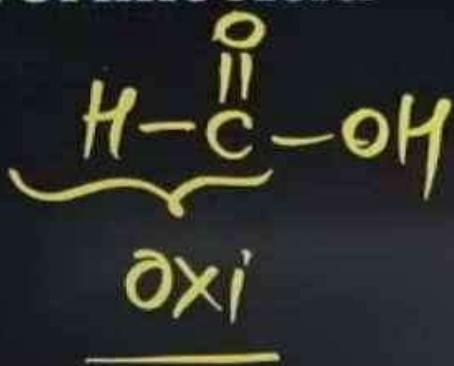
Red ppt

Compounds other than Aldehydes Perform Fehling's Test

1. α -Hydroxy Ketone



2. Formic Acid

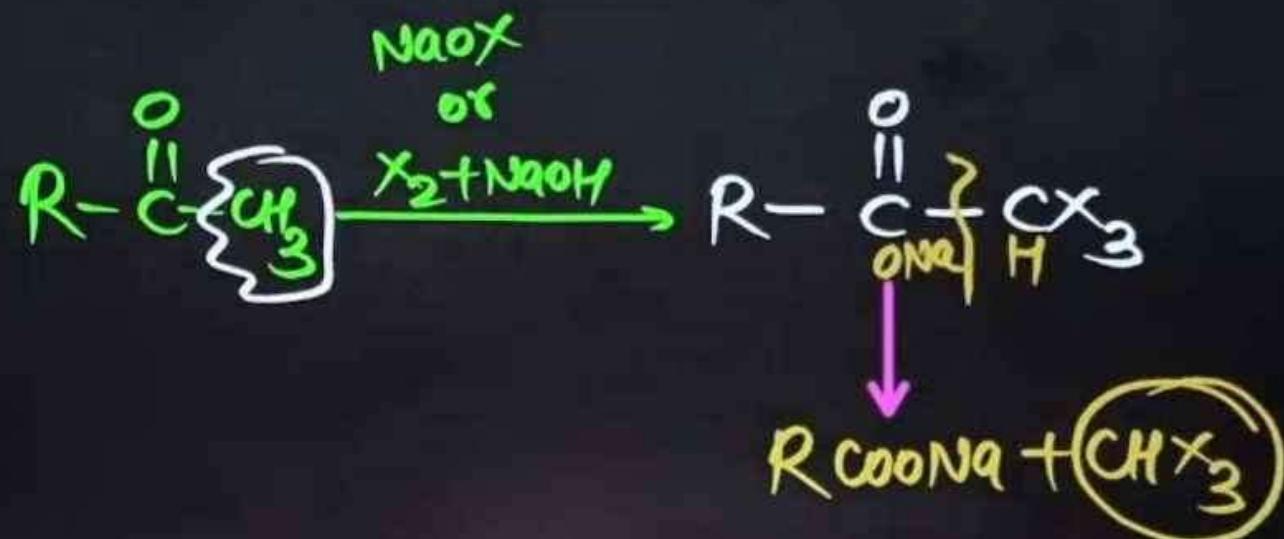
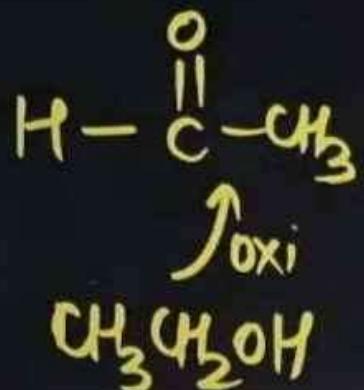
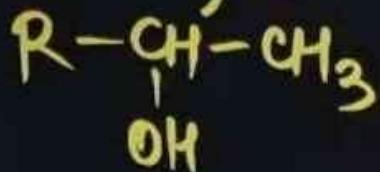
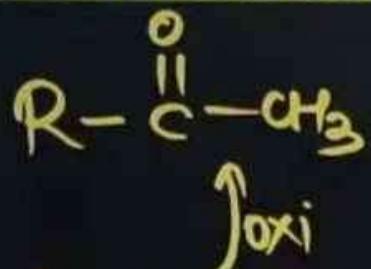


C. Benedict's Test:

Same as fehling

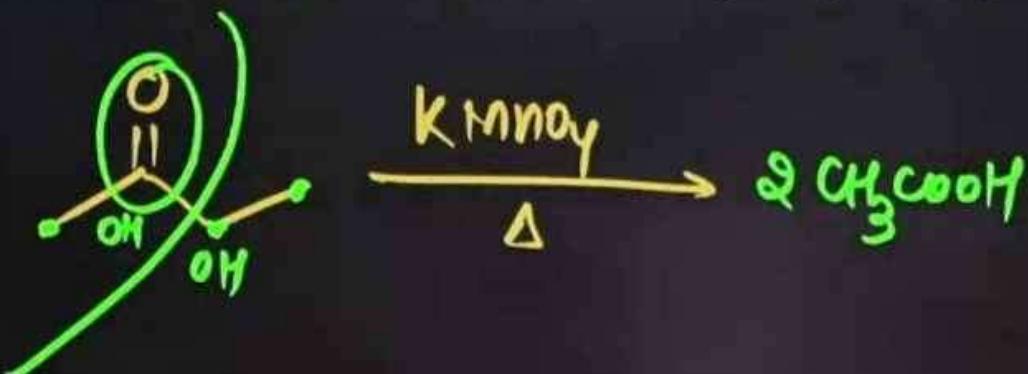
Salt → Sodium citrate

D. Haloform Test:



E. Popoff's Rule:

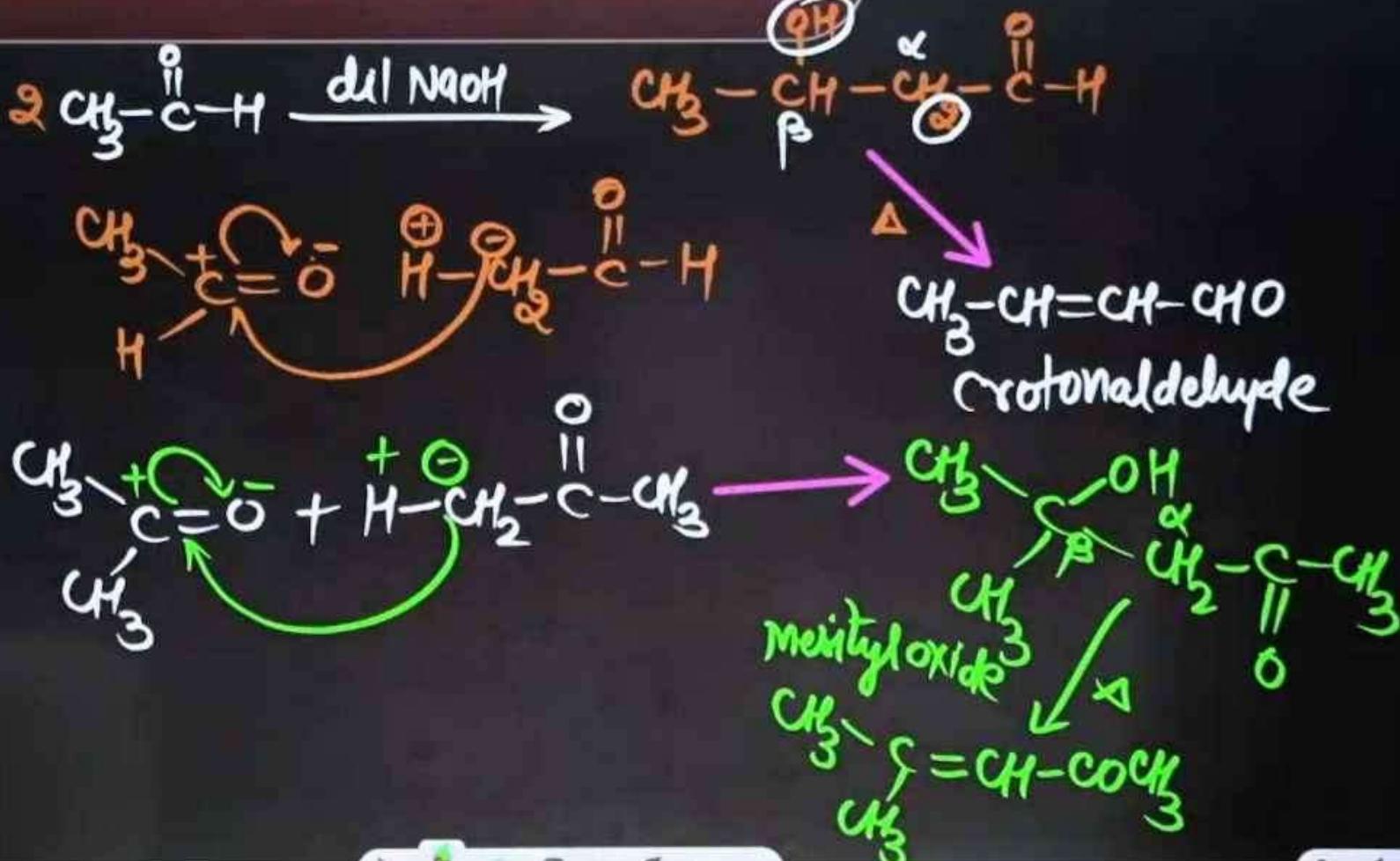
Popoff's rule states that during the oxidation of unsymmetrical ketone, the cleavage of the C-CO bond is such that the keto group always stays with smaller alkyl group.





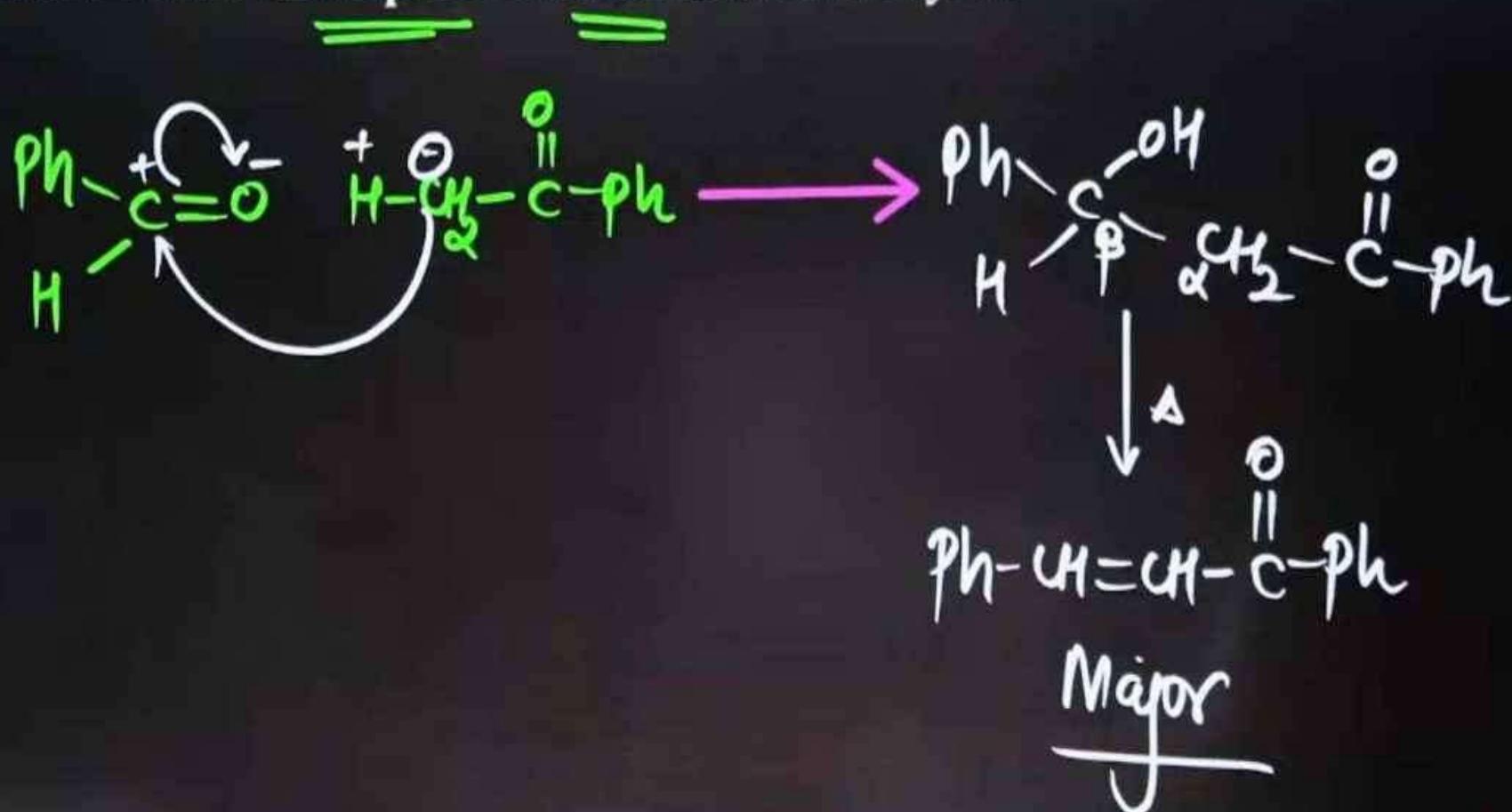
Aldol Reaction and Condensation

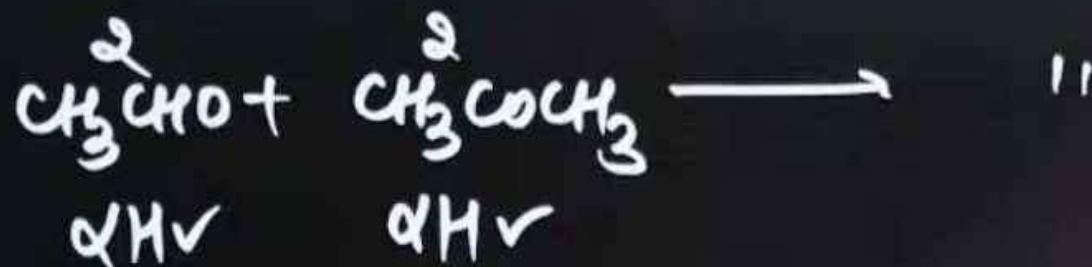
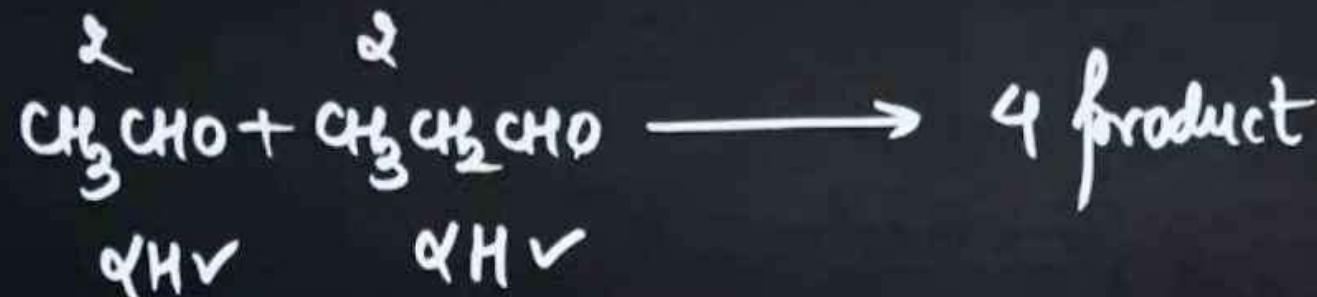
α -H ✓
carbonyl



Cross or Mixed Aldol:

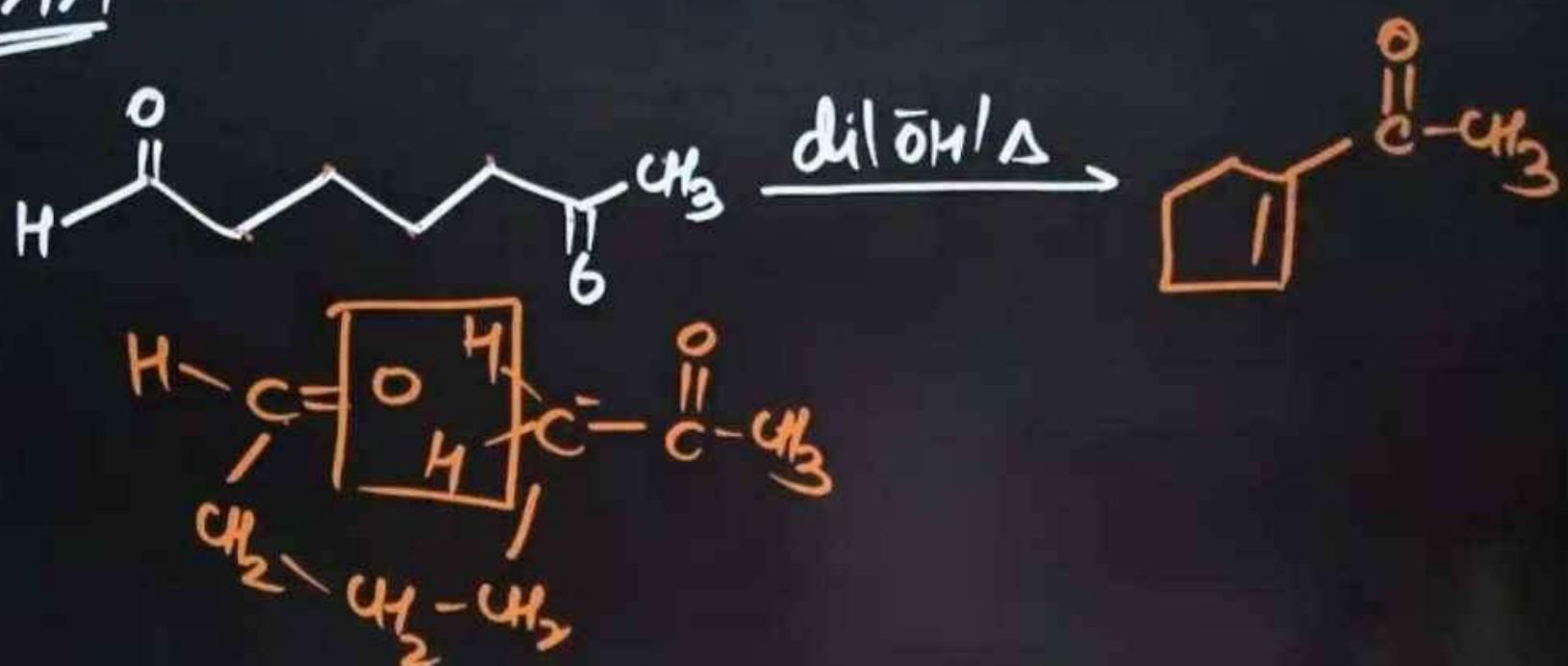
If reaction occurs between Aliphatic & Aromatic aldehyde.





Intramolecular Aldol:

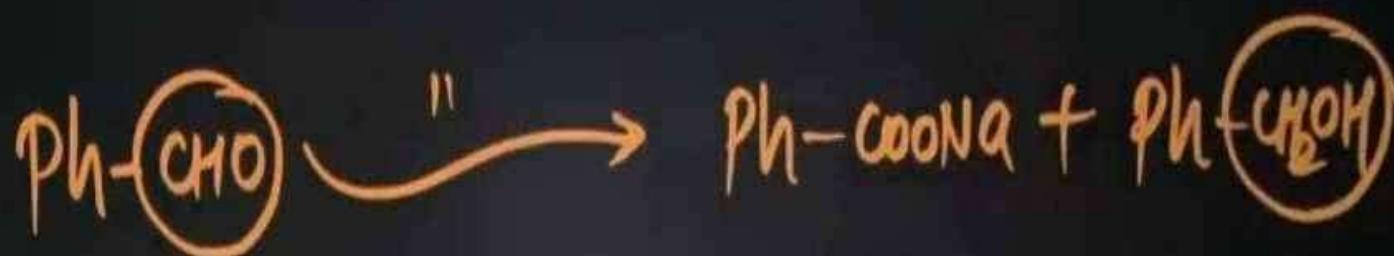
6757774



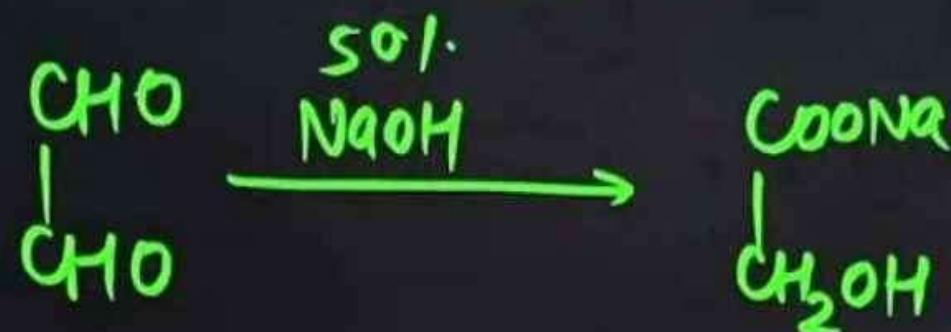


Cannizzaro Reaction

Ald
do not have
 α H

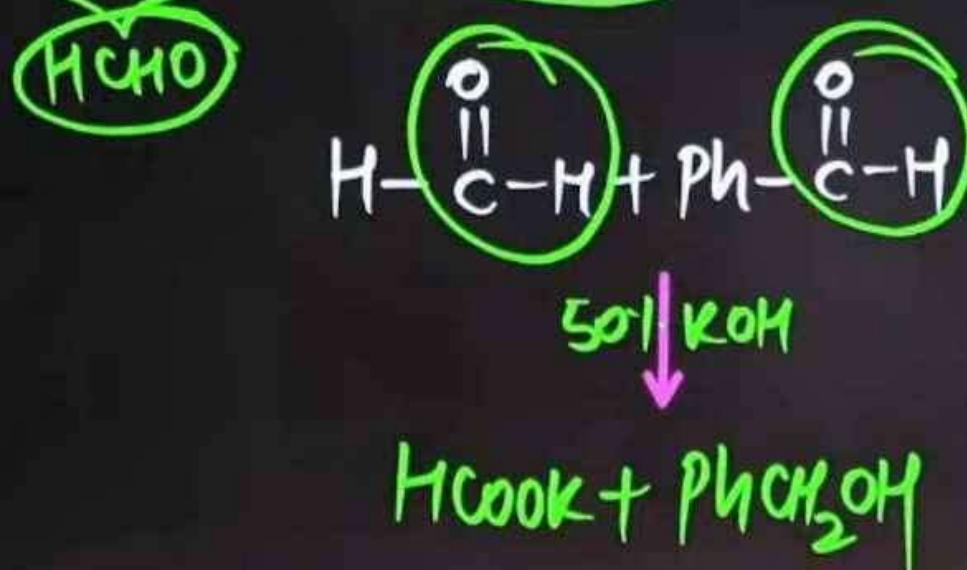


Intramolecular Cannizzaro Reaction:

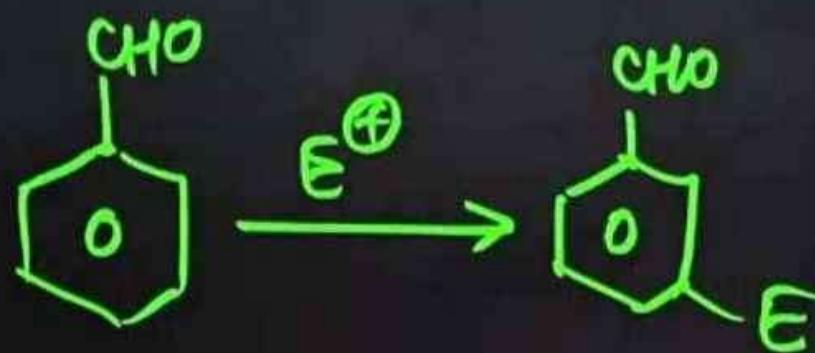


Cross Cannizzaro Reaction:

1. It is redox but not disproportionation reaction.
2. More electrophilic Aldehyde will oxidize.



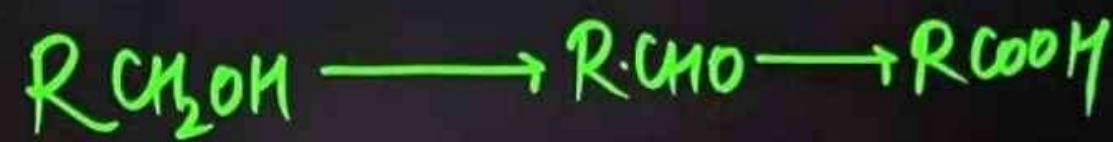
Electrophilic Substitution Reaction of Carbonyl Compounds:





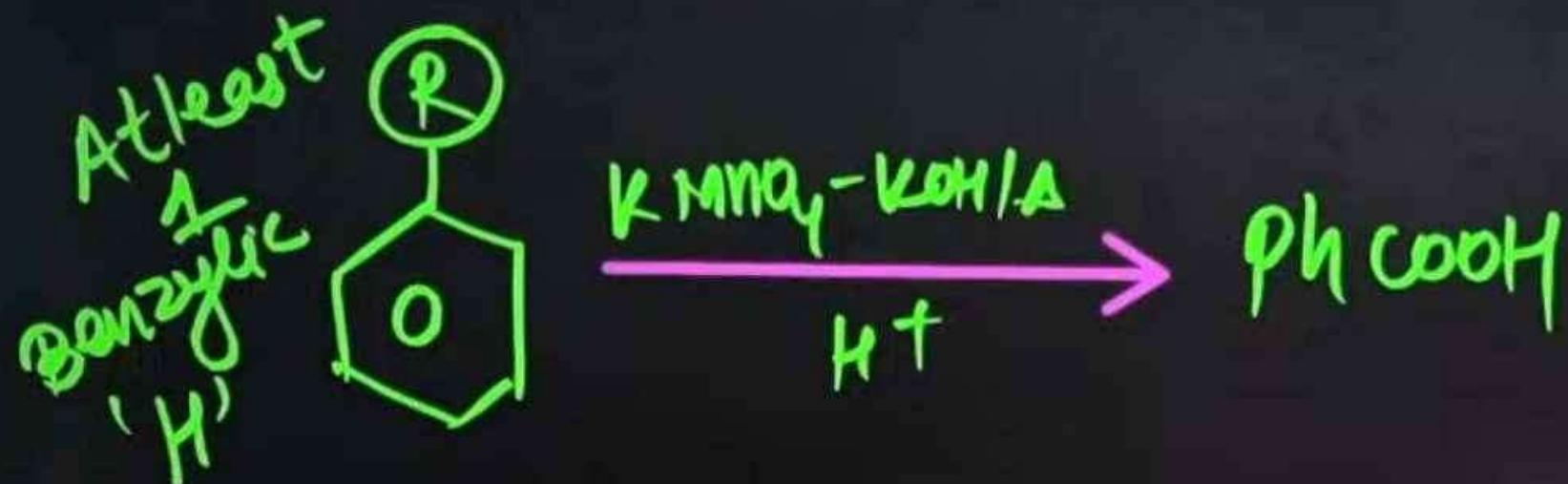
Methods of Preparation of Carboxylic Acids

1. From primary alcohols and aldehydes:



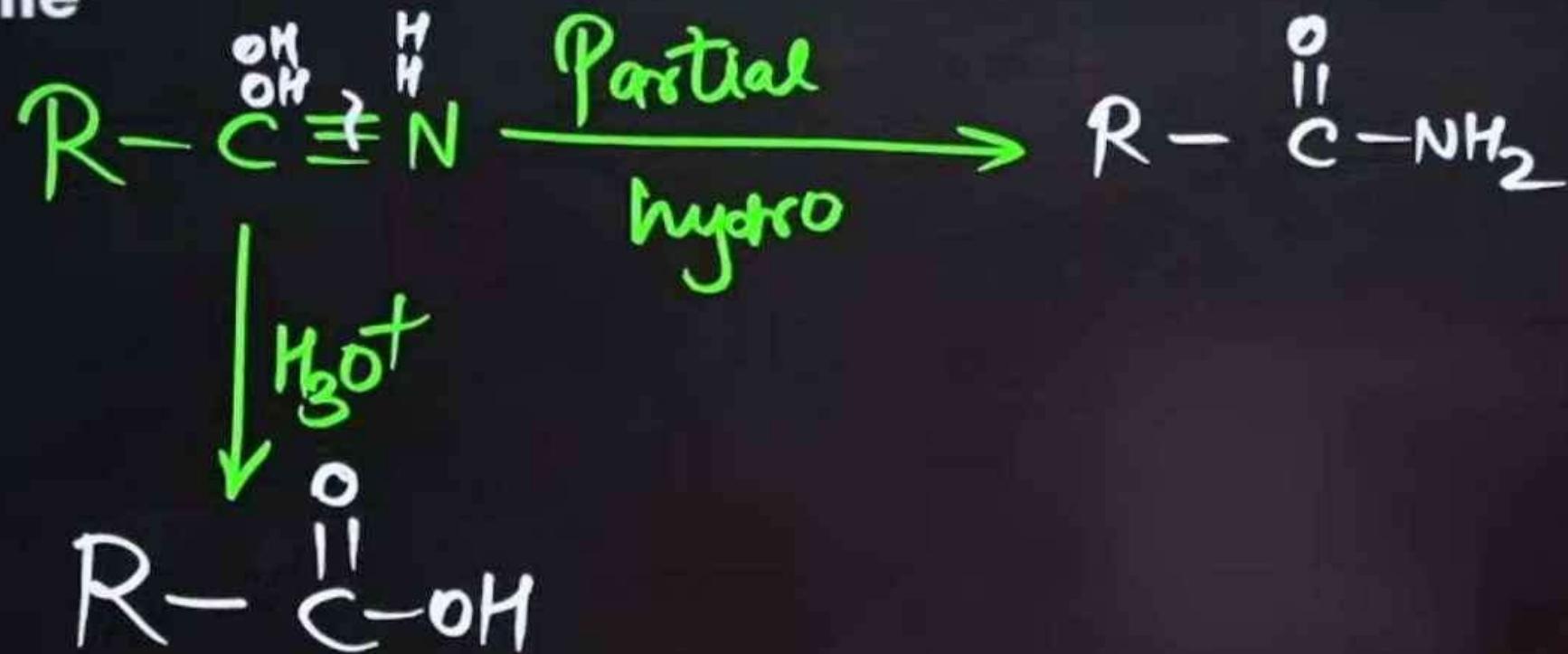
SO A ✓

2. From alkyl benzene:



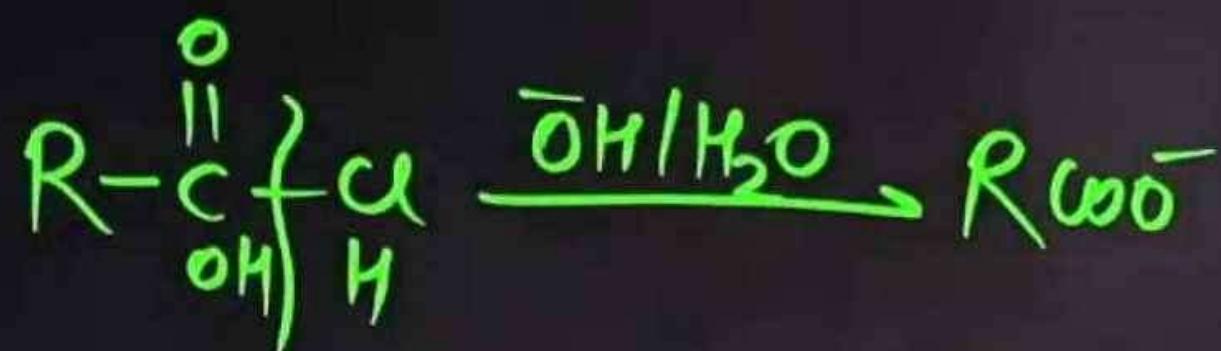
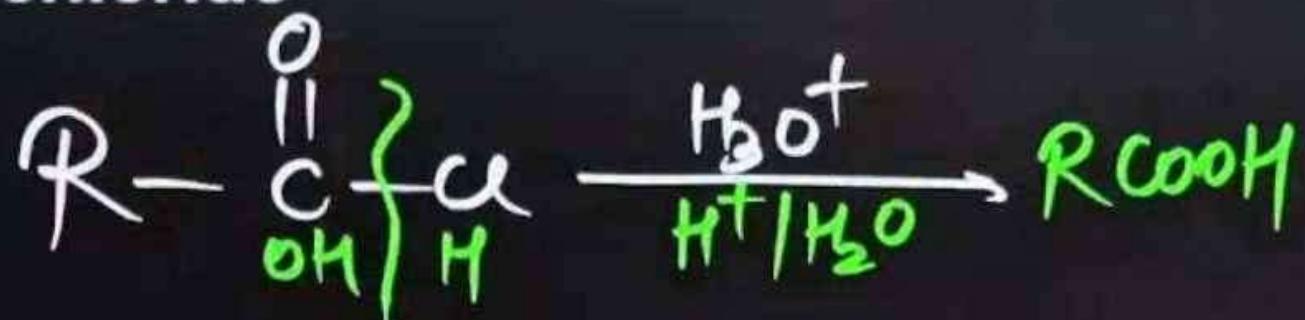
3. From hydrolysis of acid derivatives:

A. Nitrile



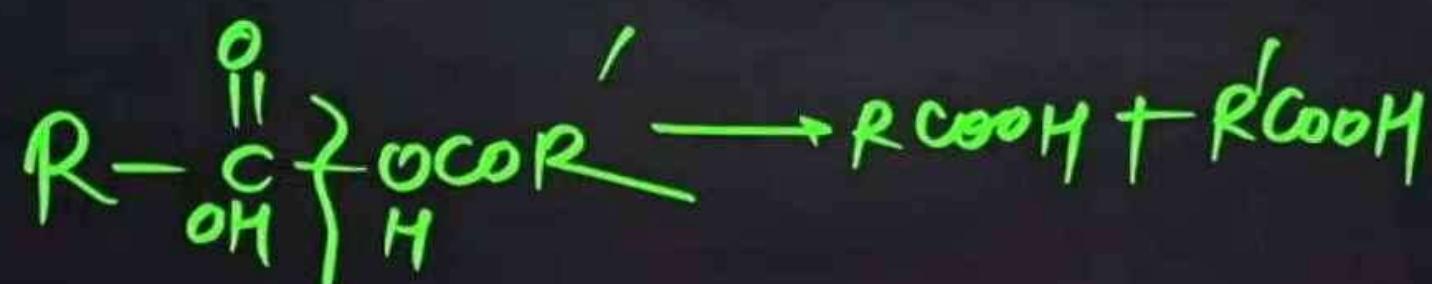
3. From hydrolysis of acid derivatives:

B. Acid chloride



3. From hydrolysis of acid derivatives:

C. Anhydride

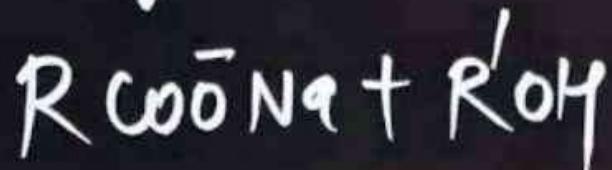


3. From hydrolysis of acid derivatives:

D. Ester

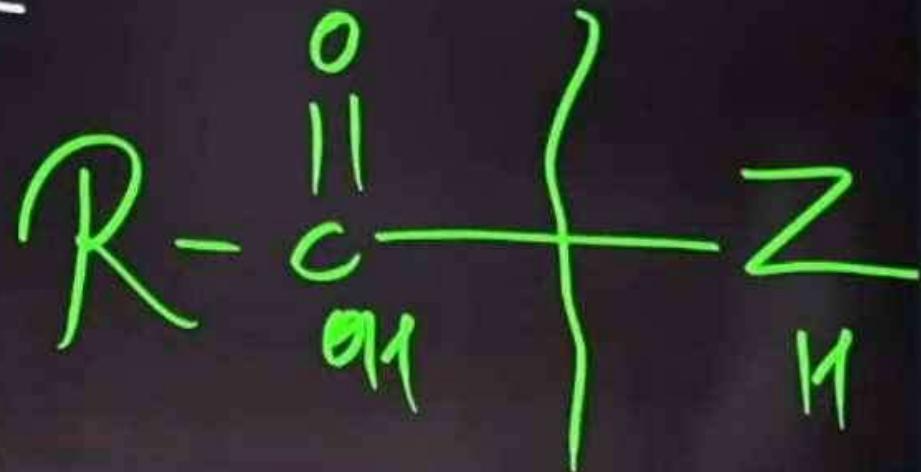
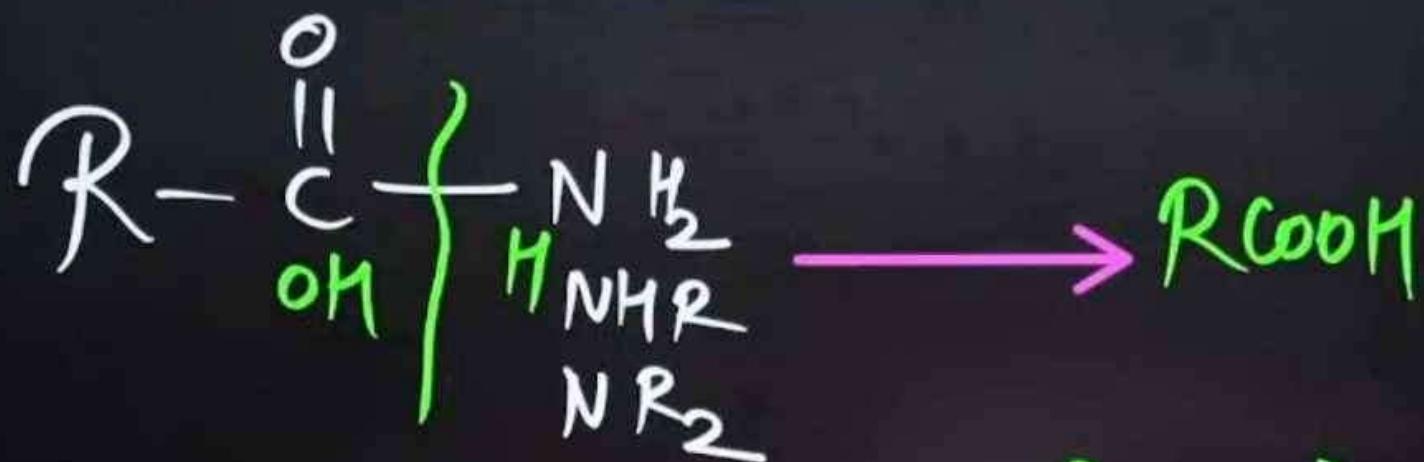


Saponification
↓ NaOH/H₂O

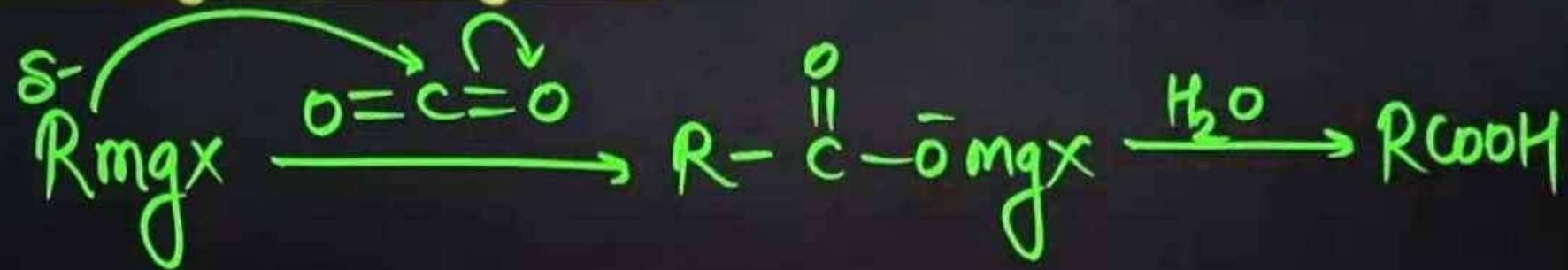


3. From hydrolysis of acid derivatives:

E. Amides



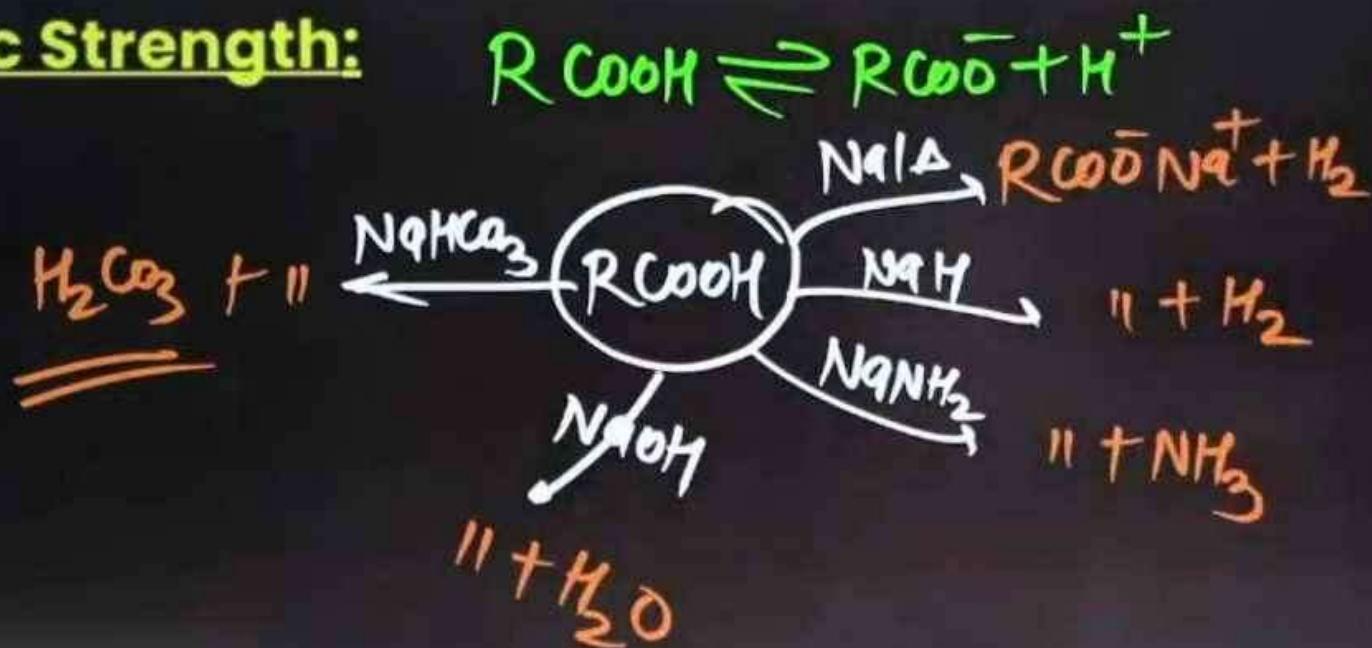
4. From Grignard reagents:



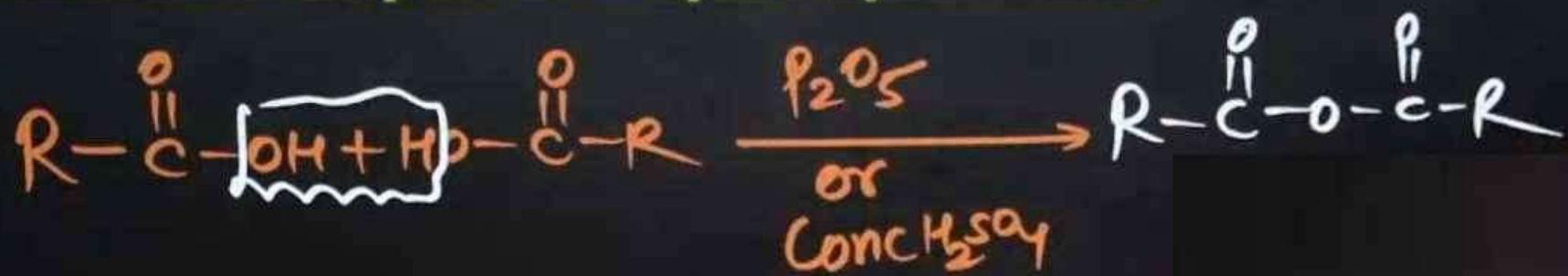


Chemical Properties of Carboxylic Acids

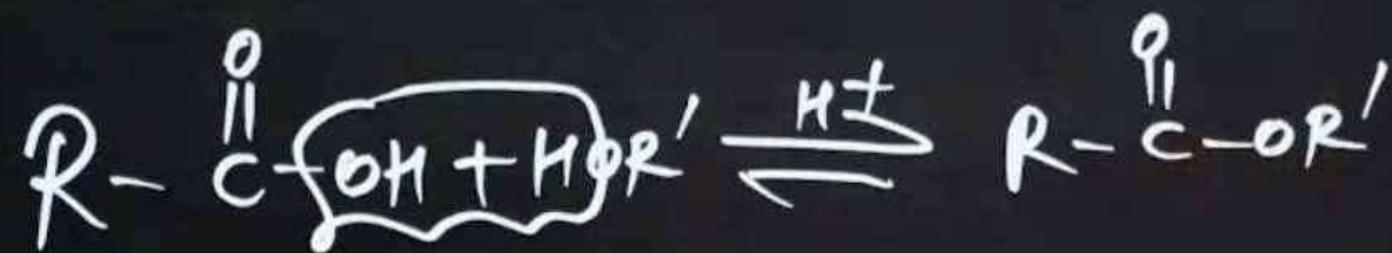
1. Acidic Strength:



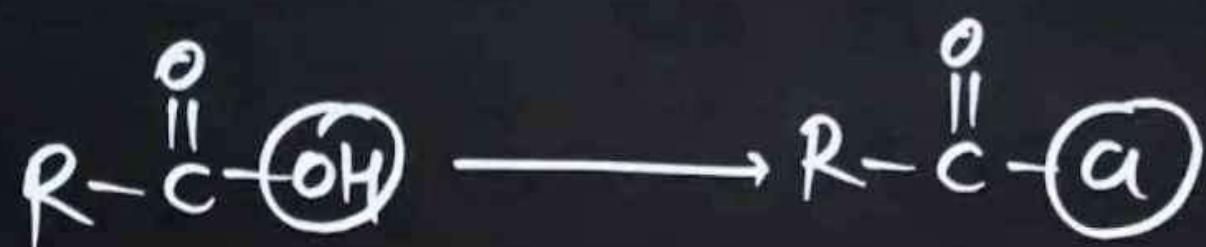
2. Formation of anhydrides by dehydration:



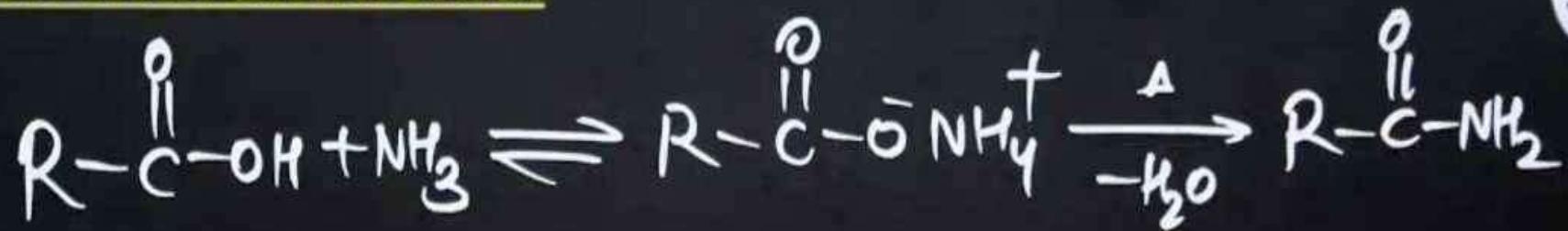
3. Esterification:



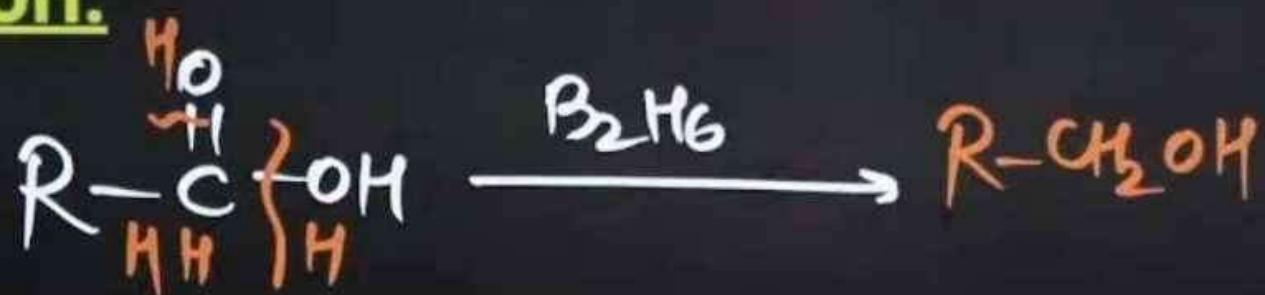
4. Reaction with PCl_3 , PCl_5 & SOCl_2 :



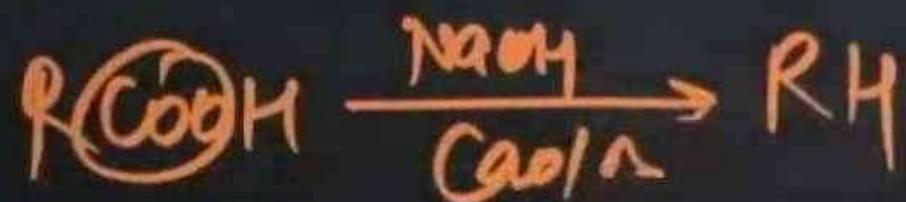
5. Reaction with ammonia:



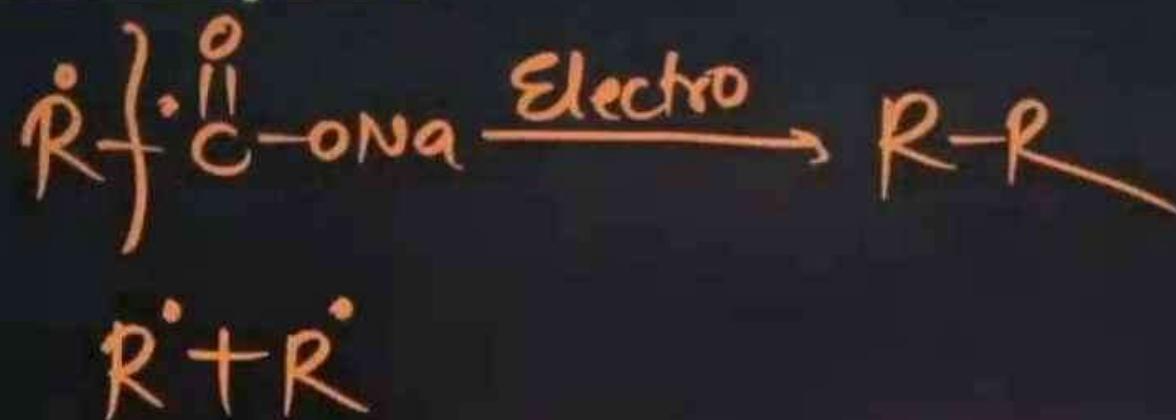
6. Reduction:



7. Decarboxylation:

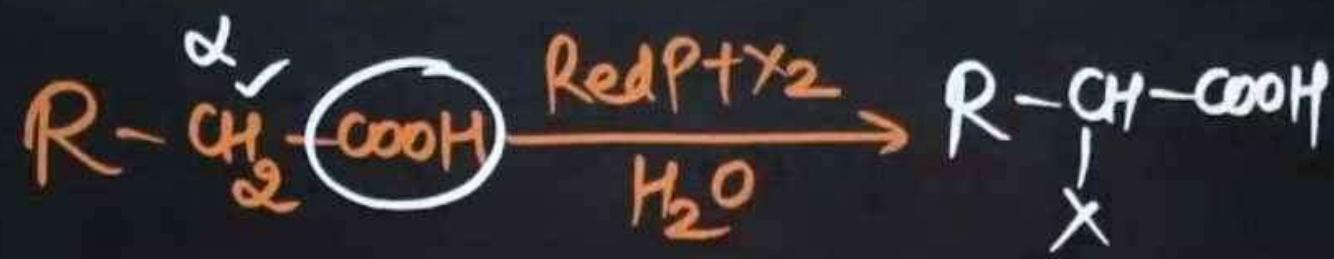


8. Kolbe's Electrolysis:

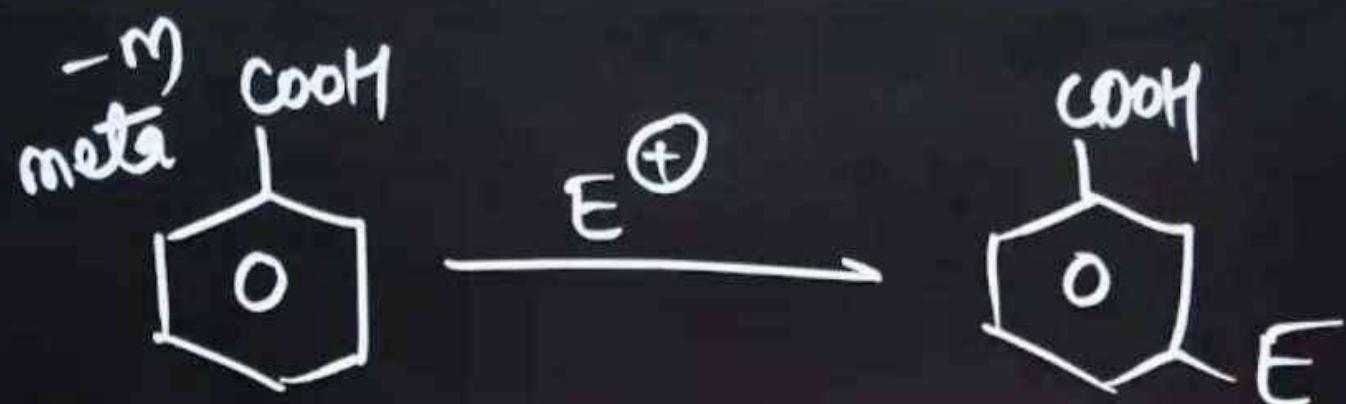


9. Halogenation (H.V.Z. Reaction):

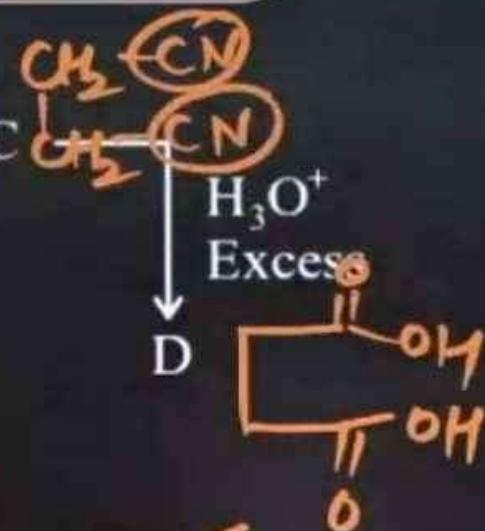
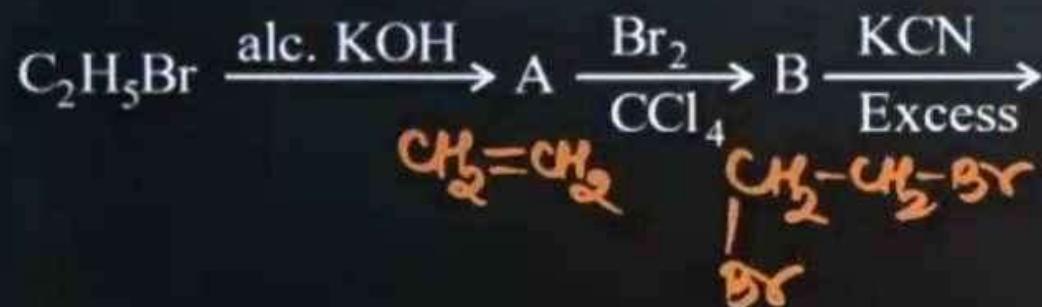
acid having
 α -H



10. Electrophilic Aromatic Substitution Reaction:



QUESTION (JEE Mains 1st Feb 2024, Evening Shift)



Acid D formed in above reaction is:

- A Gluconic acid
- B Succinic acid
- C Oxalic acid
- D Malonic acid

QUESTION (JEE Mains 1st Feb 2024, Morning Shift)



Match List-I with List-II.

List – I (Reactions)		List – II (Reagents)	
(A) $\text{CH}_3(\text{CH}_2)_5\text{C}(\text{H}_2\text{O})\text{OC}_2\text{H}_5 \rightarrow \text{CH}_3(\text{CH}_2)_5\text{CHO}$	IV	(I)	$\text{CH}_3\text{MgBr}, \text{H}_2\text{O}$
(B) $\text{C}_6\text{H}_5\text{COCl} \rightarrow \text{C}_6\text{H}_5\text{CH}_2\text{C}_6\text{H}_5$	II	(II)	$\text{Zn}(\text{Hg})$ and conc. HCl
(C) $\text{C}_6\text{H}_5\text{CHO} \rightarrow \text{C}_6\text{H}_5\text{CH}(\text{OH})\text{CH}_3$	I	(III)	$\text{NaBH}_4, \text{H}^+$
(D) $\text{CH}_3\text{COCH}_2\text{COOC}_2\text{H}_5 \rightarrow \text{CH}_3\overset{\text{H}}{\underset{\text{III}}{\text{C}}}(\text{OH})\text{CH}_2\text{COOC}_2\text{H}_5$		(IV)	DIBAL-H, H_2O

Choose the correct answer from options given below:



A

A-(III), (B)-(IV), C-(I), (D)-(II)

B

A-(IV), (B)-(II), C-(I), (D)-(III)

C

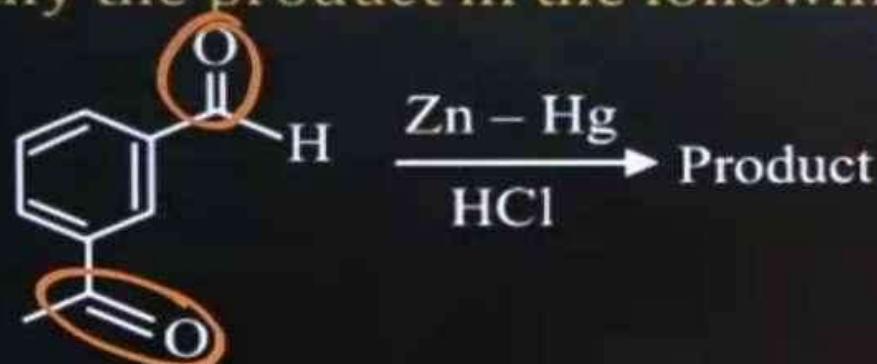
A-(IV), (B)-(II), C-(III), (D)-(I)

D

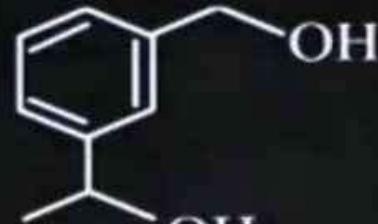
A-(III), (B)-(IV), C-(II), (D)-(I)

QUESTION (JEE Mains 4th April 2024, Morning Shift)

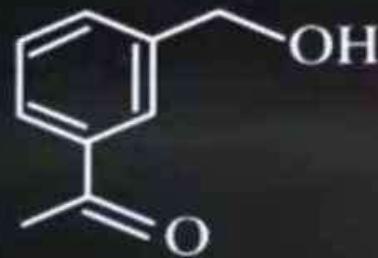
Identify the product in the following reaction:



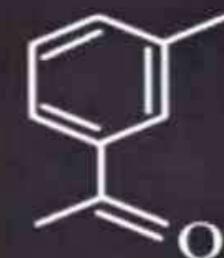
A



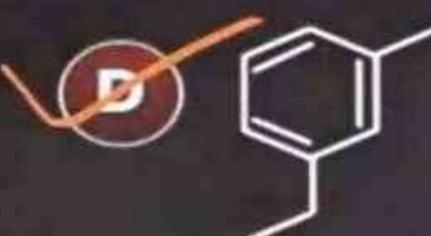
C



B



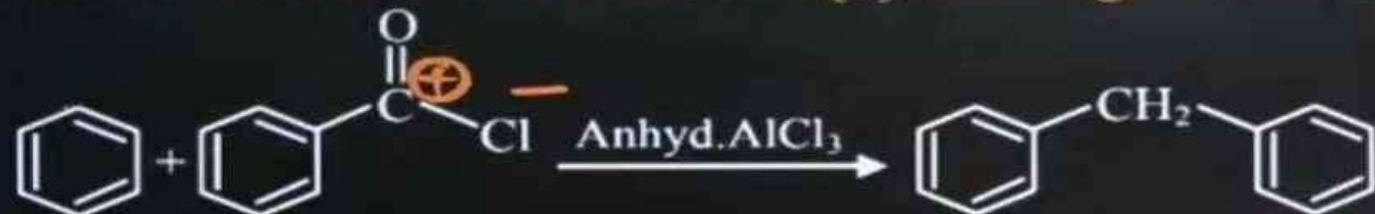
D



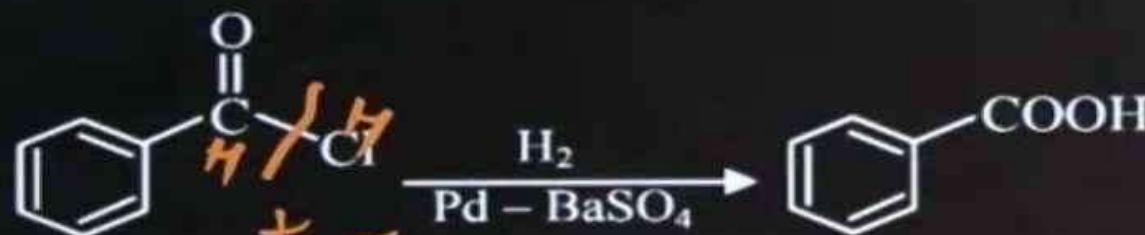
QUESTION (JEE Mains 4th April 2024, Morning Shift)

The number of correct reaction(s) among the following is _____.

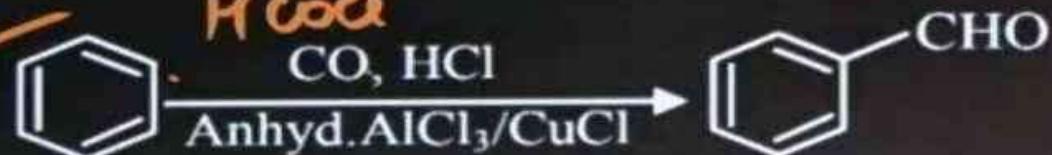
A



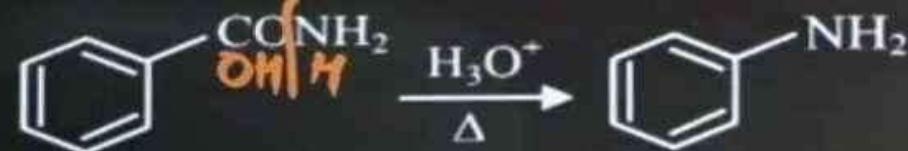
B



C

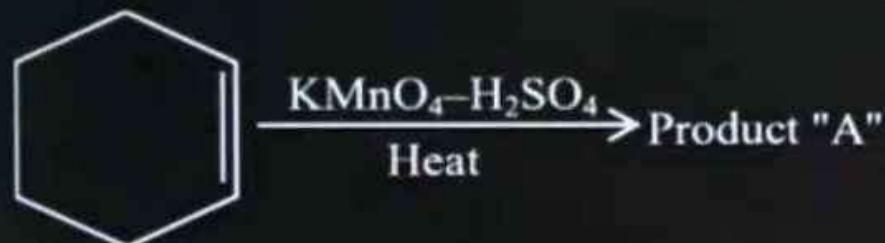


D



QUESTION (JEE Mains 5th April 2024, Evening Shift)

Consider the given chemical reaction:

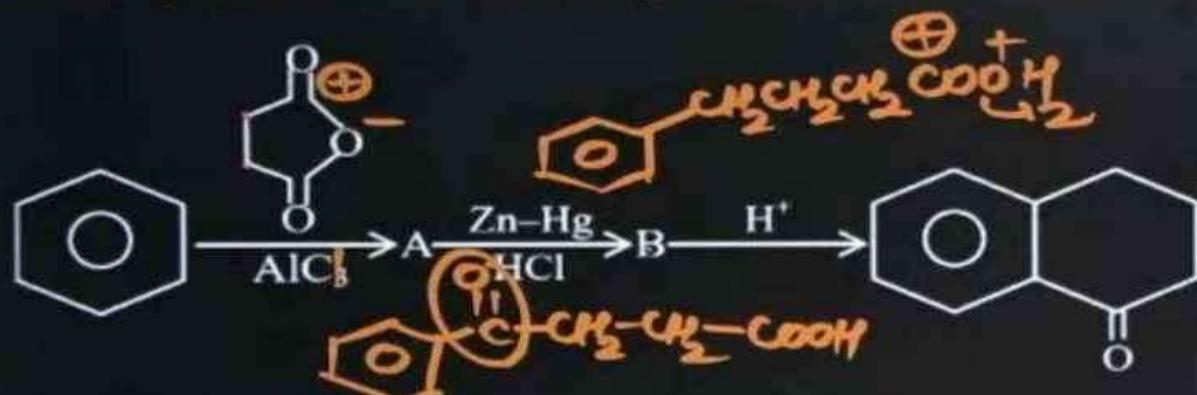


Product "A" is:

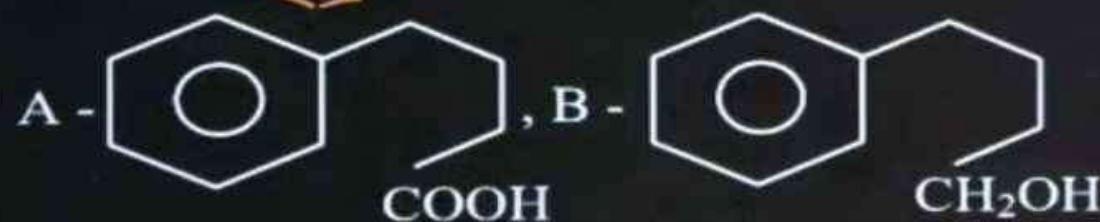
- A picric acid
- B oxalic acid
- C acetic acid
- D adipic acid

QUESTION (JEE Mains 5th April 2024, Evening Shift)

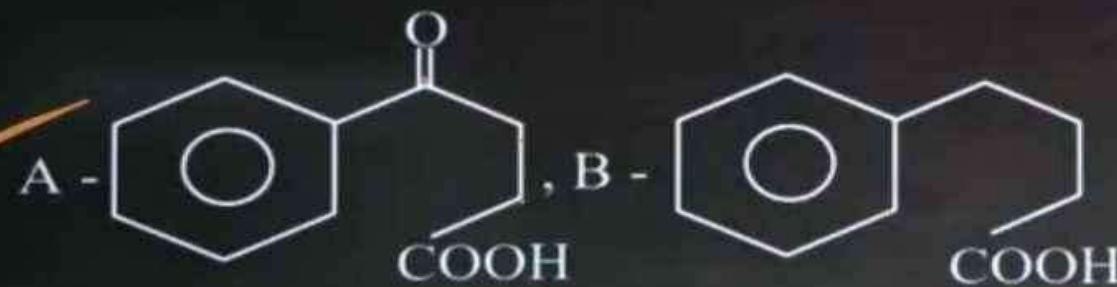
Identify A and B in the given chemical reaction sequence:



A

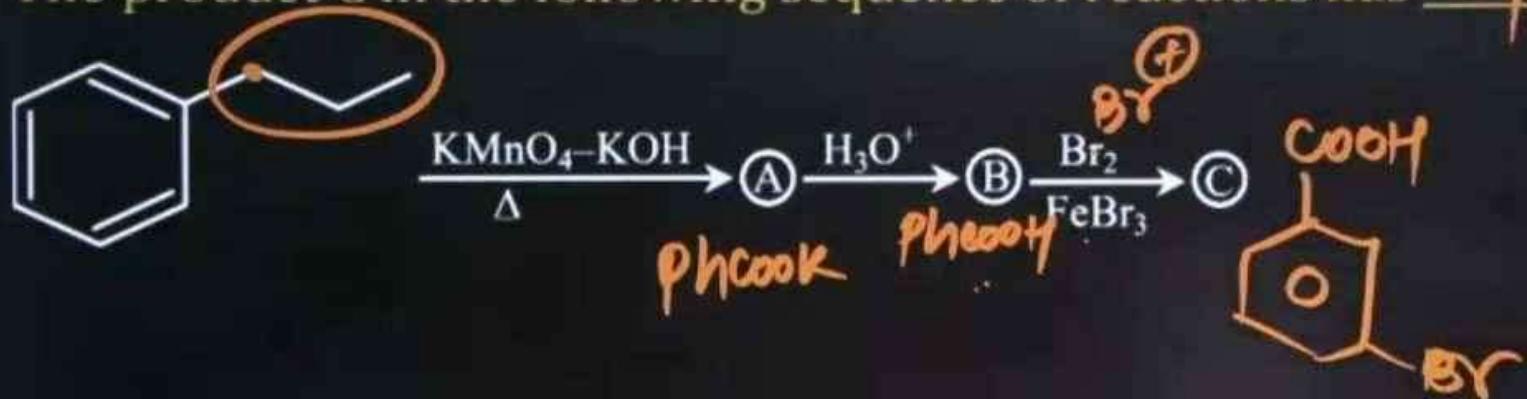


B



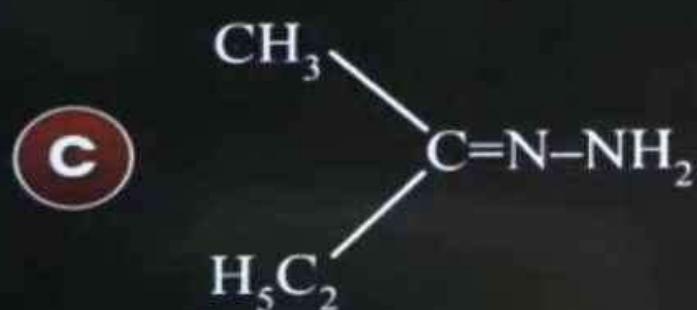
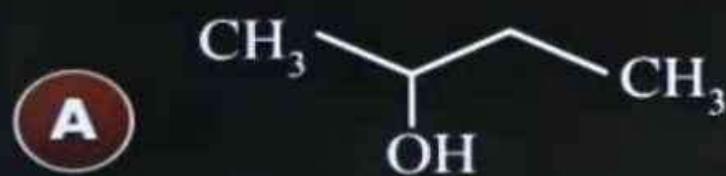
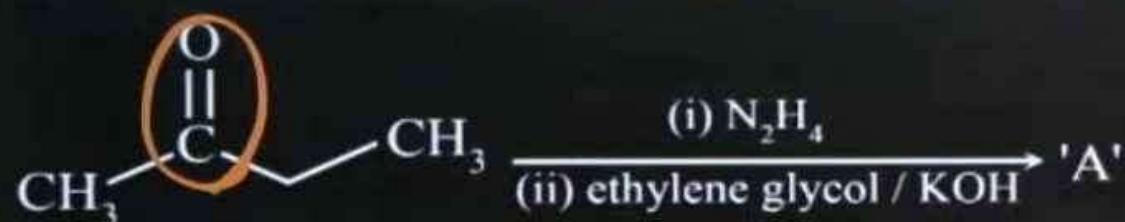
QUESTION (JEE Mains 5th April 2024, Evening Shift)

The product C in the following sequence of reactions has 4 π bonds.



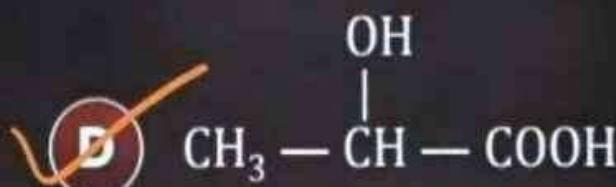
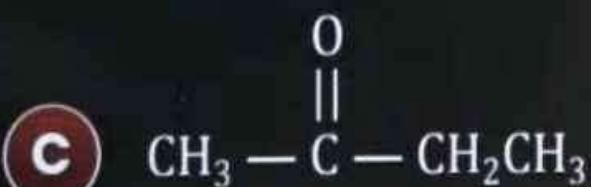
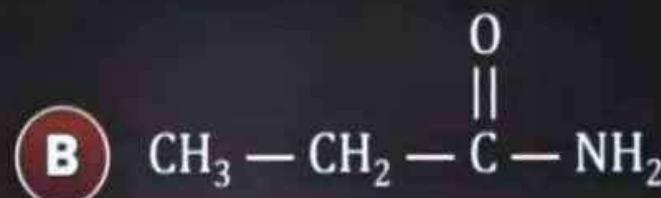
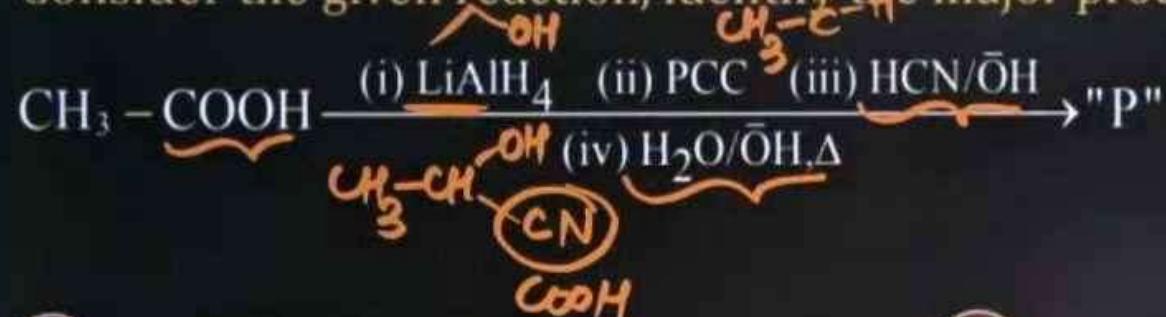
QUESTION (JEE Mains 5th April 2024, Morning Shift)

Identify 'A' in the following reaction:



QUESTION (JEE Mains 6th April 2024, Evening Shift)

Consider the given reaction, identify the major product P.



QUESTION (JEE Mains 6th April 2024, Morning Shift)

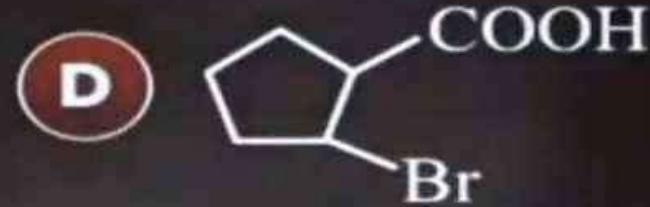
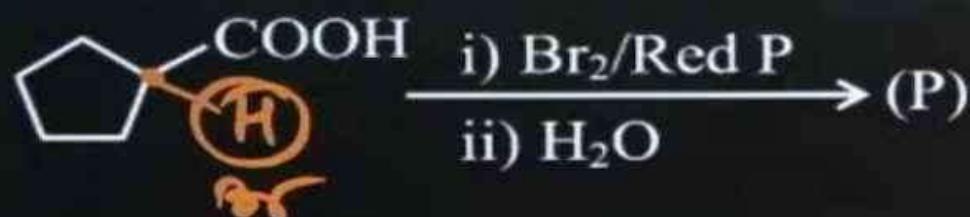
Which among the following aldehydes is most reactive towards nucleophilic addition reactions?

- A** $\text{H}-\overset{\text{O}}{\parallel}\text{C}-\text{H}$
- B** $\text{C}_2\text{H}_5-\overset{\text{O}}{\parallel}\text{C}-\text{H}$
- C** $\text{CH}_3-\overset{\text{O}}{\parallel}\text{C}-\text{H}$
- D** $\text{C}_3\text{H}_7-\overset{\text{O}}{\parallel}\text{C}-\text{H}$

QUESTION (JEE Mains 8th April 2024, Morning Shift)

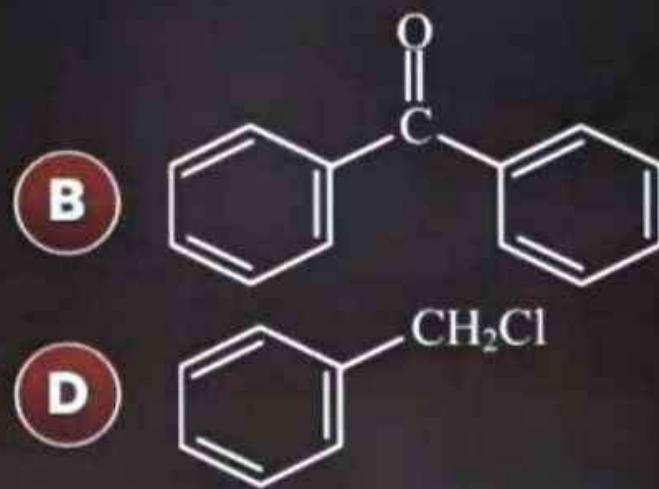
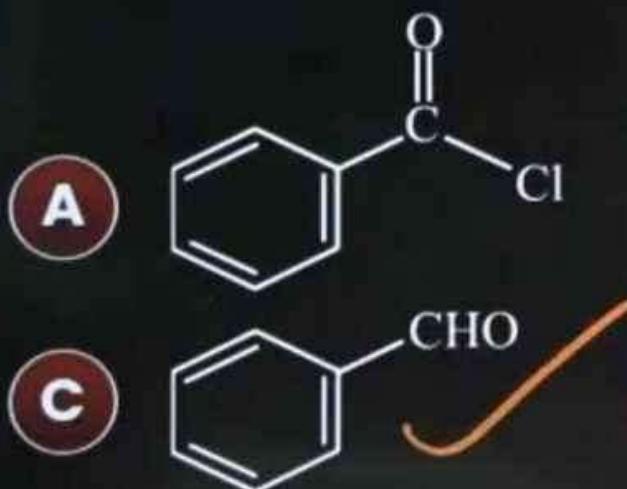
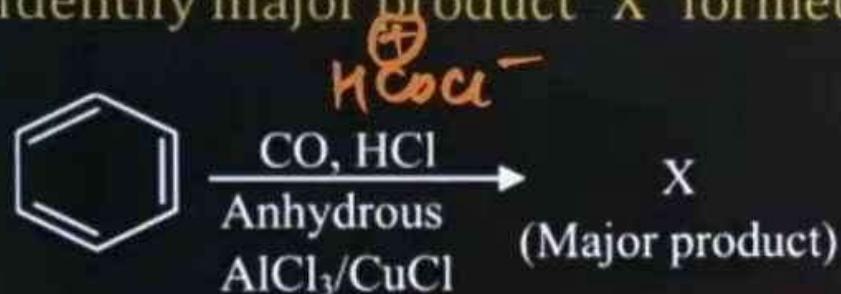
Hν

Identify the product (P) in the following reaction:



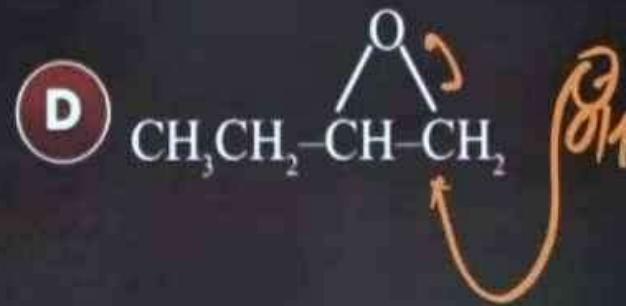
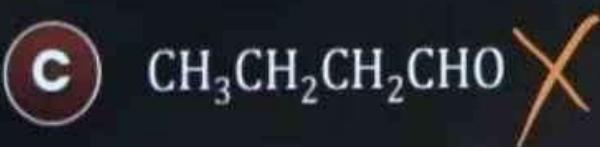
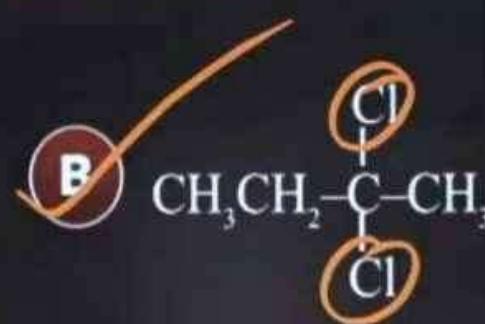
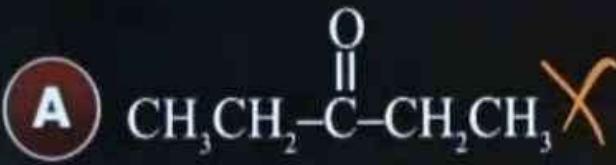
QUESTION (JEE Mains 9th April 2024, Morning Shift)

Identify major product "X" formed in the following reaction:



QUESTION (JEE Mains 9th April 2024, Evening Shift)

Which of the following compound can give positive iodoform test when treated with aqueous KOH solution followed by potassium hypoiodite.





QUESTION (JEE Mains 9th April 2024, Evening Shift)

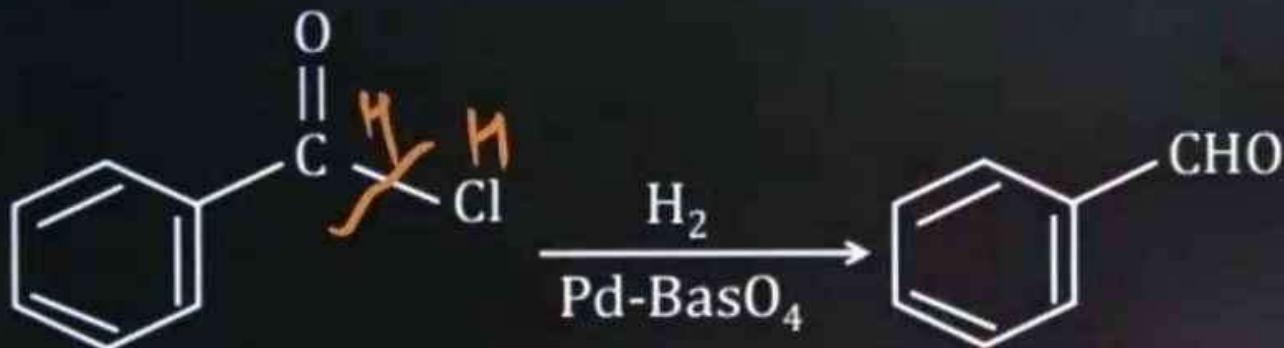
Which of the following compounds will give silver mirror with ammoniacal silver nitrate?

- (A) Formic acid HCOOH ✓
- (B) Formaldehyde HCHO ✓
- (C) Benzaldehyde PhCHO ✓
- (D) Acetone CH_3COCH_3 X

Choose the correct answer from the options given below:

- A** C and D only
- C** A only
- B** A, B and C only
- D** B and C only

QUESTION (JEE Mains 30 January 2024, Morning Shift)

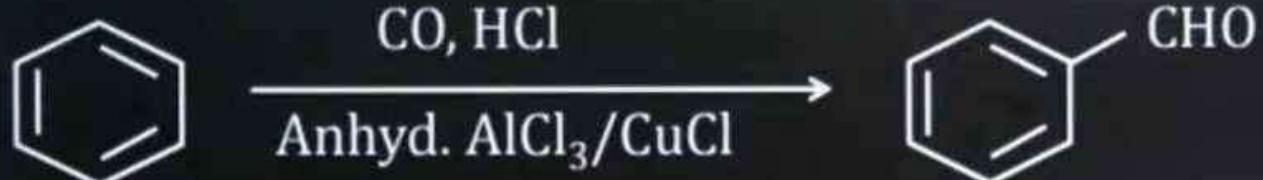


This reduction reaction is known as:

- A** Rosenmund reduction ✓
- B** Wolff-Kishner reduction
- C** Stephen reduction
- D** Etard reduction

QUESTION (JEE Mains 31 January 2024, Evening Shift)

Identify the name reaction.

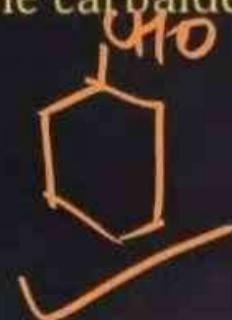


- A Stephen reaction
- B Etard reaction
- C Gatterman-koch reaction
- D Rosenmund reduction

QUESTION (JEE Mains 29 January 2024, Morning Shift)

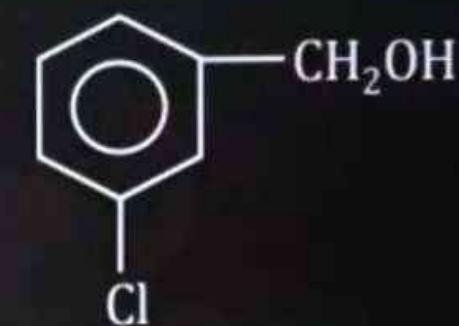
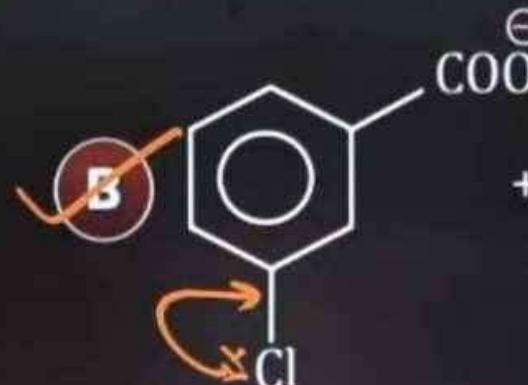
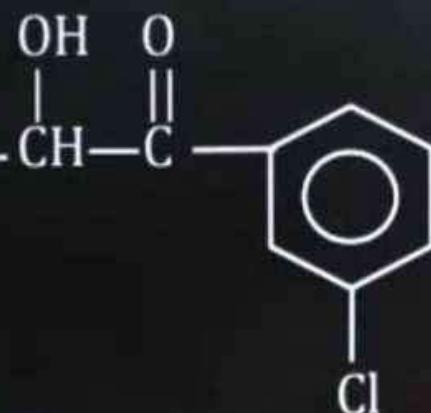
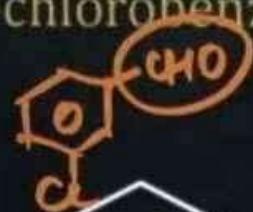
From the compounds given below, number of compounds which give positive Fehling's test is 3.

- Benzaldehyde, CH_3CHO , Acetone, Acetophenone , HCHO , Methanal, 4-nitrobenzaldehyde, cyclohexane carbaldehyde.

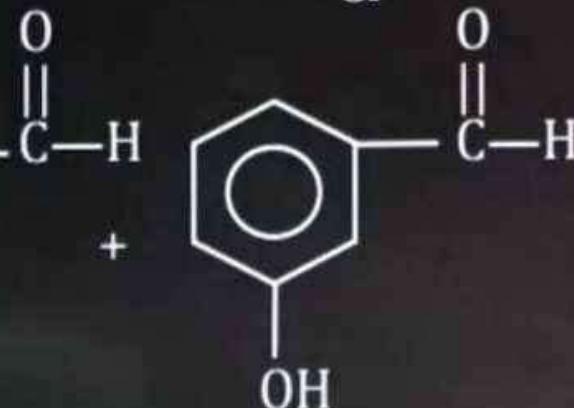


QUESTION (JEE Mains 30 January 2024, Evening Shift)

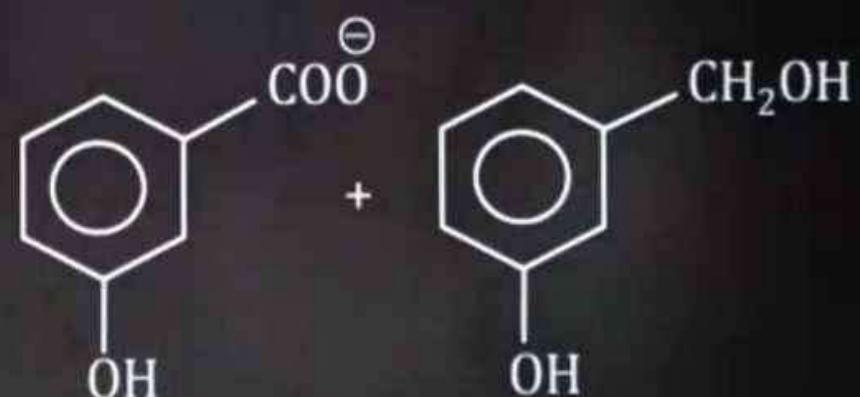
m-chlorobenzaldehyde on treatment with 50% KOH solution yields



A



D

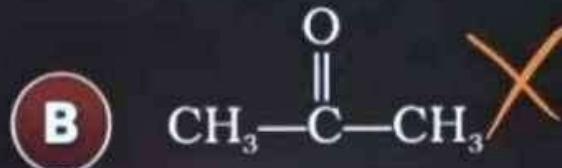
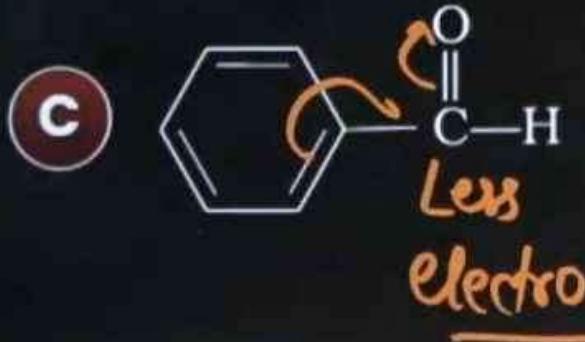
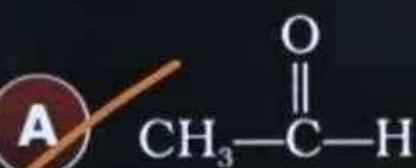


C



QUESTION (NCERT Exemplar)

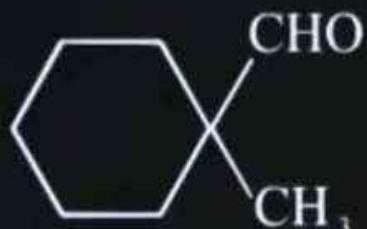
Which of the following compounds is most reactive towards nucleophilic addition reactions?



QUESTION (NCERT Exemplar)

Cannizaro's reaction is not given by _____.

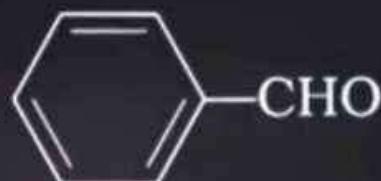
A



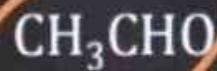
C



B



D



QH ✓

QUESTION (NCERT Exemplar)

Which product is formed when the compound  is treated with concentrated aqueous KOH solution?

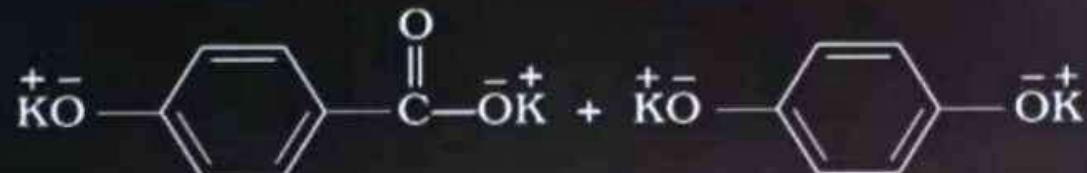
A



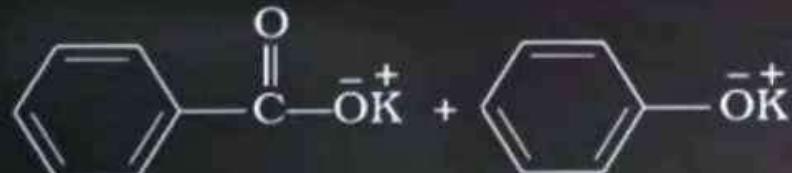
B



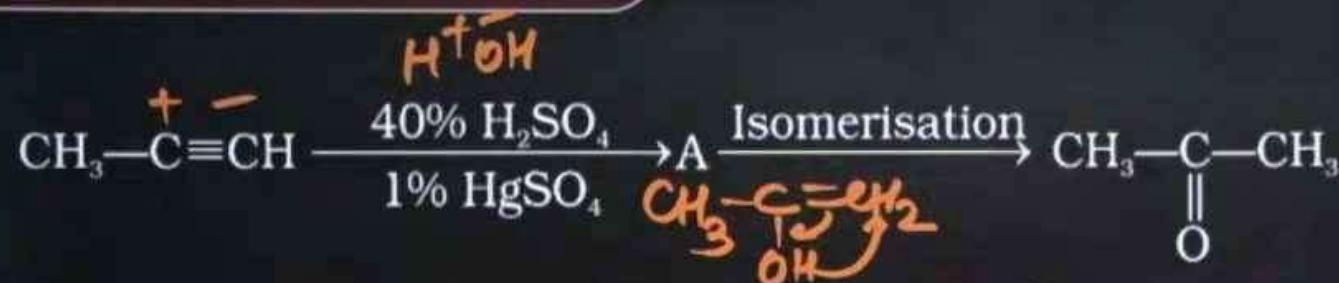
C



D



QUESTION (NCERT Exemplar)



Structure of 'A' and type of isomerism in the above reaction are respectively.

- A** Prop-1-en-2-ol, metamerism
- B** Prop-1-en-1-ol, tautomerism
- C** Prop-2-en-2-ol, geometrical isomerism
- D** Prop-1-en-2-ol, tautomerism

QUESTION (NCERT Exemplar)

Which is the most suitable reagent for the following conversion?



- A Tollen's reagent
- B Benzoyl peroxide
- C I_2 and NaOH solution
- D Sn and NaOH solution

QUESTION (NCERT Exemplar)

Which of the following compounds will give butanone on oxidation with KMnO_4 solution?

- A Butan-1-ol
- C Both (A) & (B)

- B Butan-2-ol
- D None of these

QUESTION (NCERT Exemplar)

Assertion: The α -hydrogen atom in carbonyl compounds is less acidic.

Reason: The anion formed after the loss of α -hydrogen atom is resonance stabilized.

- A** Assertion and reason both are correct and reason is correct explanation of assertion.
- B** Assertion and reason both are wrong statements.
- C** Assertion is correct statement but reason is wrong statement.
- D** Assertion is wrong statement but reason is correct statement.

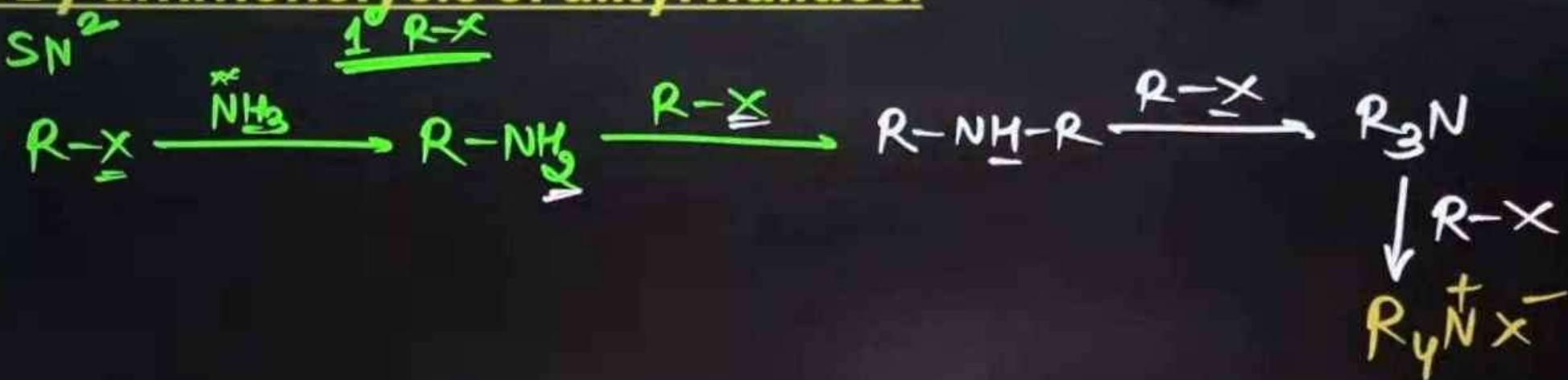
Amines
&
Diazonium
Salts



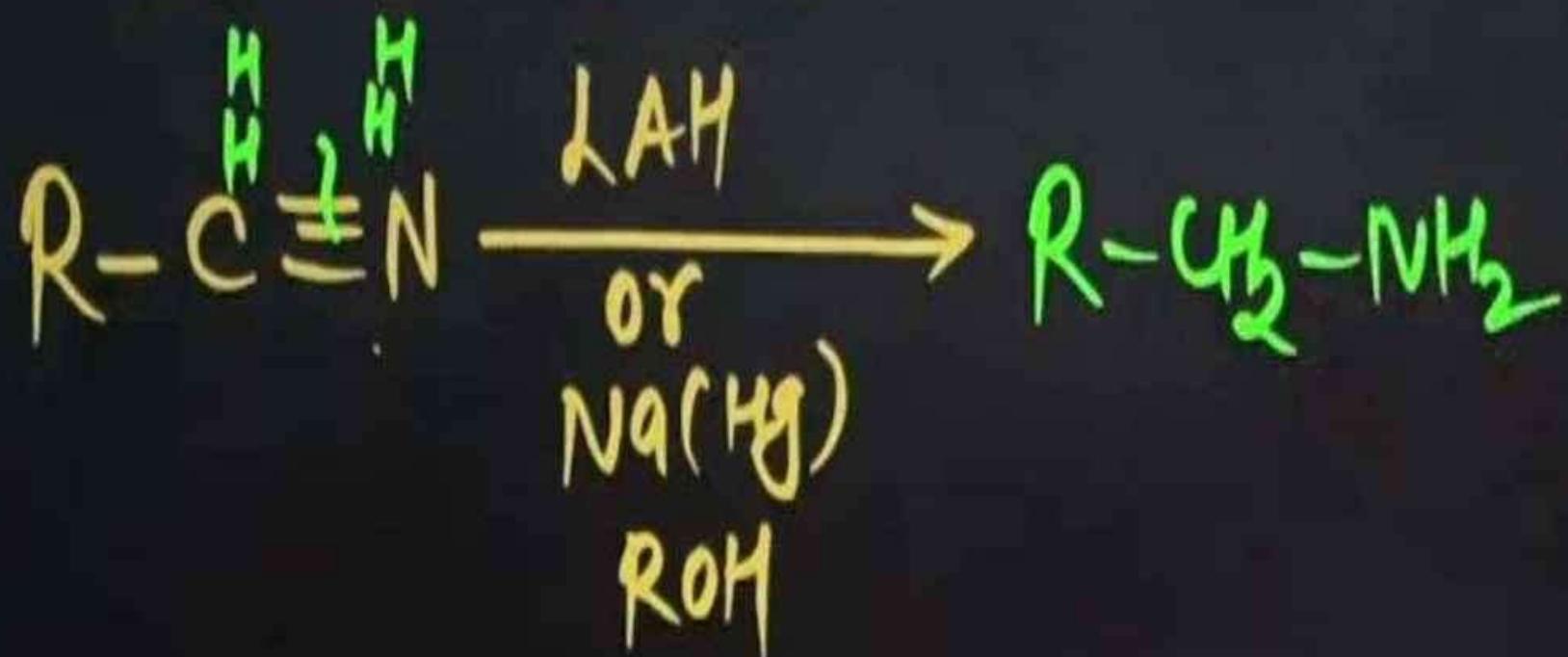
Methods of Preparation of Amines



2. By ammonolysis of alkyl halides:



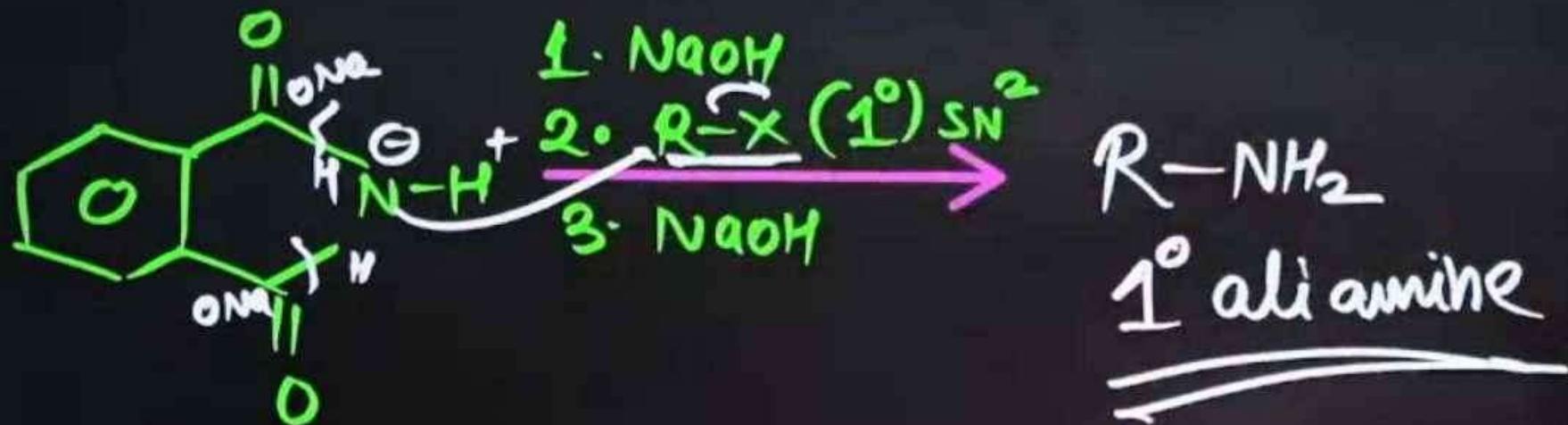
3. By reduction of nitriles:



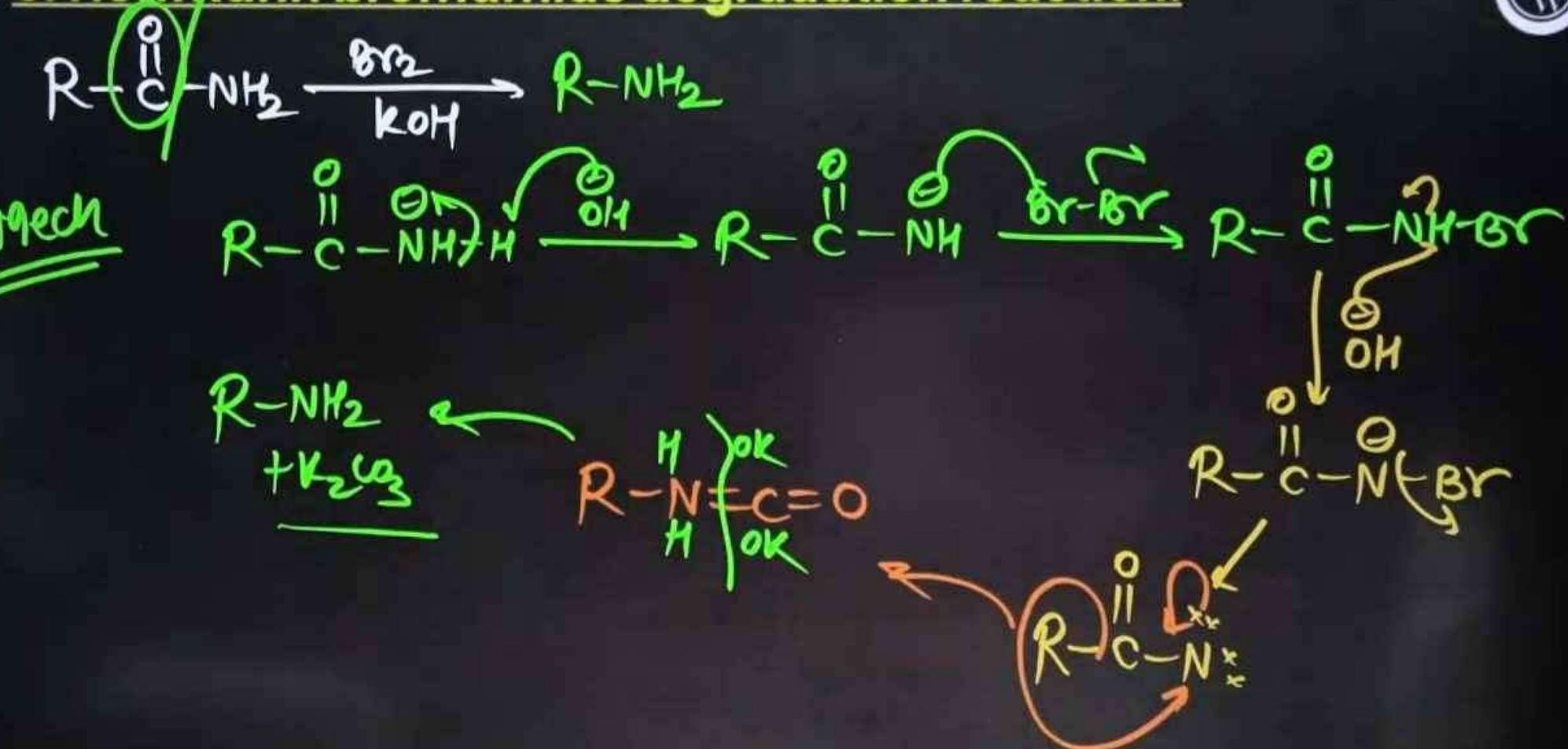
4. By reduction of amides:



5. Gabriel phthalimide synthesis:



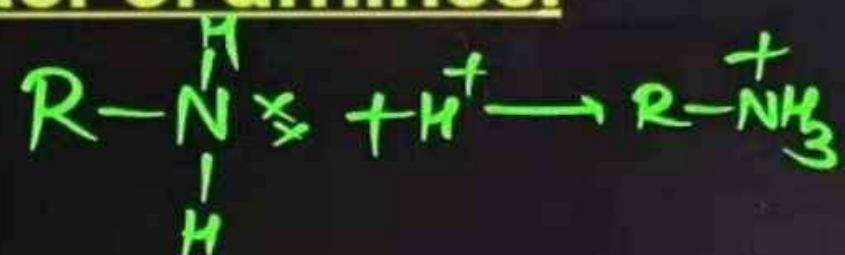
6. Hoffmann bromamide degradation reaction:





Chemical Properties of Amines

1. Basic character of amines:

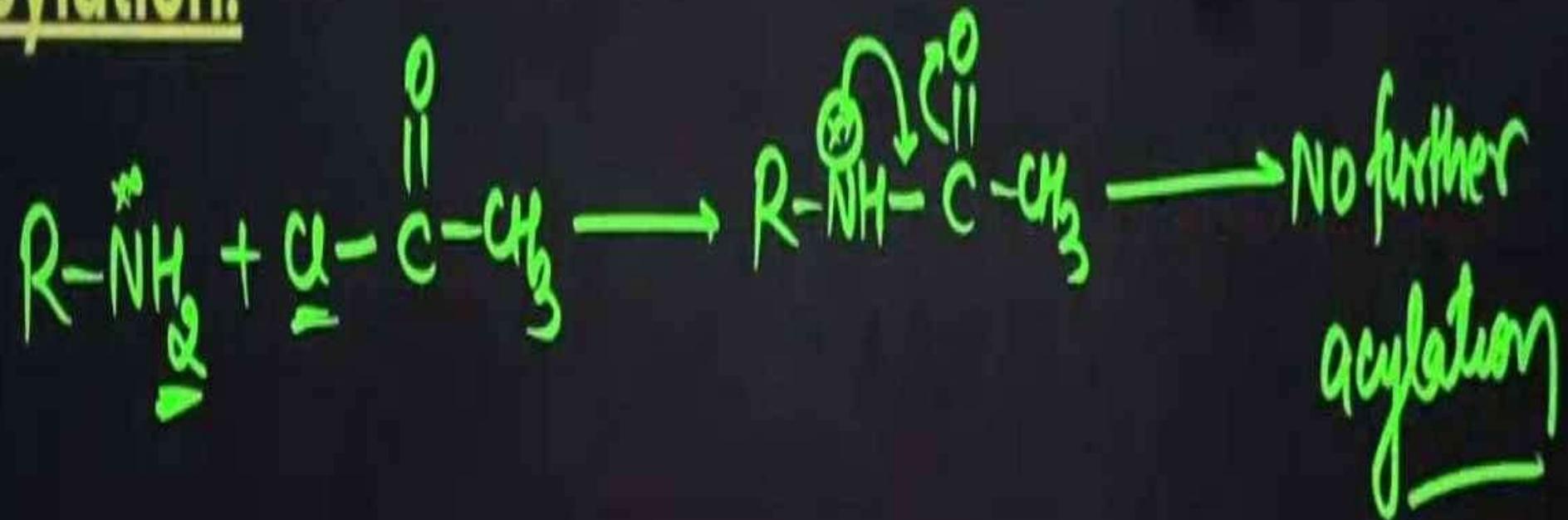


2. Alkylation:

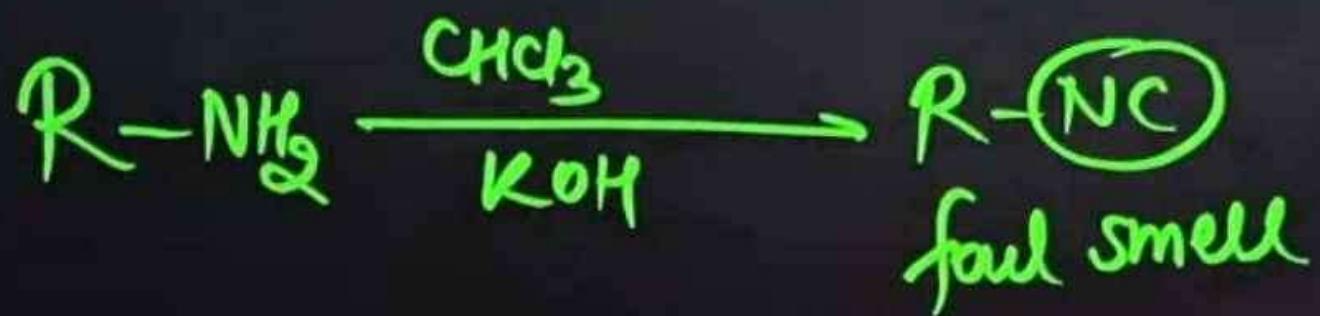
Ammonolysis

✓
done

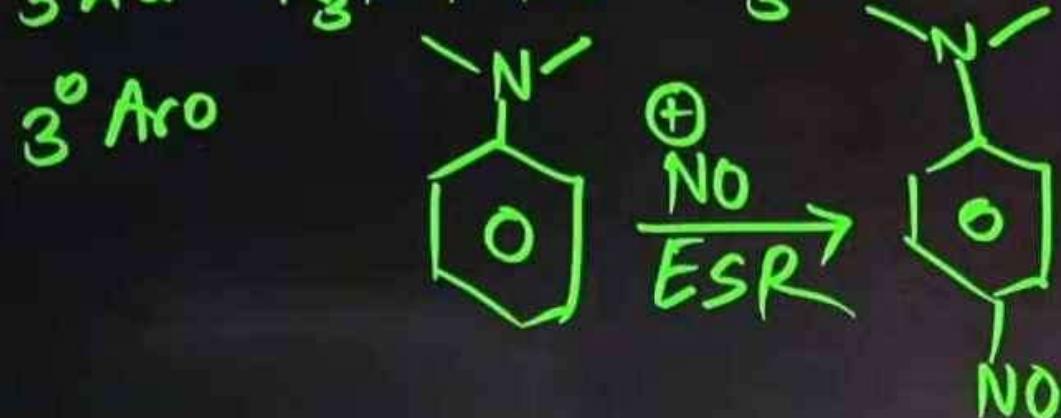
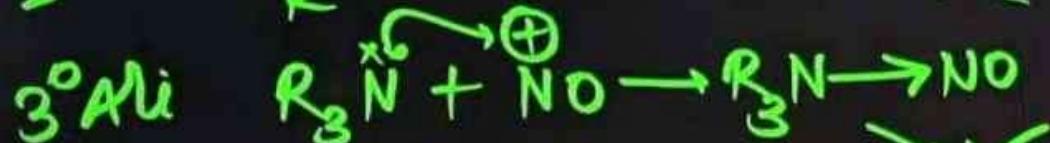
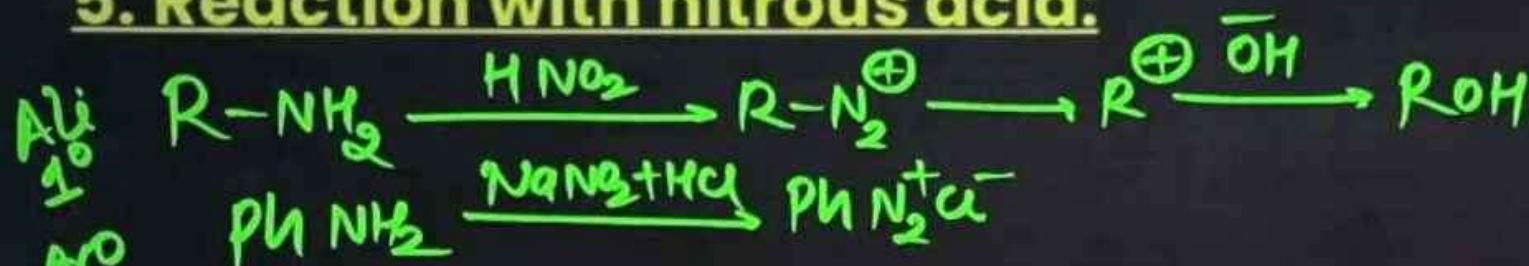
3. Acylation:



4. Carbylamine Test:

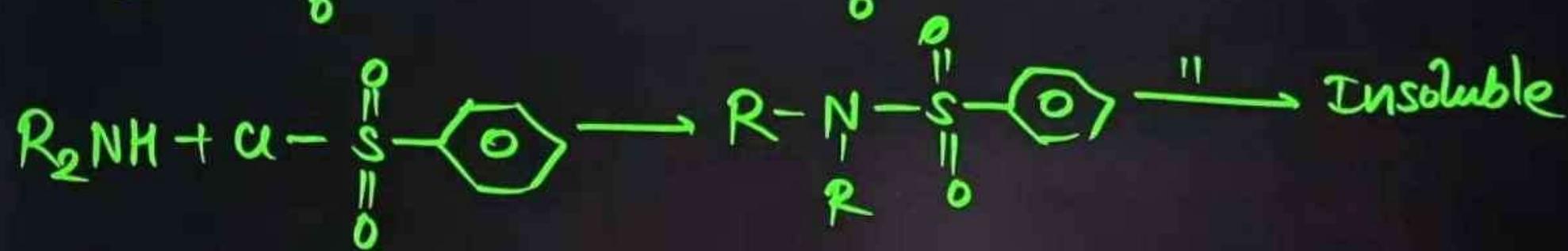
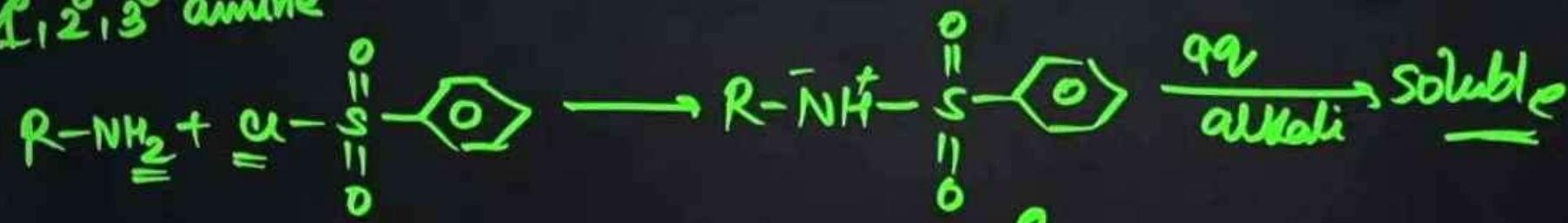


5. Reaction with nitrous acid:



6. Reaction with Aryl sulphonyl chlorides (Hinsberg's Reagent):

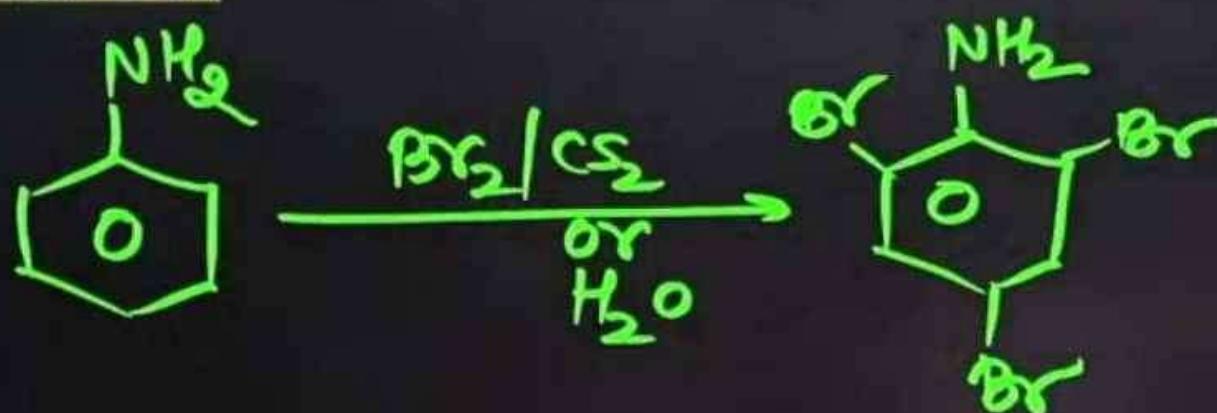
1, 2, 3° amine



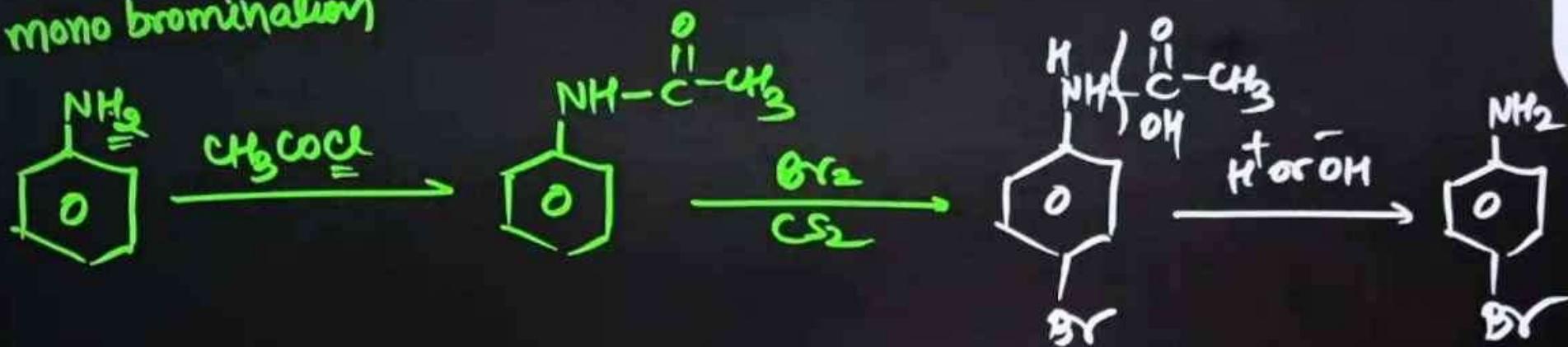
3° \longrightarrow No rxn

7. Electrophilic aromatic substitution reaction:

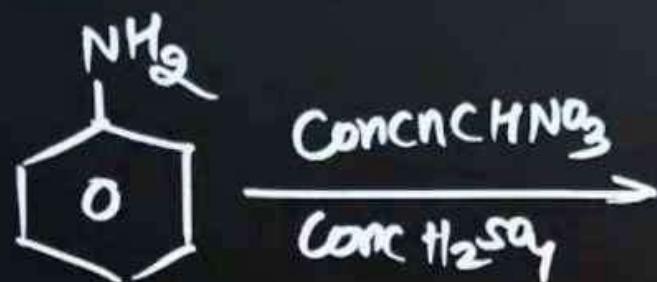
A. Bromination:



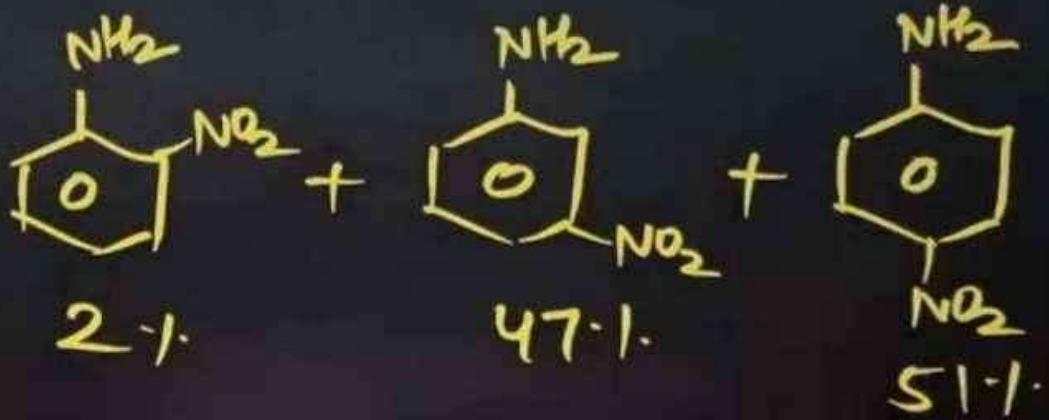
for mono bromination



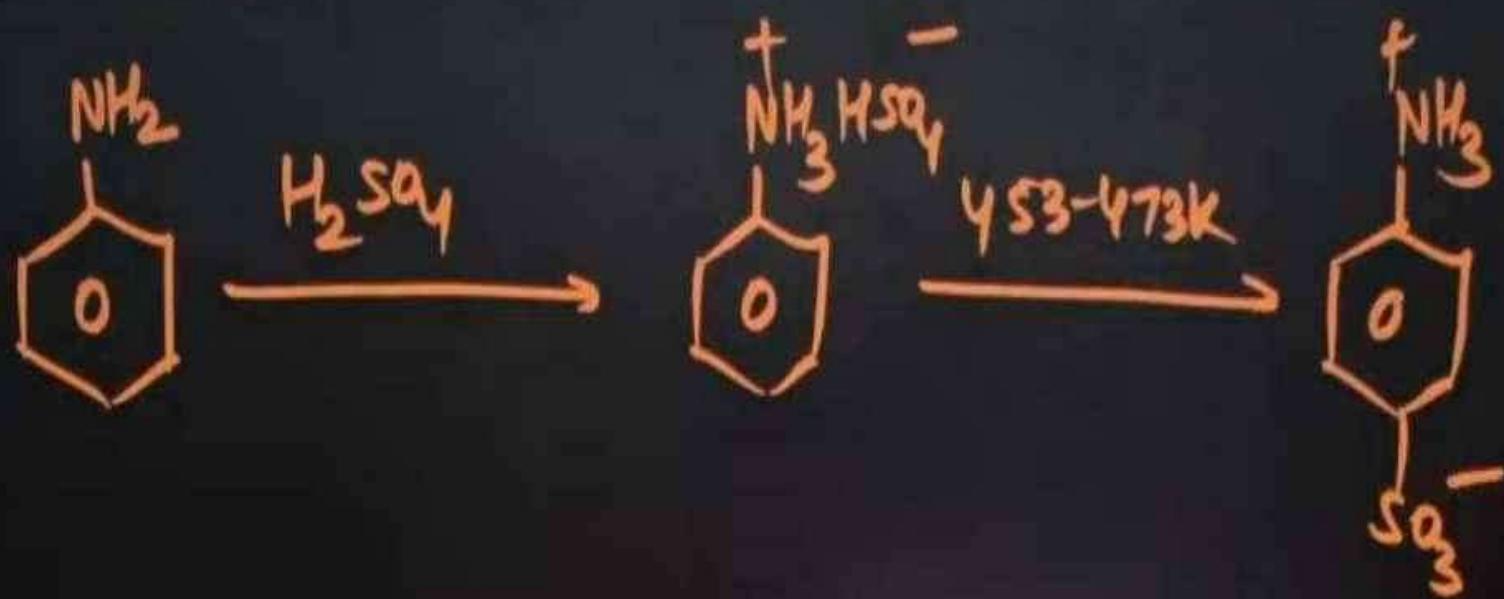
B. Nitration:



Anium ion

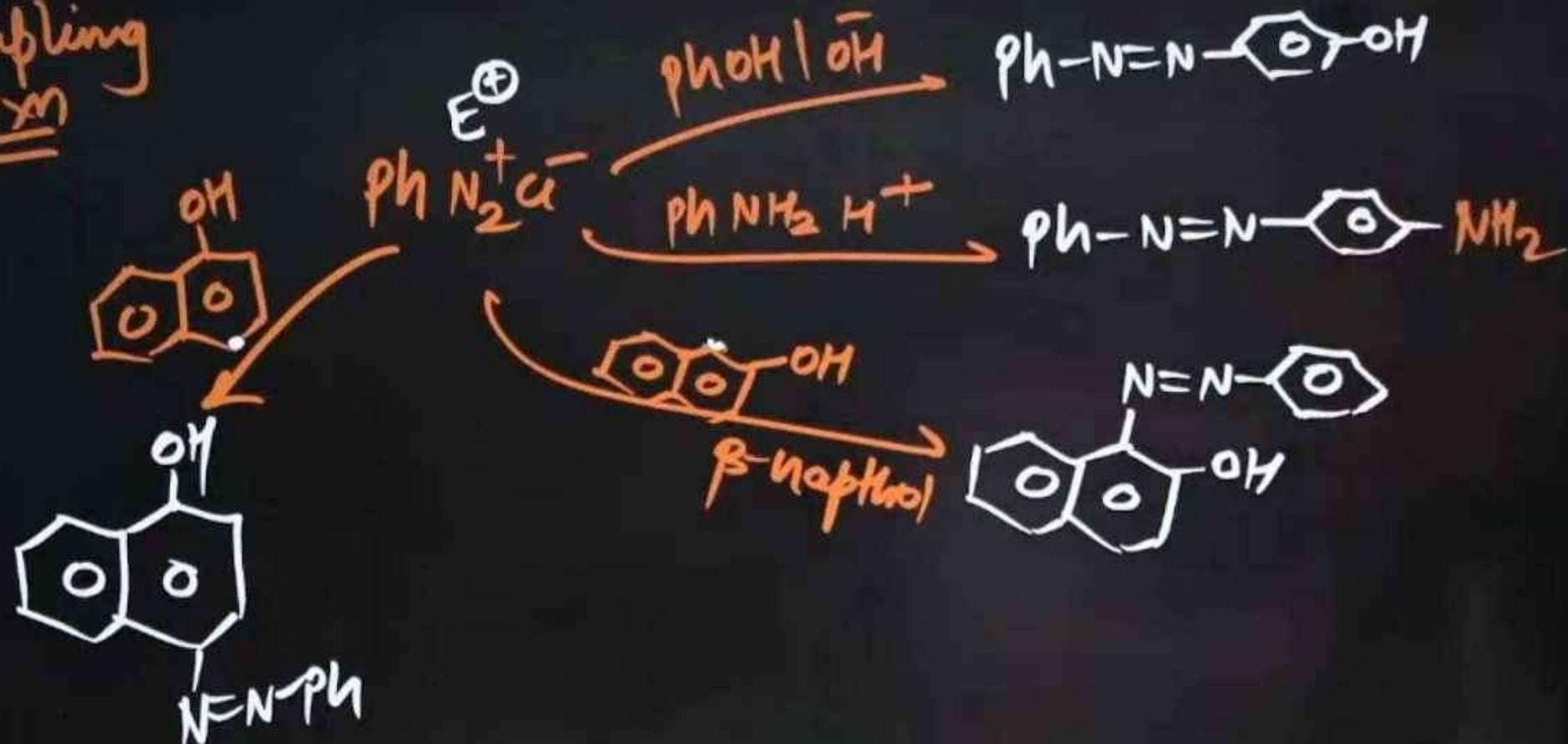


C. Sulphonation:



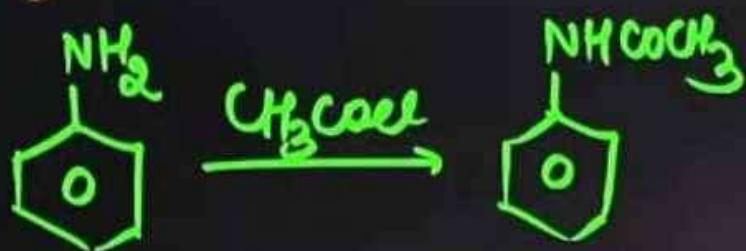
Zwitter ion

Coupling
rxn



QUESTION (JEE Mains 4th April 2024, Evening Shift)

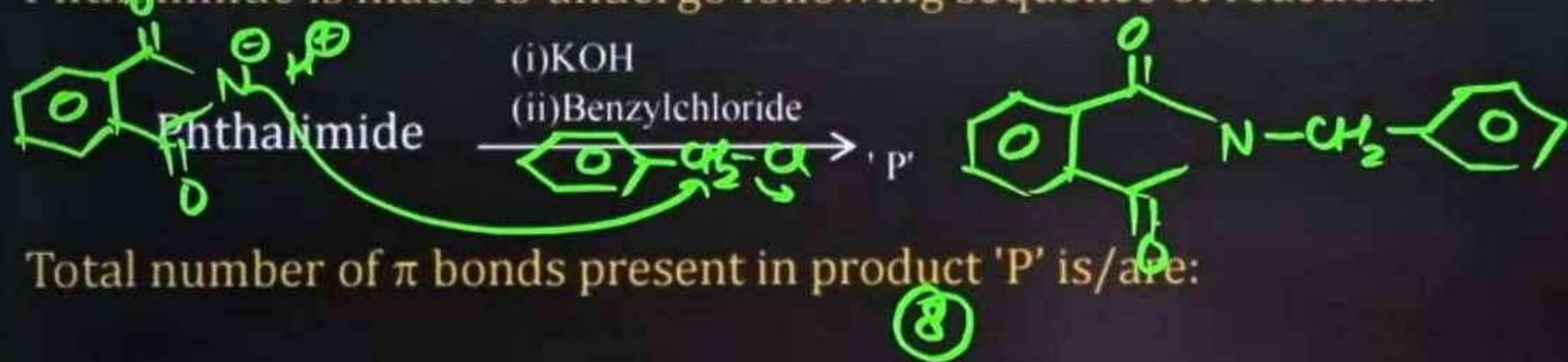
From 6.55 g of aniline, the maximum amount of acetanilide that can be prepared will be _____ $\times 10^{-1}$ g.



$$\frac{6.55}{\text{MW}_{\text{Aniline}}} = \frac{\omega}{\text{MW}_{\text{acetani}}}$$

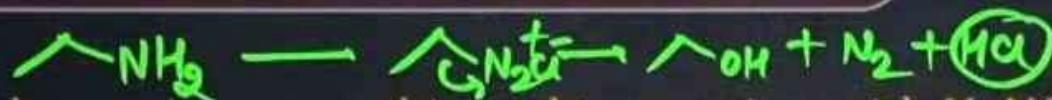
QUESTION (JEE Mains 4th April 2024, Evening Shift)

Phthalimide is made to undergo following sequence of reactions.





QUESTION (JEE Mains 5th April 2024, Evening Shift)



X gm of ethanamine was subjected to reaction with NaNO_2/HCl followed by hydrolysis to liberate N_2 and HCl . The HCl generated was completely neutralised by 0.2 moles of NaOH . X is ____ g.

$$\frac{X}{\text{MW}_{\text{C}_2\text{H}_5\text{NH}_2}} = 0.2$$

QUESTION (JEE Mains 6th April 2024, Morning Shift)

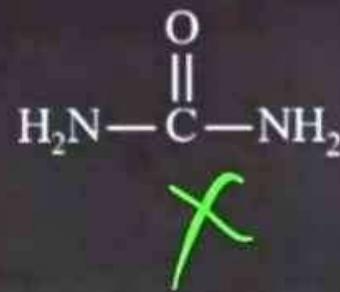
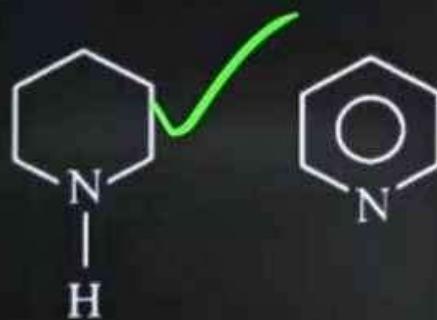
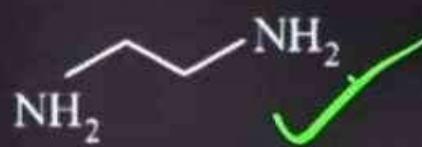
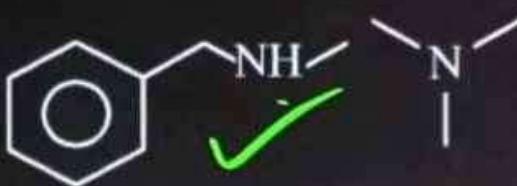
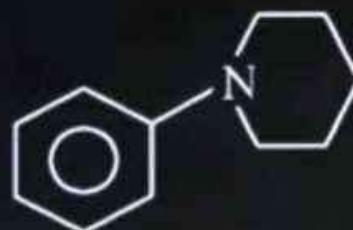
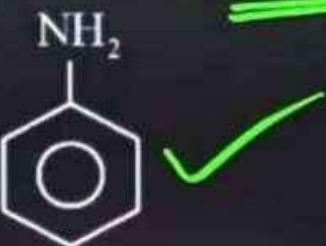
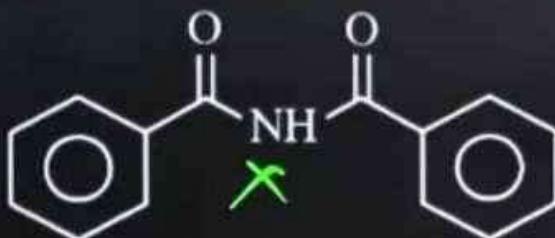
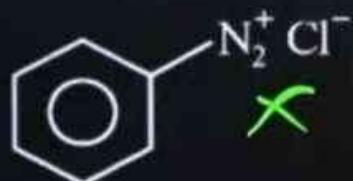


9.3 g of pure aniline upon diazotization followed by coupling with phenol gives an orange dye. The mass of orange dye produced (assume 100% yield/conversion) is _____ g. (nearest integer)

$$\frac{9.3}{\text{MW}_{\text{aniline}}} = \frac{\omega}{\text{MW}_{\text{orangedye}}}$$

QUESTION (JEE Mains 1st Feb 2024, Evening Shift)

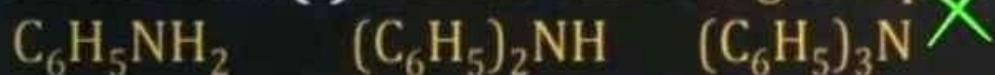
Number of compound which give reaction with Hinsberg's reagent is 5.



QUESTION (JEE Mains 8th April 2024, Evening Shift)

Given below are two statements:

Statement (I): All the following compounds react with p-toluene sulfonyl chloride.



Statement (II): Their products in the above reaction are soluble in aqueous NaOH.

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

- A** Both Statement I and Statement II is false. ✓
- B** Statement I is true but Statement II is false.
- C** Statement I is false but Statement II is true.
- D** Both Statement I and Statement II is true.

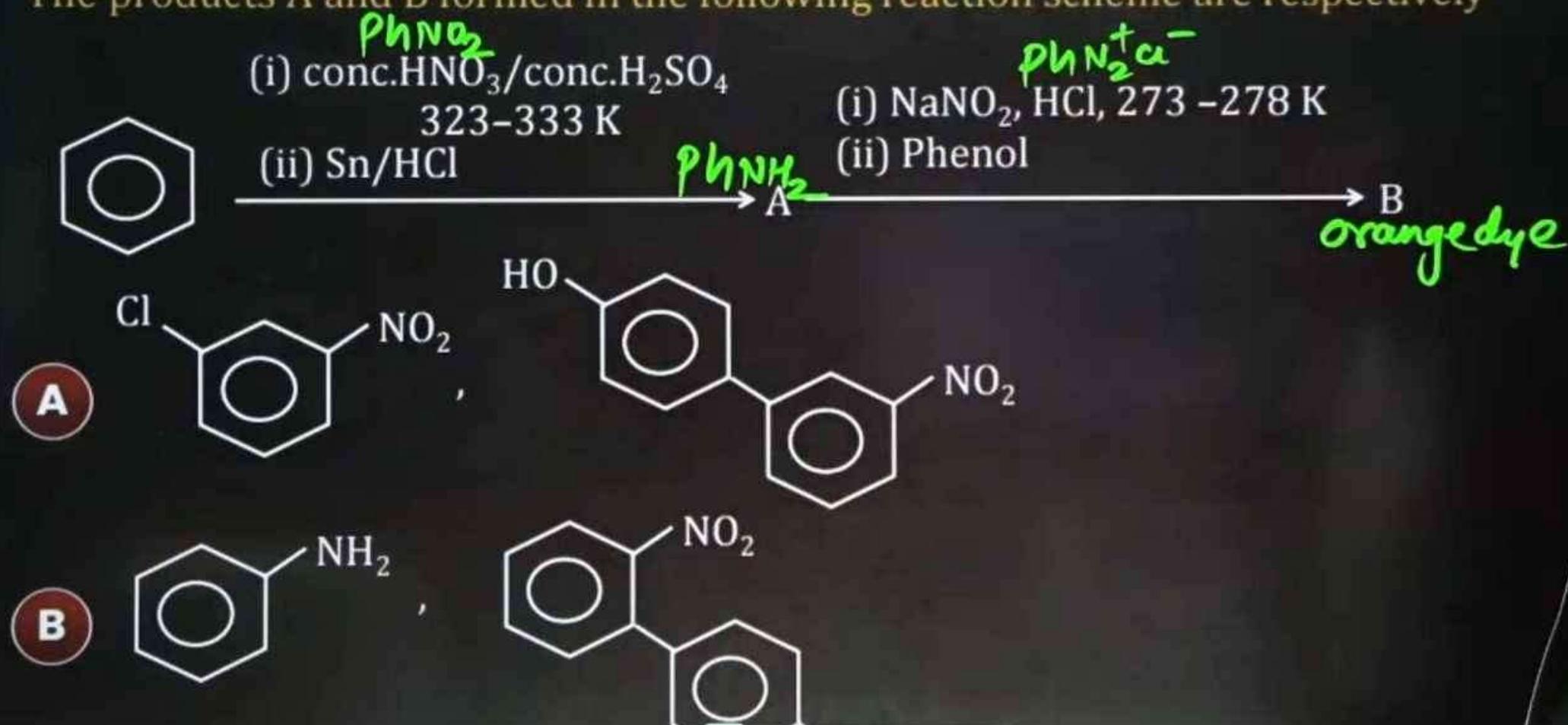
QUESTION (JEE Mains 27th January 2024, Evening Shift)

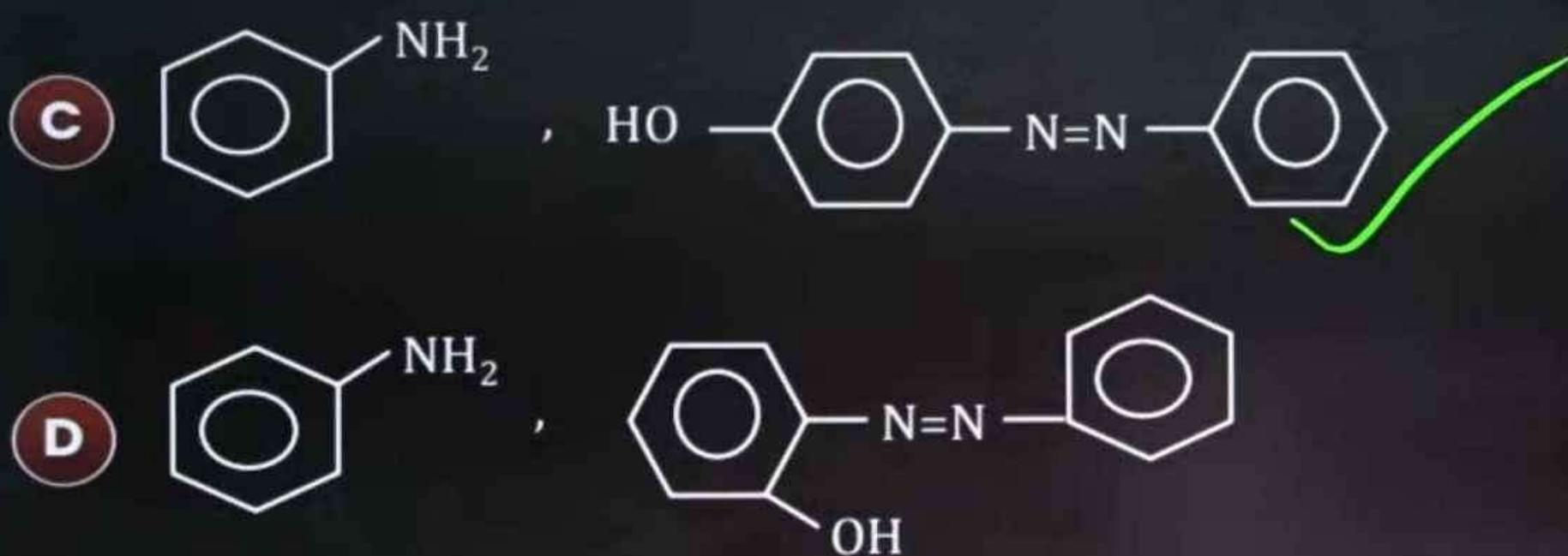
9.3 g of aniline is subjected to reaction with excess of acetic anhydride to prepare acetanilide. The mass of acetanilide produced if the reaction is 100% completed is _____ $\times 10^{-1}$ g. (Given molar mass in g mol⁻¹ N : 14, O : 16, C : 12, H : 1)

$$\frac{9.3}{\text{MW}_{\text{aniline}}} = \frac{\omega}{\text{MW}_{\text{acetanilide}}}$$

QUESTION (JEE Mains 30 January 2024, Evening Shift)

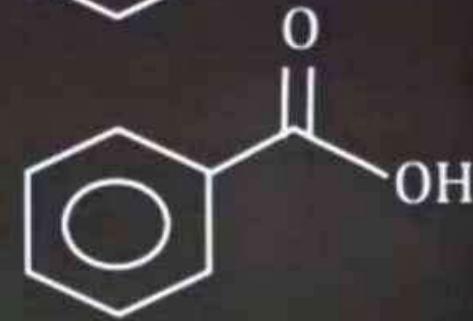
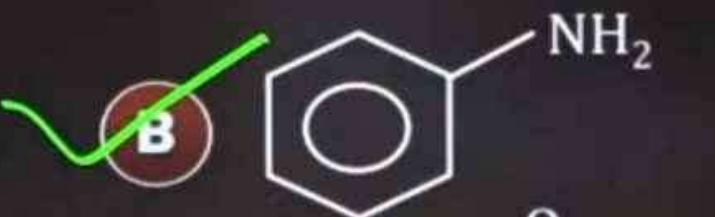
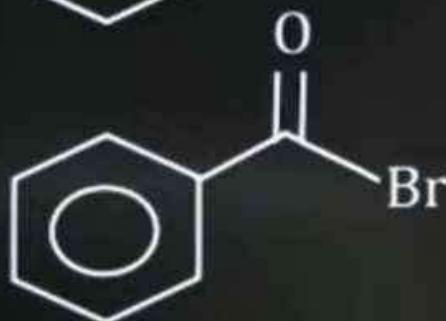
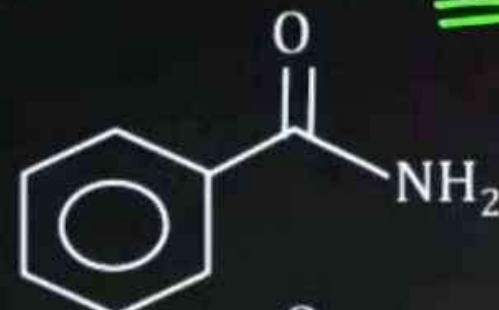
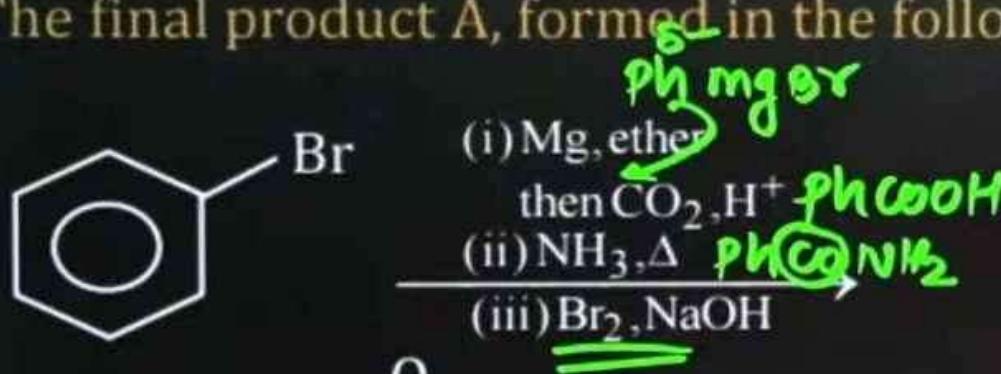
The products A and B formed in the following reaction scheme are respectively





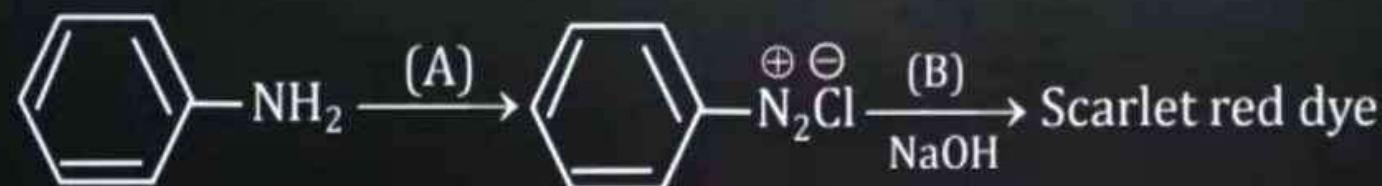
QUESTION (JEE Mains 30 January 2024, Morning Shift)

The final product A, formed in the following multistep reaction sequence is:



QUESTION (JEE Mains 30 January 2024, Morning Shift)

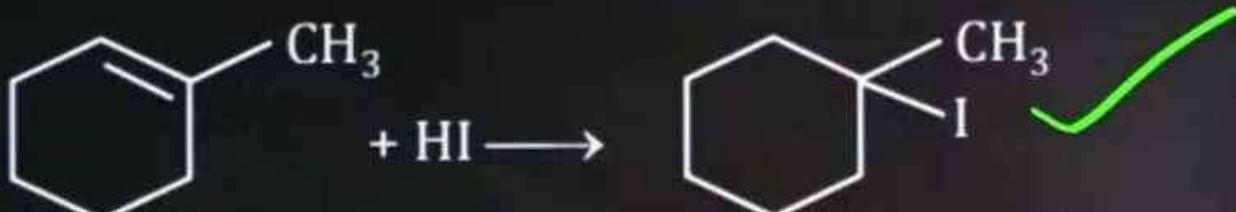
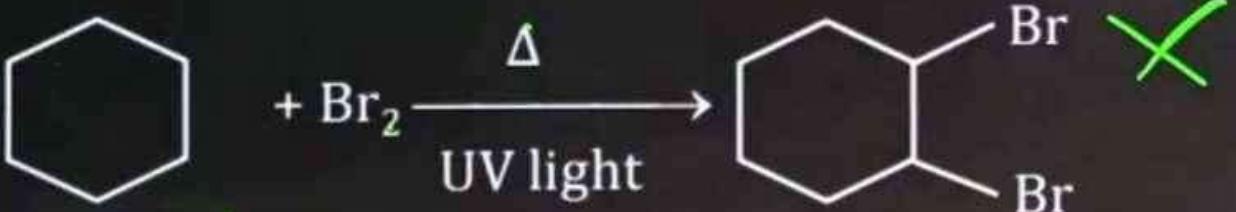
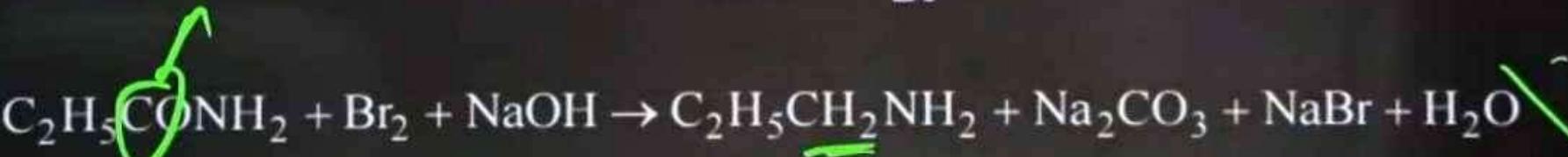
Following is a confirmatory test for aromatic primary amines. Identify reagent (A) and (B).



- A** $\text{A}=\text{HNO}_3/\text{H}_2\text{SO}_4;$ $\text{B}=$
- B** $\text{A}=\text{NaNO}_2+\text{HCl}, 0-5^\circ\text{C};$ $\text{B}=$
- C** $\text{A}=\text{NaNO}_2+\text{HCl}, 0-5^\circ\text{C};$ $\text{B}=$
- D** $\text{A}=\text{NaNO}_2+\text{HCl}, 0-5^\circ\text{C};$ $\text{B}=$

QUESTION (JEE Mains 29 January 2024, Evening Shift)

Which of the following reaction is correct?

- A** $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2 \xrightarrow[\text{H}_2\text{O}]{\text{HNO}_2, 0^\circ\text{C}} \text{CH}_3\text{CH}_2\text{OH} + \text{N}_2 + \text{HCl}$ ✗
- B**  ✓
- C**  ✗
- D**  ✗

QUESTION (NCERT Exemplar)

The source of nitrogen in Gabriel synthesis of amines is _____.

A Sodium azide, NaN_3

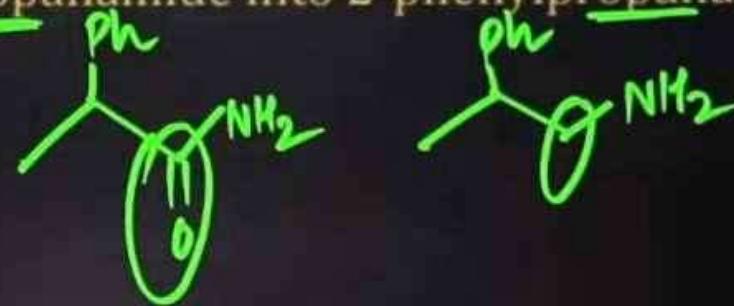
B Sodium nitrite, NaNO_2

C Potassium cyanide, KCN

D Potassium phthalimide, $\text{C}_6\text{H}_4(\text{CO})_2\text{N}^-\text{K}^+$

QUESTION (NCERT Exemplar)

The best reagent for converting 2-phenylpropanamide into 2-phenylpropanamine is _____.



- A** excess H_2
- B** Br_2 in aqueous NaOH
- C** iodine in the presence of red phosphorus
- D** LiAlH_4 in ether ✓

QUESTION (NCERT Exemplar)

Reduction of aromatic nitro compounds using Fe and HCl gives _____.

- A aromatic oxime
- C aromatic primary amine
- B aromatic hydrocarbon
- D aromatic amide

QUESTION (NCERT Exemplar)

Which of the following compound will not undergo azo coupling reaction with benzene diazonium chloride?

A

Aniline

C

Anisole

B

Phenol

D

Nitrobenzene

ESR
FM



Biomolecules

Carbohydrates

Hydrates of carbon are called carbohydrates

- General formula # $C_x(H_2O)_y$
$$\text{Ex: } \underline{C_6(H_2O)_6} \Rightarrow \underline{C_6H_{12}O_6}$$
- Exception : $C_2(H_2O)_2$
$$C_2H_4O_2 \Rightarrow \underline{CH_3COOH}$$
 (acetic acid) not a carbohydrate
- Rhamnose, $\underline{C_6H_{12}O_5}$ is a carbohydrate but does not fit in this definition

Carbohydrates

- The carbohydrates may be defined as optically active polyhydroxy aldehydes or ketones or the compounds which produce such units on hydrolysis.
- Some of the carbohydrates, which are sweet in taste, are also called sugars.
- The most common sugar, used in our homes is named as sucrose whereas the sugar present in milk is known as lactose

Classification

1. Based on hydrolysis

(i) monosaccharides
does not hydrolyse
further.

Exp: Glucose ✓
Fructose ✓
Galactose etc. ✓

(ii) Oligosaccharides
Produces 2 to 10
monosac units on
hydrolysis

- Disac → 2 unit

Exp: sucrose, maltose,
Lactose etc. ✓

- Trisac → 3 unit

Exp: Raffinose ✓

(iii) Polysaccharides

- Carbohydrates which yield a large number of monosaccharide units on hydrolysis are called polysaccharides. Some common examples are starch, cellulose, glycogen, gums, etc.
- Polysaccharides are not sweet in taste, hence they are also called non-sugars

Classification 2. Reducing and non reducing sugar

1. Reducing → Reduces

Tollen's reagent

Fehling's reagent

Benedict's reagent,

2. Non-reducing Do not reduce

T.R

F.R

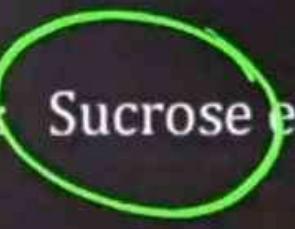
B.R

Exp. 1. monosac like Glucose

fructose, Galactose etc

2. Disac like maltose, Lactose etc.

Hemi acetal

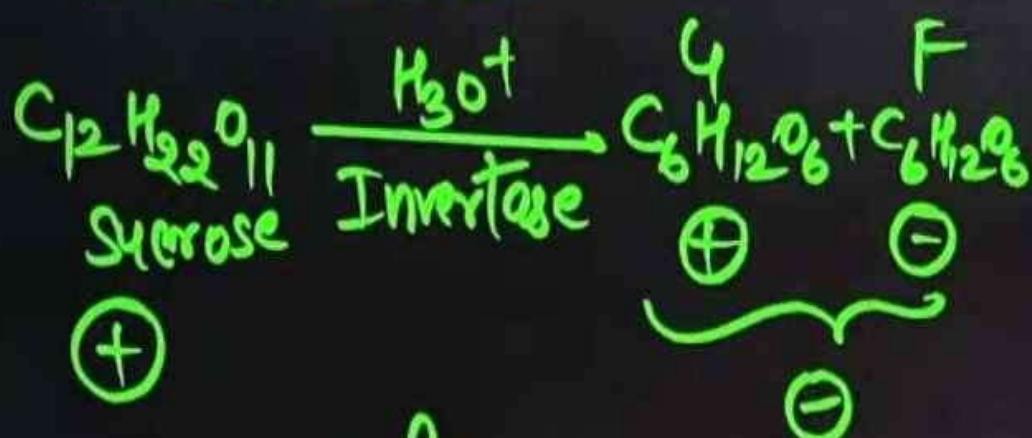
Exp.  Sucrose etc

Classification 3. Based on number of carbon atoms

No. of carbons	Ald	Ket
3	<u>Aldotriose</u>	<u>Ketotriose</u>
4	Aldotetrose	<u>Ketotetrose</u>
5	Aldopentose	<u>Ketopentose</u>
6	Aldohexose	<u>Ketohexose</u>

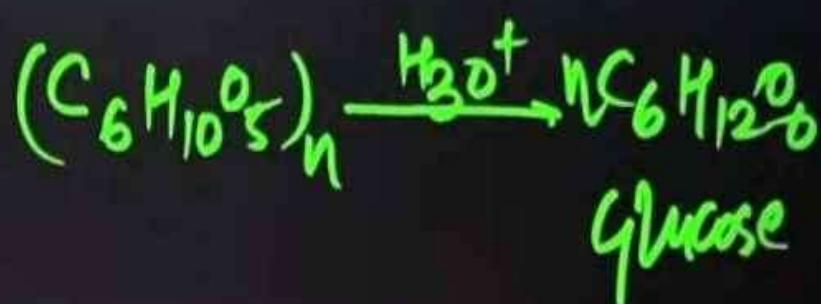
MOP of Glucose

1. From Sucrose



Inversion of
Cane sugar

2. From Starch

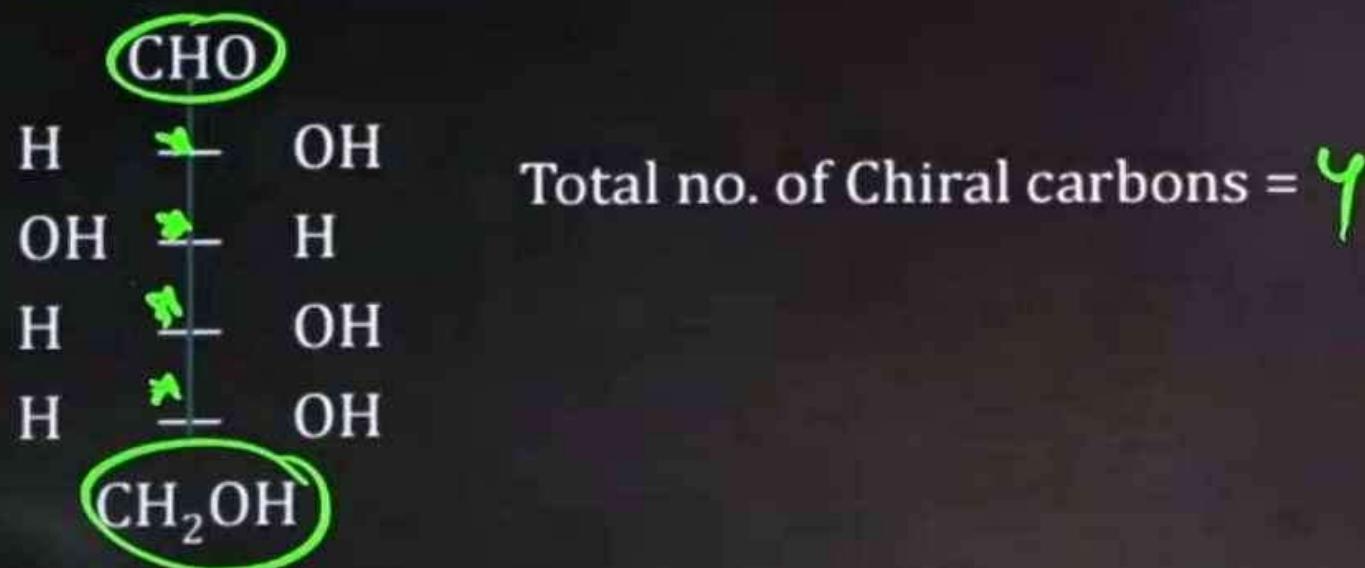


Properties

- Glucose is also known as dextrose (+) or Aldohexose
- Structure

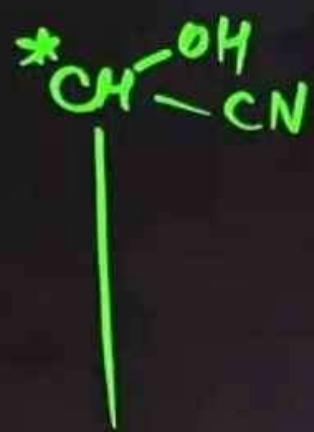
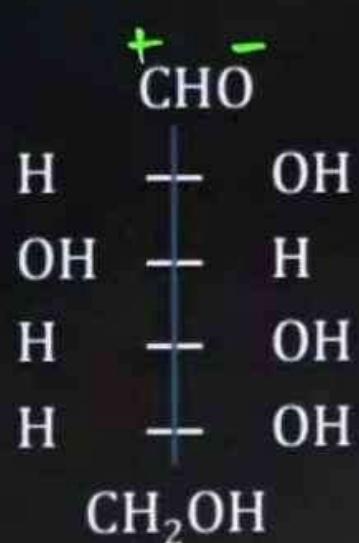


Fischer projection formula



Chemical Reactions

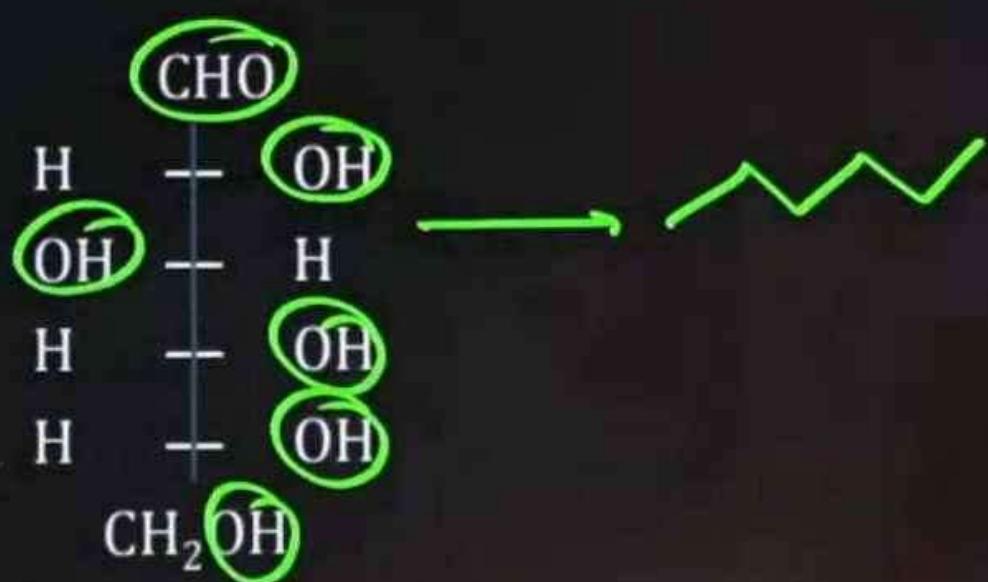
1. Rxn with HCN



Total no. of Chiral carbons = 5

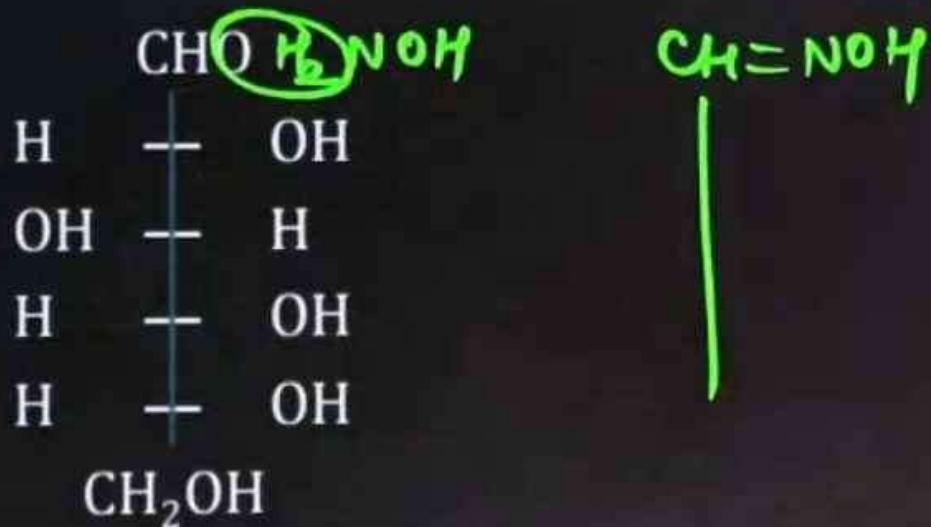
Chemical Reactions

2. Rxn with HI/Red P



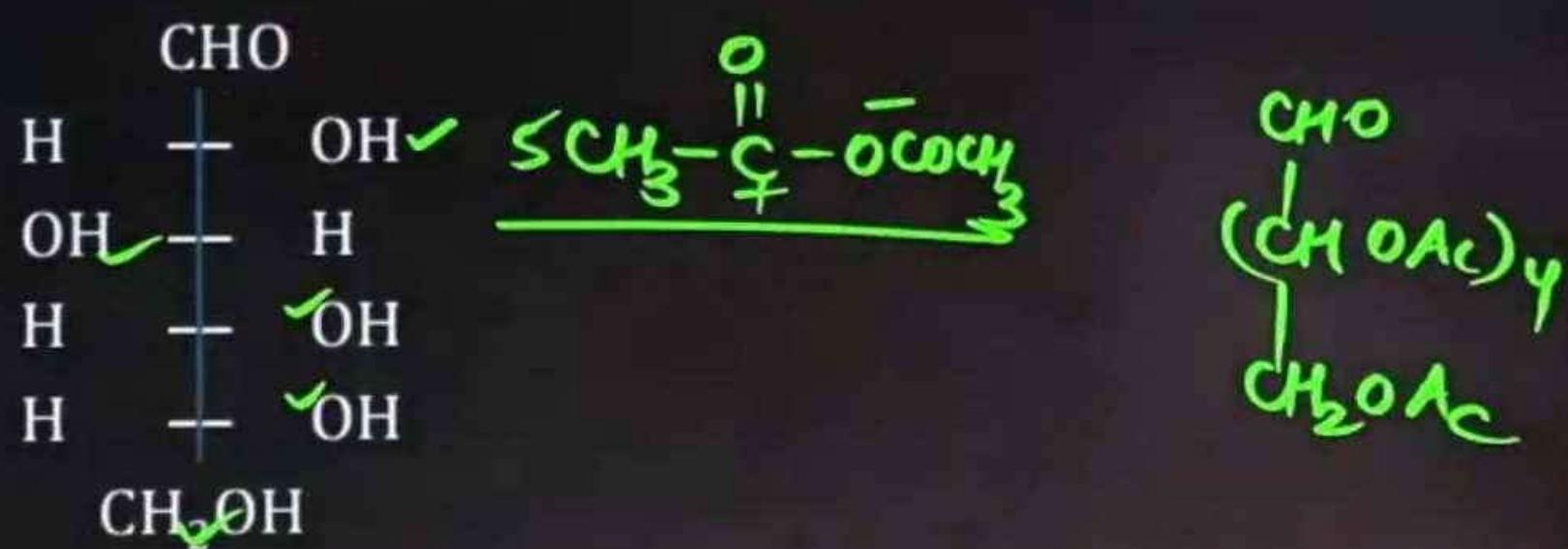
Chemical Reactions

3. Rxn with NH₂OH



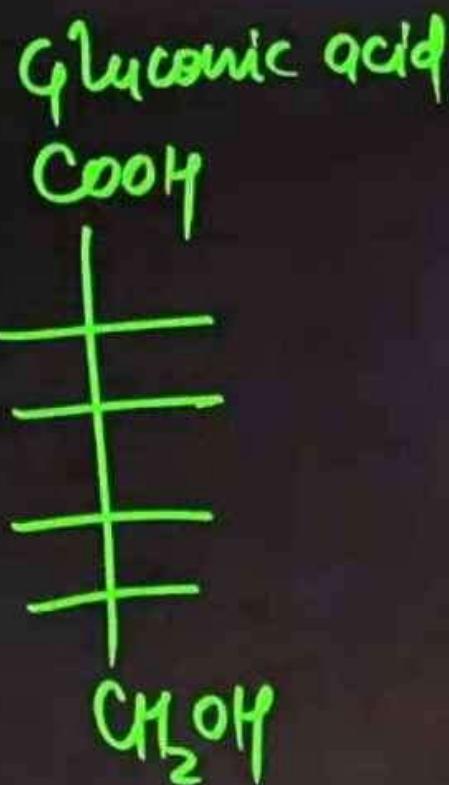
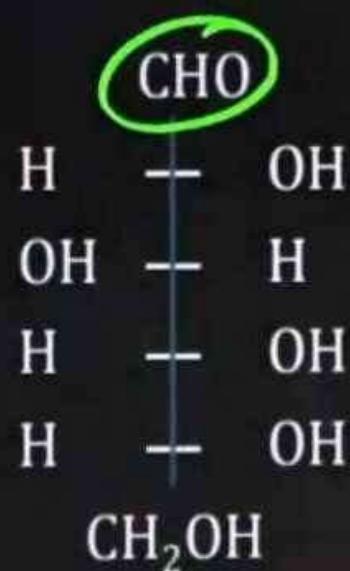
Chemical Reactions

4. Rxn with acetic anhydride



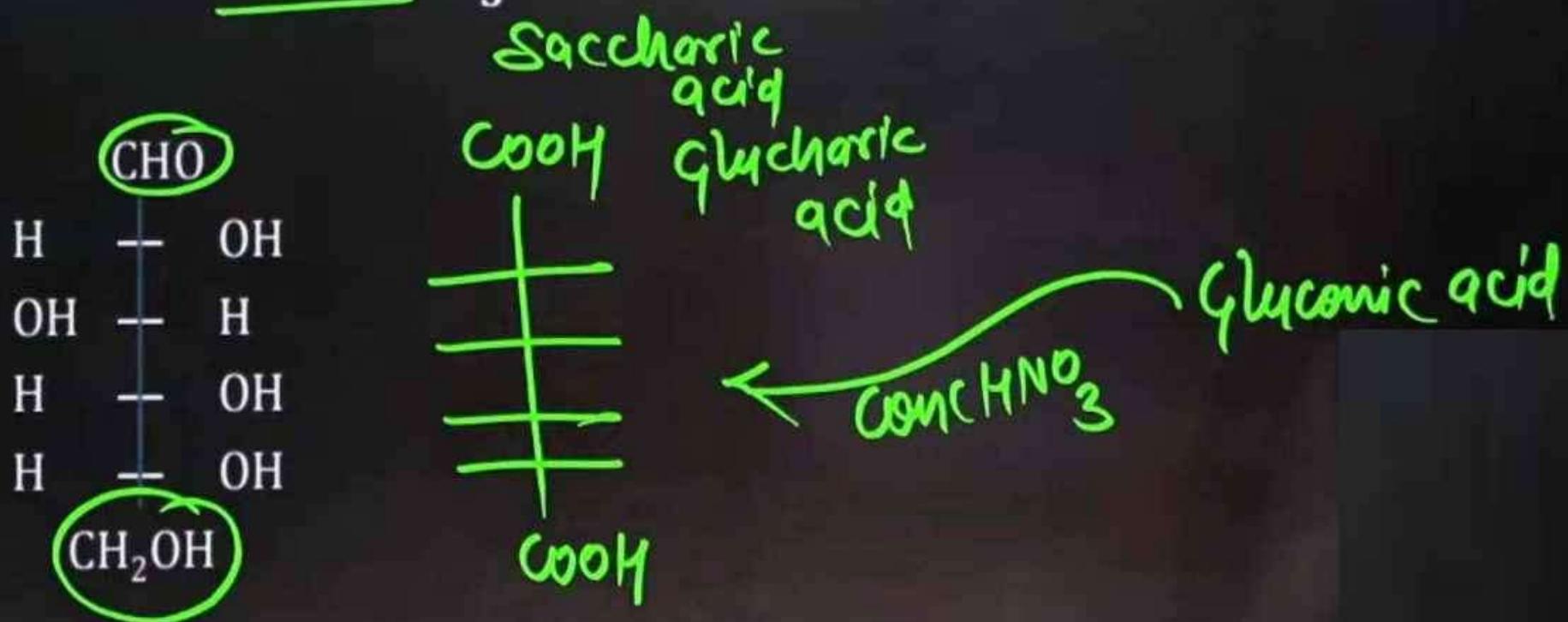
Chemical Reactions

5. Rxn with Br₂+H₂O



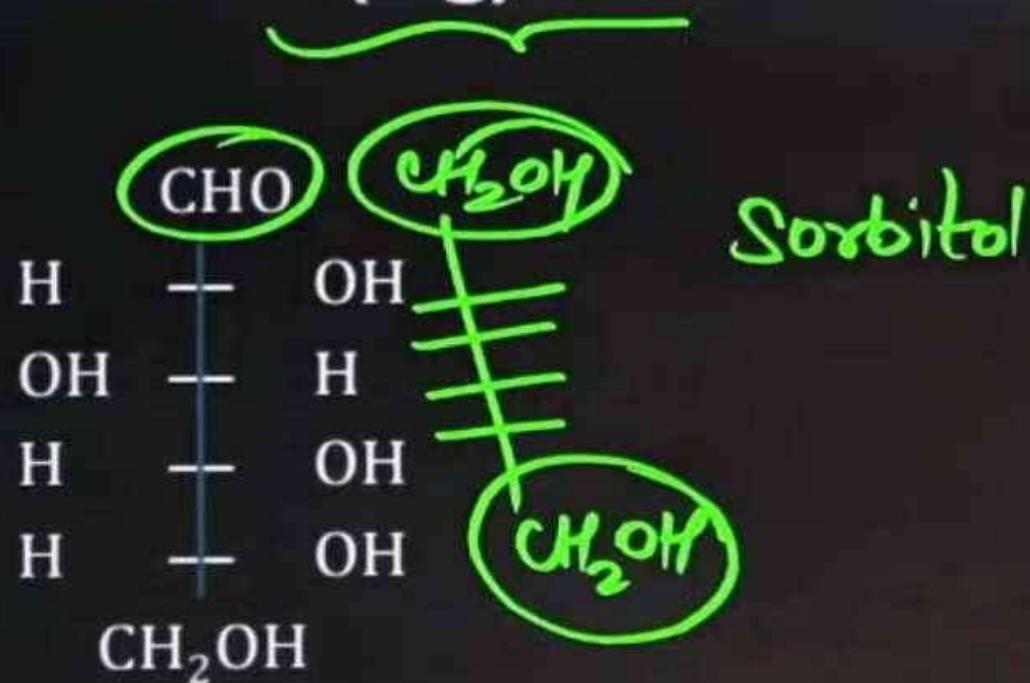
Chemical Reactions

6. Rxn with conc. HNO_3



Chemical Reactions

7. Rxn with $\text{Na}(\text{Hg}) + \text{ROH}$ or $\text{NaBH}_4/\text{MeOH}$ or $\text{H}_2 +$



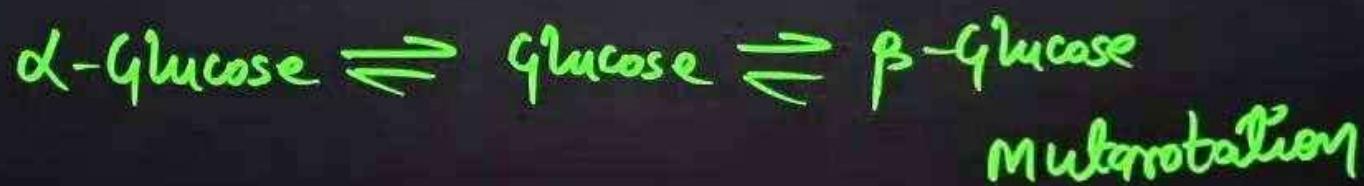
Rxns which support cyclic structure

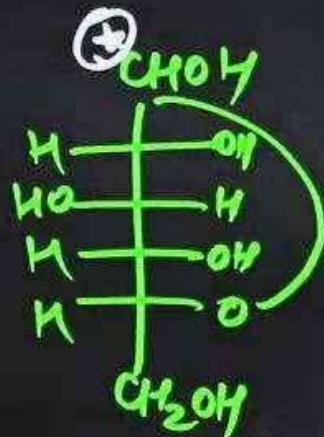
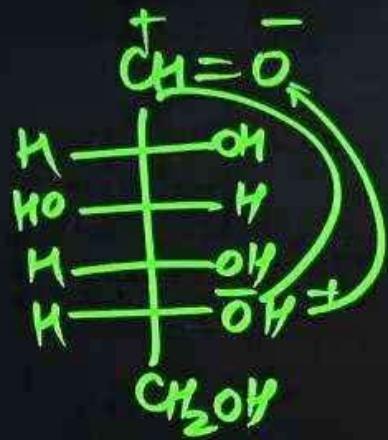
1. NO rxn with NaHSO_3 ✓
2. NO rxn with Schiff's Test ✓ *R Rosaniline + HCl + SO₂
Magenta*
3. NO rxn with 2,4DNP test ✓
4. NO rxn of Glucose penta acetate with NH_2OH ✓

Glucose exists in two Cyclic crystalline forms

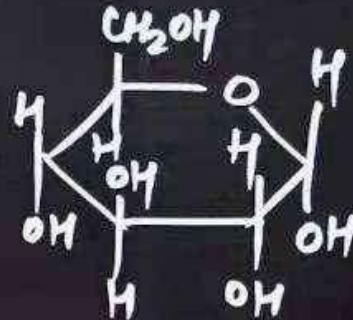
1. Conc. Solution gives α -Glucose (M.P 419K) at 303K
2. Aq. Solution gives β -Glucose(MP 423K) at 371K

Glucose exist in 3 forms in liquid solution

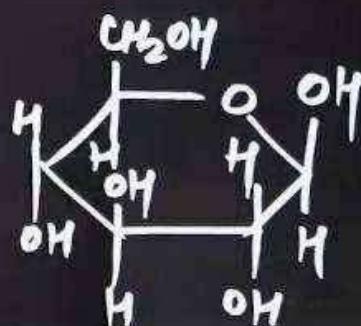




S chiral
Carbon



α -D-(+)
Glucopyranose



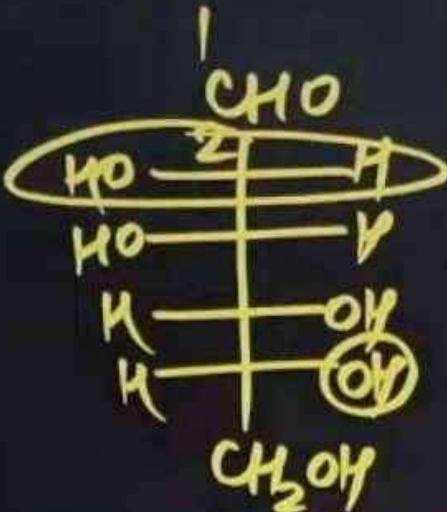
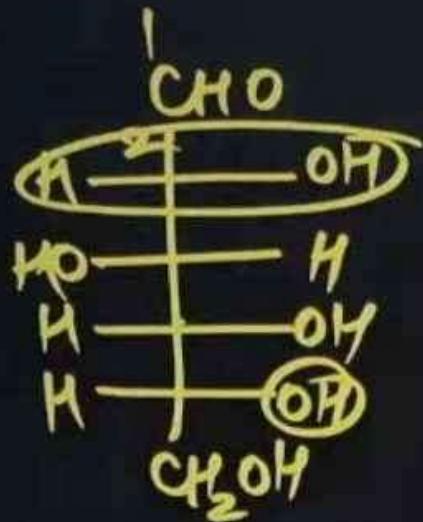
β -D-(+)
Glucopyranose

α & β C₁-anomer

OP points

1. Net optical Rotation of Glucose = +52.4°
2. % α = 36% (Sp. Rotation = 112°),
% β = 63.8% (Sp. Rotation = 19°)
3. α & β are Diastereomer or Anomer
4. L-Glucose is the mirror image of D-Glucose

Epimers

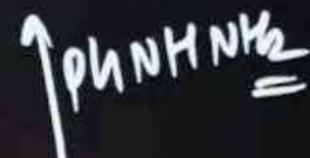
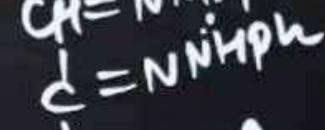
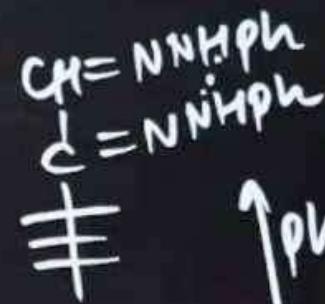
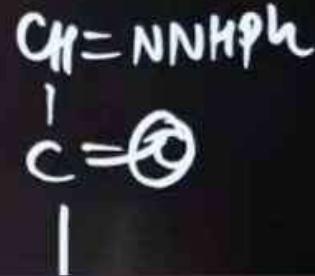
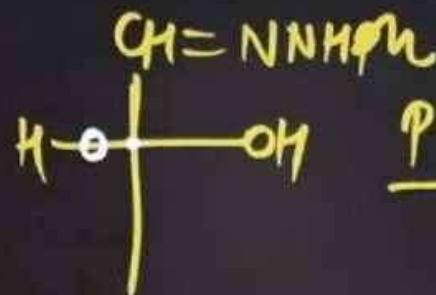
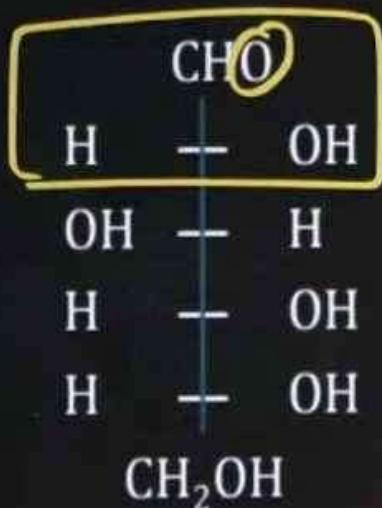


D-Glucose & D-Mannose are C₂-epimer

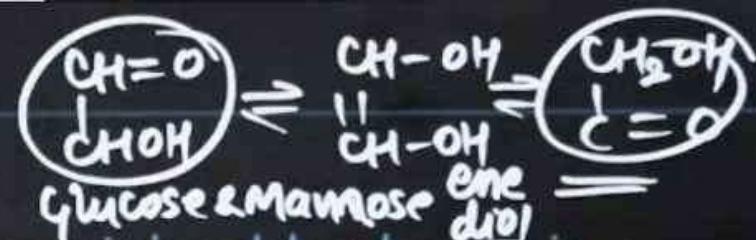
Chemical Reactions of Glucose & Fructose & Mannose



1. Osazone formation

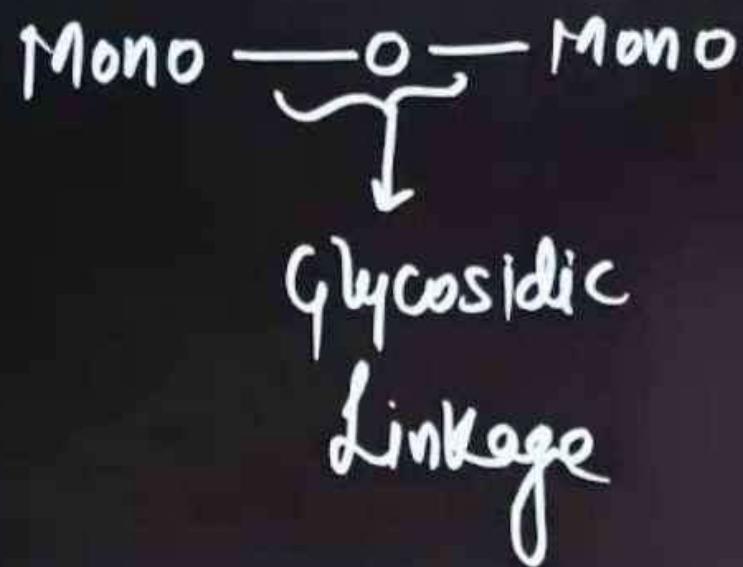


OP points

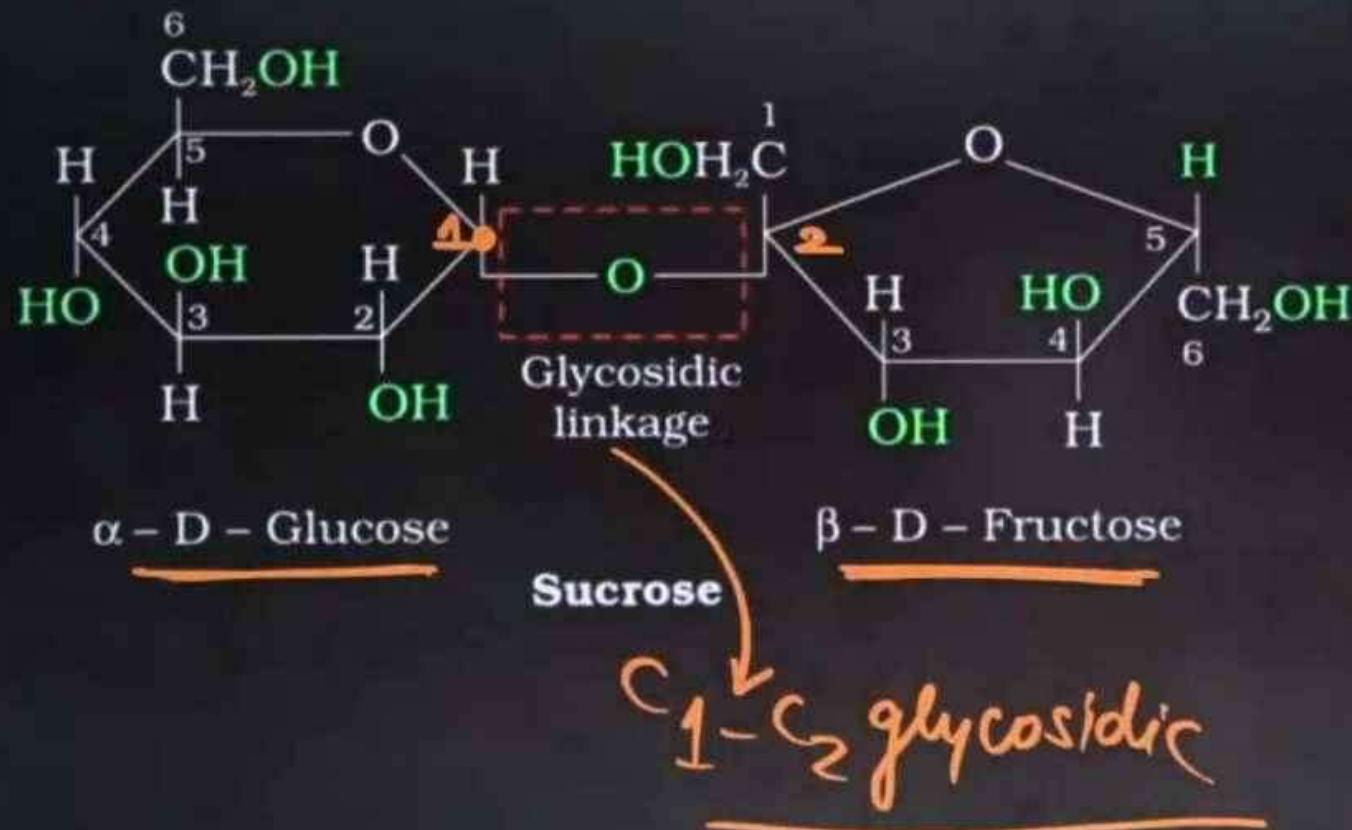


1. Glucose and fructose can be distinguished by bromine water not by T.R , F.R, B.R
2. Glucose , fructose and mannose give same osazone because in osazone formation take place at first two carbon atoms
3. Osazone is stable by intramolecular H bonding
4. Glucose/ fructose is converted to ethyl alcohol by fermentation in presence of zymase enzyme

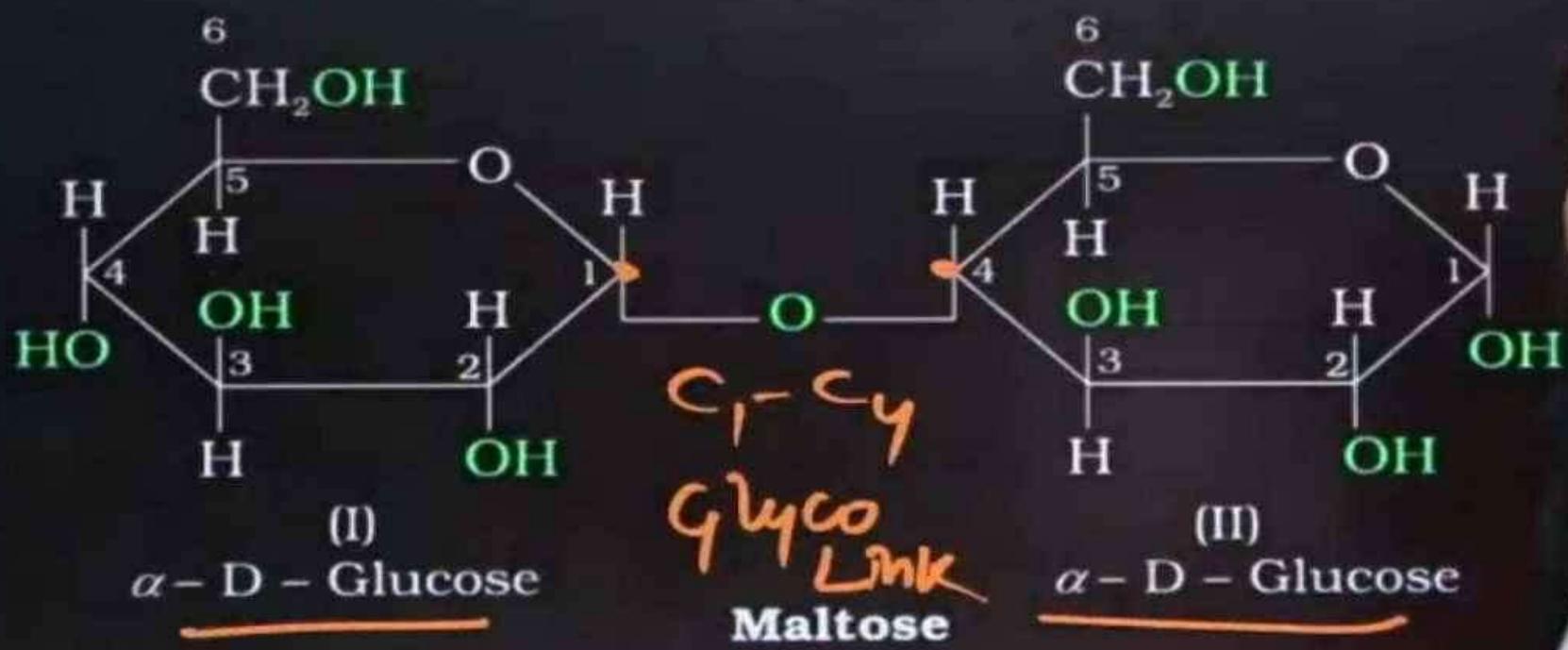
Disaccharides:



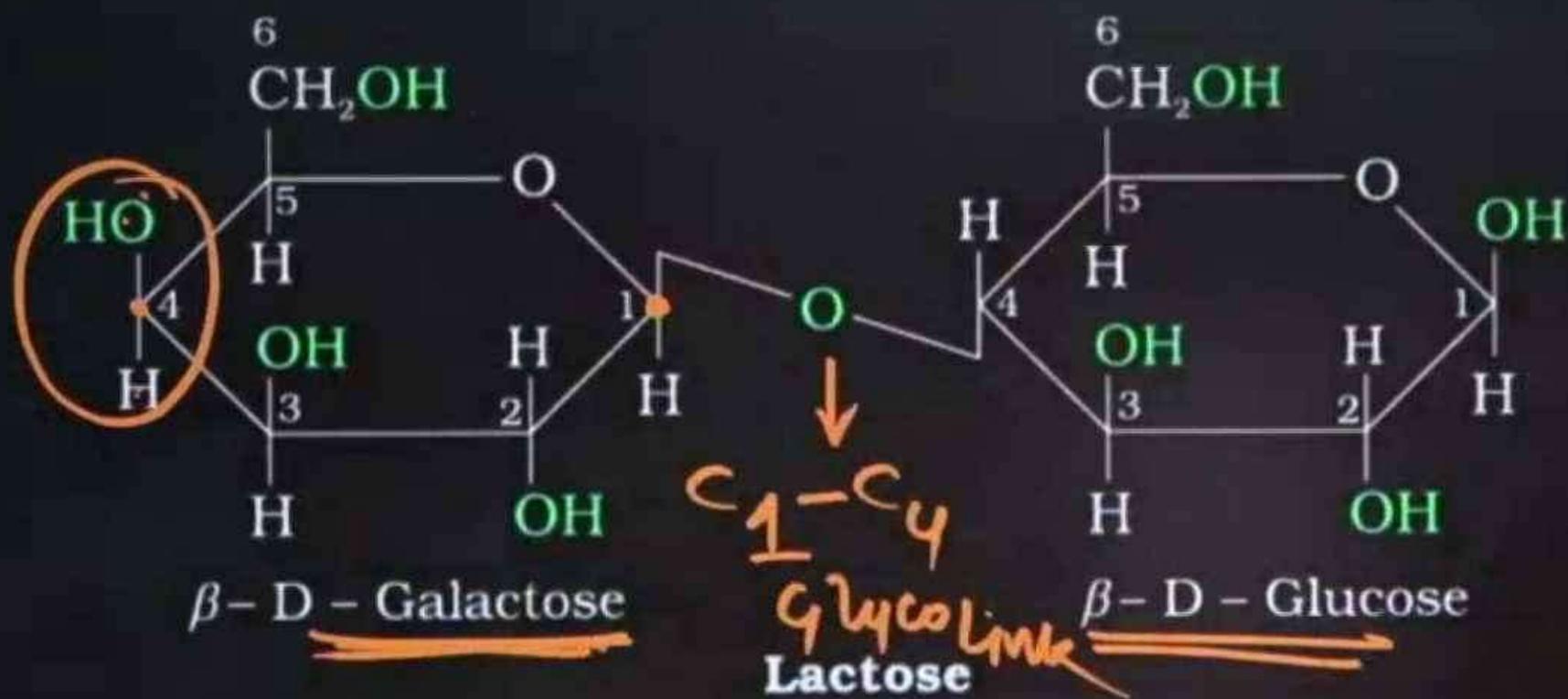
A. Structure of Sucrose:



B. Structure of Maltose:



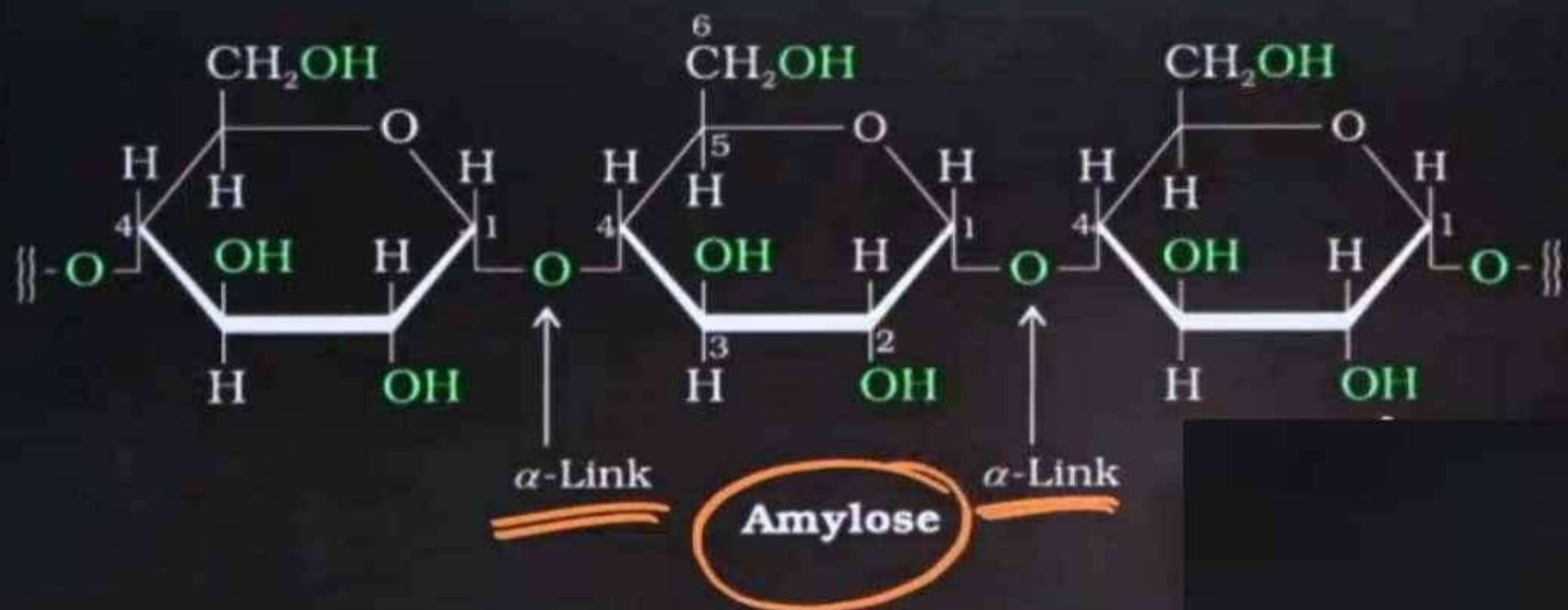
C. Structure of Lactose:



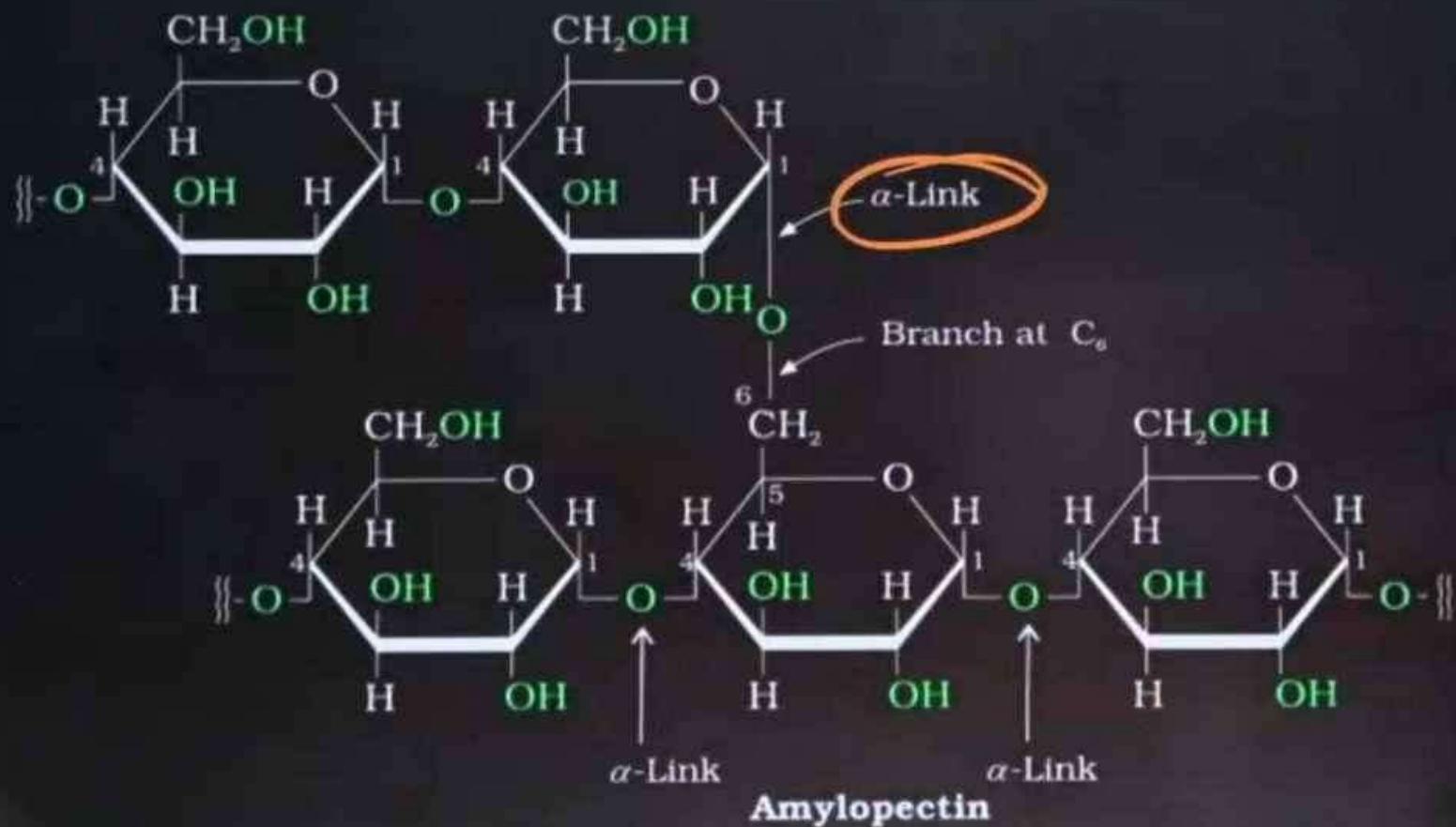
Polysaccharides:

Mono — O — Mono — O-Mono — O —

A. Structure of Starch:



A. Structure of Starch:



Diff b/w amylose and amylopectin

Amylose

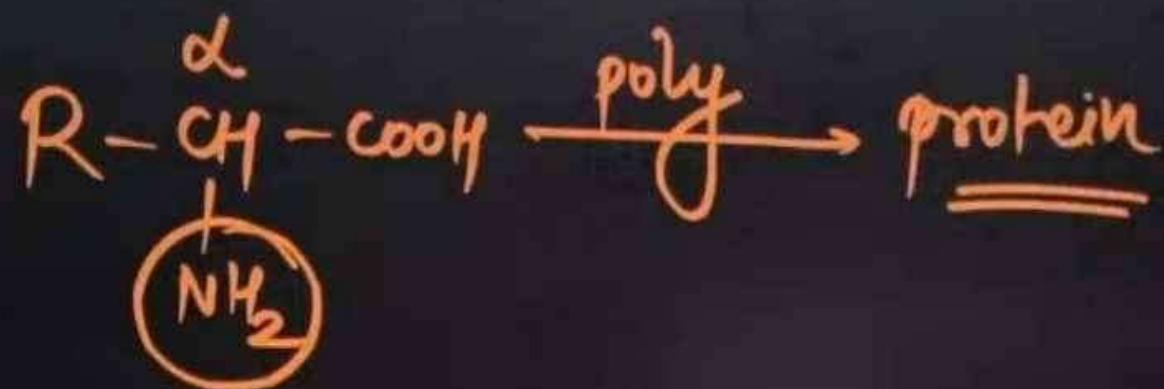
1. Linear polymer ✓
2. 15-20% starch ✓
3. Water soluble ✓
4. Glycosidic linkage at C_1 and C_4 ✓

Amylopectin

1. Branched Polymer ✓
2. 80-85% starch ✓
3. Water insoluble
4. Glycosidic linkage at C_1 and C_4 and Branch at C_6

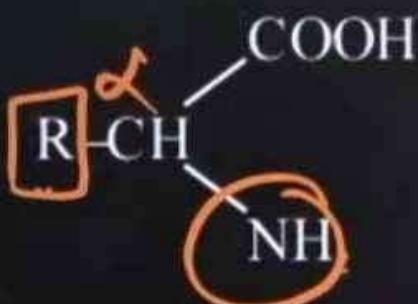


Amino Acids

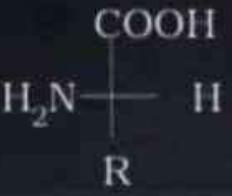


Amino acid (α -amino acids)

Based on R



1. If R contains COOH Acidic amino acid
2. If R contains NH_2 Basic amino acid
3. If R neither contains
 COOH nor NH_2 Neutral amino acid

Natural Amino Acids		Name of the amino acids	Characteristic feature of side chain, R	Three letter symbol	One letter code
		1. Glycine	H ⁺	Gly	G
		2. Alanine	-CH ₃	Ala	A
		3. Valine*	(H ₃ C) ₂ CH-	Val	V
		4. Leucine*	(H ₃ C) ₂ CH-CH ₂ -	Leu	L
		5. Isoleucine*	H ₃ C-CH ₂ -CH- CH ₃	Ile	I
		6. Arginine*	HN=C-NH-(CH ₂) ₃ - NH ₂	Arg	R
		7. Lysine*	H ₂ N-(CH ₂) ₄ -	Lys	K
		8. Glutamic acid	HOOC-CH ₂ -CH ₂ -	Glu	E
		9. Aspartic acid	HOOC-CH ₂ -	Asp	D
		10. Glutamine	H ₂ N-C(=O)-CH ₂ -CH ₂ -	Gln	Q

Amino acid (Imp. α -amino acids)

Three letter symbol	Name	Structure
Phe*	Phenyl alamine	$\text{Ph}-\text{CH}_2-\text{CH}(\text{NH}_2)-\text{COOH}$
Val*	Valine	$\text{Me}_2\text{CH}-\text{CH}(\text{NH}_2)-\text{COOH}$
Leu*	Leucene	$\text{Me}_2\text{CH}-\text{CH}_2-\text{CH}(\text{NH}_2)-\text{COOH}$
Ile*	Isoleucene	$\text{Et}-\text{CH}(\text{NH}_2)-\text{CH}(\text{Me})-\text{COOH}$

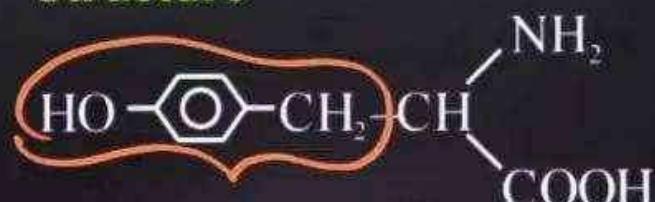


Amino acid (Imp. α -amino acids)

Three letter symbol Name Structure

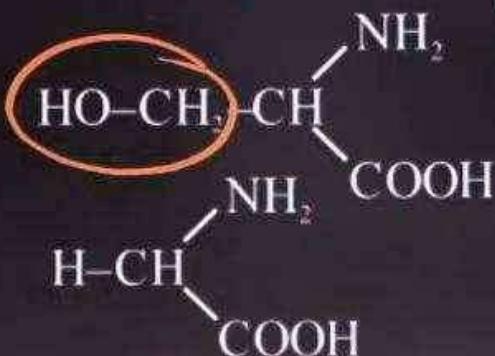
Tyr

Tyrocene



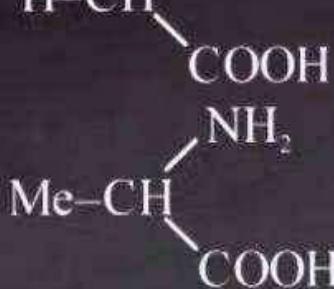
Ser

Serine



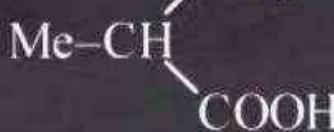
Gly

Glycine

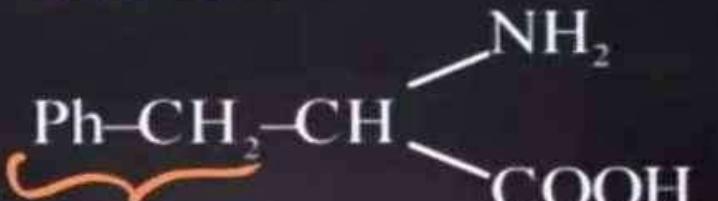
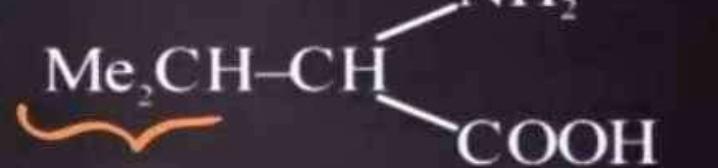
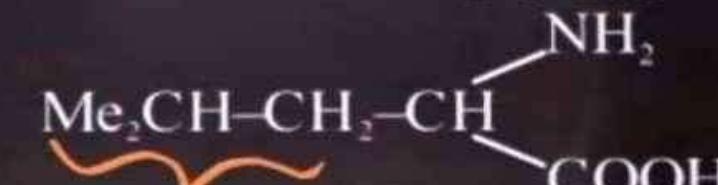
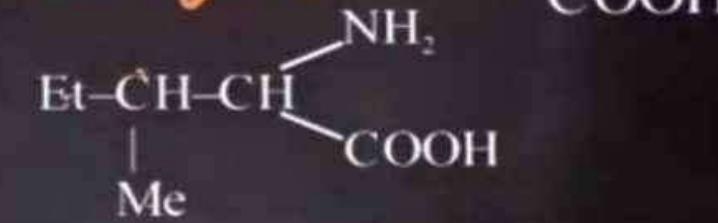


Ala

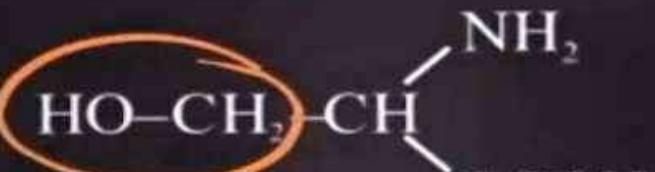
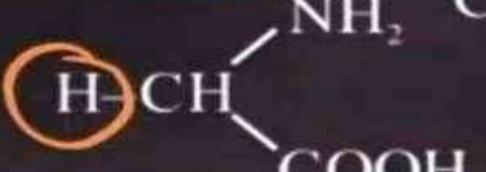
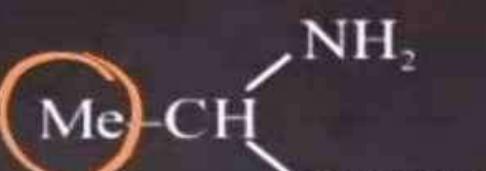
Alanine



Amino acid (Imp. α -amino acids)

Three letter symbol	Name	Structure
Phe*	Phenyl alamine	
Val*	Valine	
Leu*	Leucene	
Ile*	Isoleucene	

Amino acid (Imp. α -amino acids)

Three letter symbol	Name	Structure
Tyr	<u>Tyrocene</u>	
Ser	Serine	
Gly	<u>Glycine</u>	
Ala	Alanine	

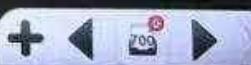
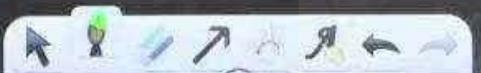
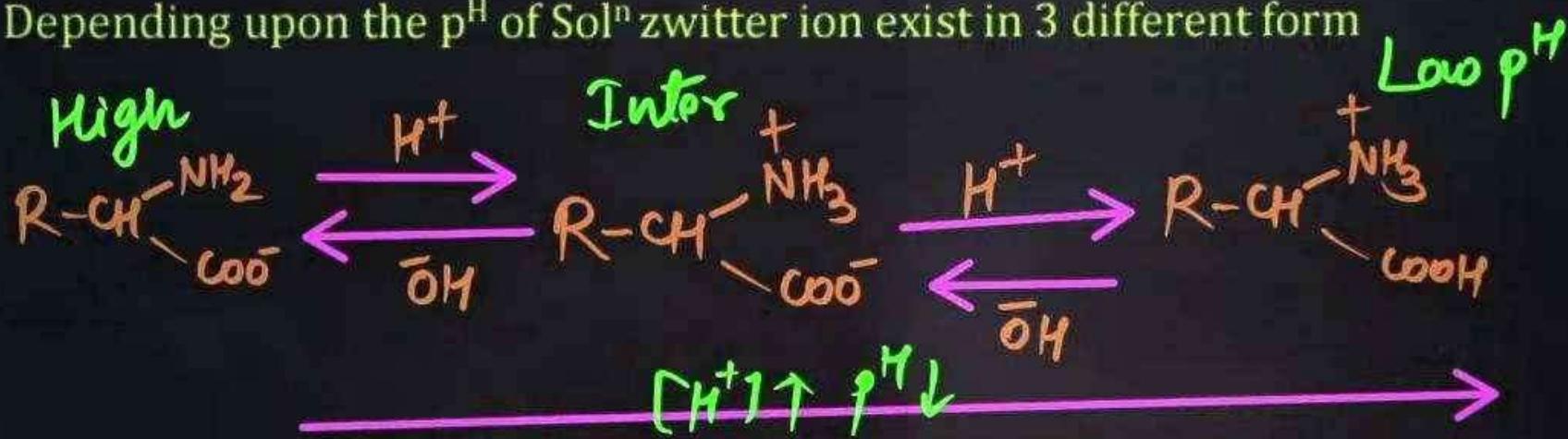
Amino acid (Imp. α -amino acids)

Three letter symbol	Name	Structure
Lys*	Lysine	$\text{H}_2\text{N}-\text{CH}_2-\overset{\text{+}}{\underset{\text{orange wavy line}}{\text{CH}}}-\text{NH}_2$ COOH
Asp	Aspartic acid	$\text{HOOC}-\text{CH}_2-\overset{\text{orange wavy line}}{\text{CH}}-\text{NH}_2$ COOH
Glu	Glutamic acid	$\text{HOOC}-\text{CH}_2-\text{CH}_2-\overset{\text{orange wavy line}}{\text{CH}}-\text{NH}_2$ COOH
Arg*	Arginine	$\text{H}_2\text{N}-\text{C}(\text{NH})=\text{NH}-\text{CH}_2-\text{CH}_2-\overset{\text{orange wavy line}}{\text{CH}}-\text{NH}_2$ COOH

Zwitter ion



Depending upon the ρ^{H} of Solⁿ zwitter ion exist in 3 different form



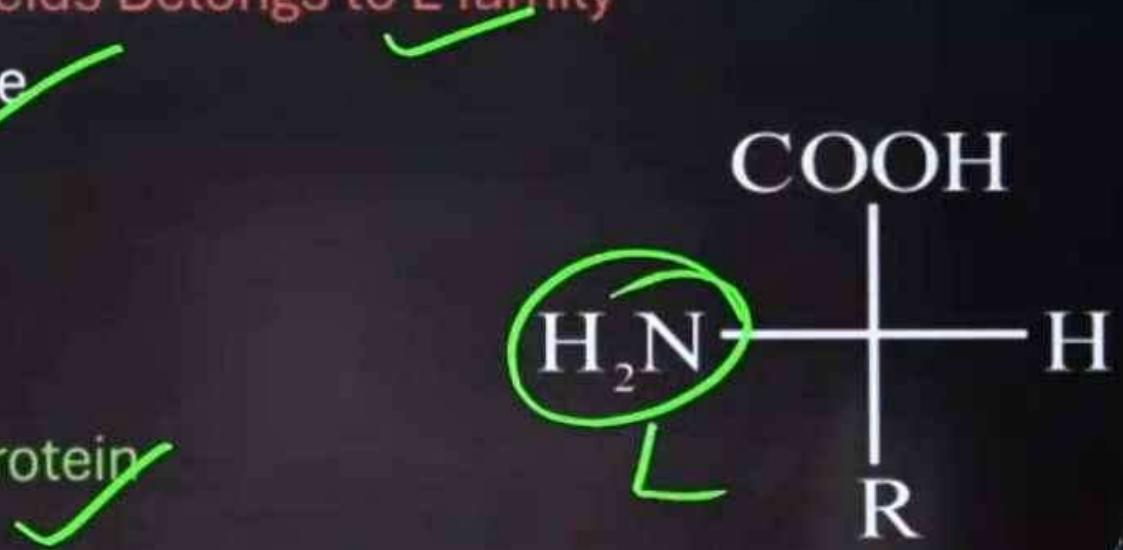
Calculation of pH at Isoelectric points (P^I)

Case 1- for neutral amino acid (usually 6)

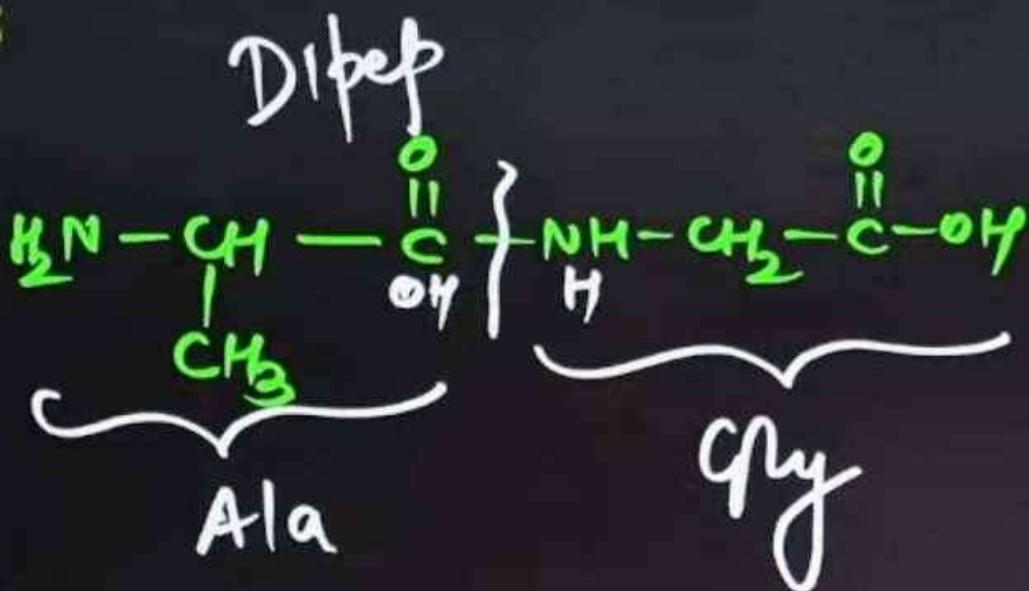
$$P^I \text{ or } P^H = \frac{pK_{a_1} + pK_{a_2}}{2}$$

OP points of α -Amino Acids

1. Most natural occurring amino acids Belongs to L family
2. Glycine is only optically in active
3. High M.P and B.P
4. Water soluble
5. Behave like salt
6. α -amino acid is monomer of Protein



Peptides

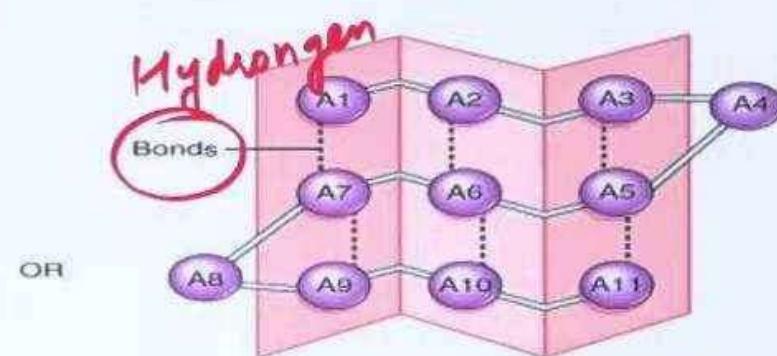
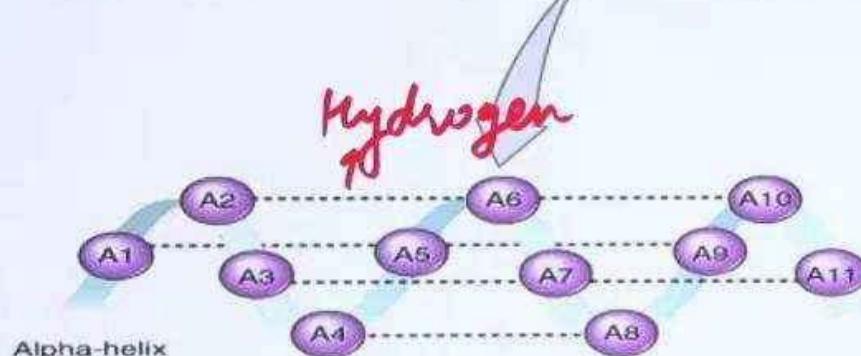


Globular & Fibrous Protein

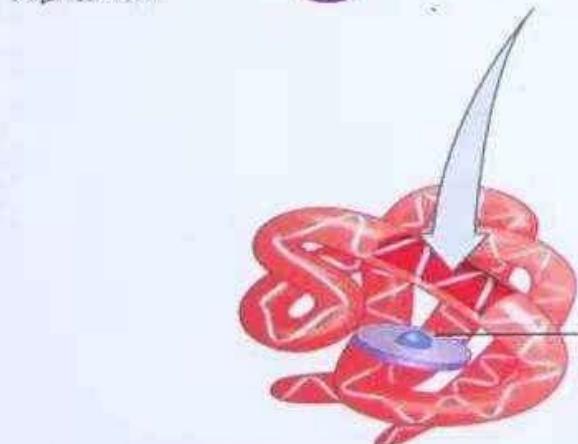
Globular and Fibrous are 2 main types of proteins

	Fibrous (collagen)	Globular (myoglobin)
Molecules	Long, thin Lie side by side to form fibres.	Fold into spherical 3-D shape.
Examples	Collagen (in skin and bone). keratin (present in hair, wool, silk) and myosin (present in muscles)	Haemoglobin Insulin (51 amino acid) Enzymes albumins
Solubility in water	Insoluble	Soluble
Roles	Structural : - Collagen in bone and cartilage - Keratin in fingernails and hair.	Metabolic - Enzymes in all organisms - Plasma proteins, antibodies in mammals.

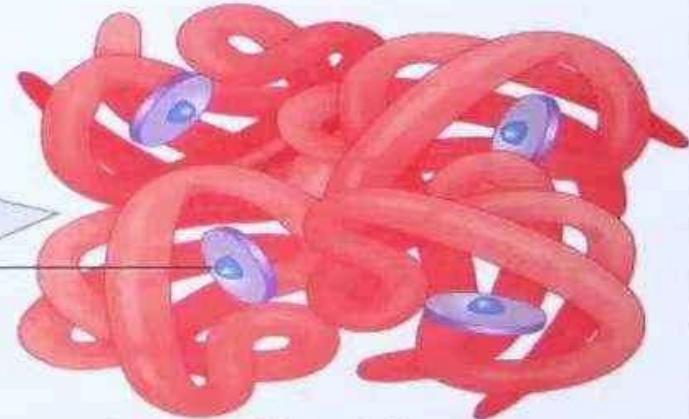
Structure of Globular PROTEINS



(b) Secondary structure (pleated sheet)



(c) Tertiary structure



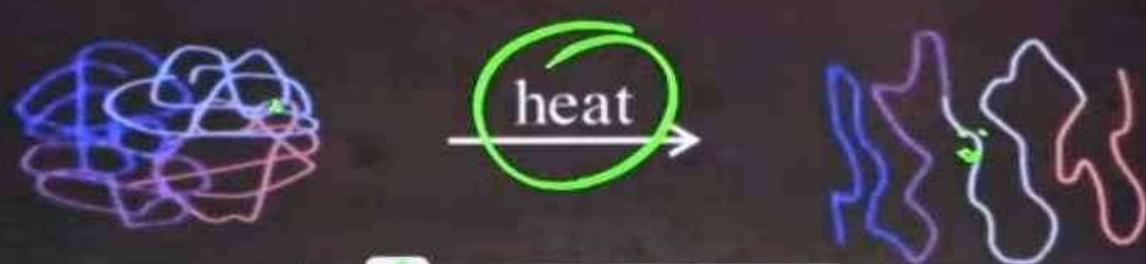
(d) Quaternary structure

Hemoglobin
(globular protein)



Denaturation of PROTEINS

1. Protein found in a biological system with a unique 3D structure and biological activity is called a native protein.
2. When a protein in its native form, is subjected to physical change like change in temperature or chemical change like change in pH, the hydrogen bonds are disturbed. Due to this, globules unfold and helix get uncoiled and protein loses its biological activity. This is called denaturation of protein.
3. During denaturation secondary and tertiary structures are destroyed but primary structure remains intact.
4. Exp- coagulation of egg white on boiling , curdling of milk which is caused due to the formation of lactic acid by the bacteria present in milk.





Nucleic Acids

Nucleoside

sugar + Base

Nucleotide

Sugar + Base + phosphate

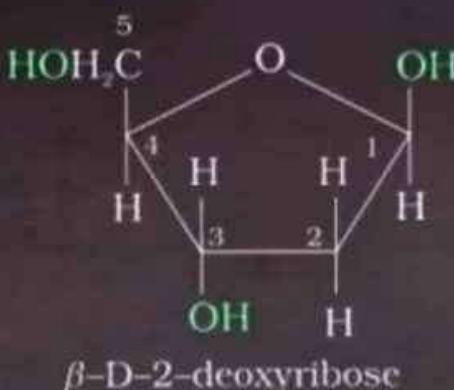
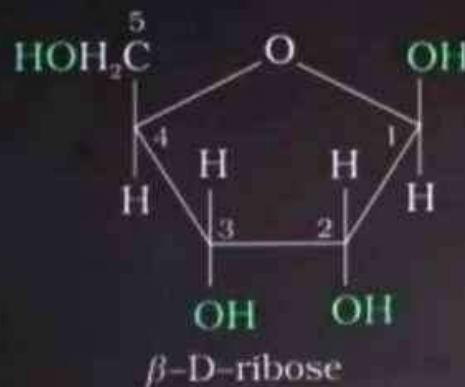
DNA β -Deoxyribose AGCT

RNA β - Ribose AGCU



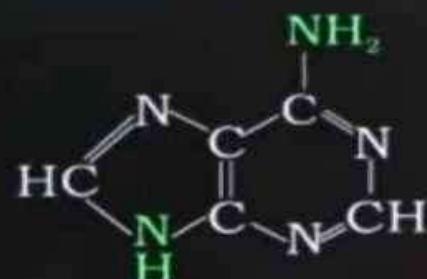
Chemical Composition of Nucleic Acids

1. Complete hydrolysis of DNA (or RNA) yields a pentose sugar, phosphoric acid and nitrogen containing heterocyclic compounds (called bases).
2. The DNA molecules, the sugar moiety is β -D-2-deoxyribose whereas in RNA molecule, it is β -D-ribose.



Bases in DNA & RNA

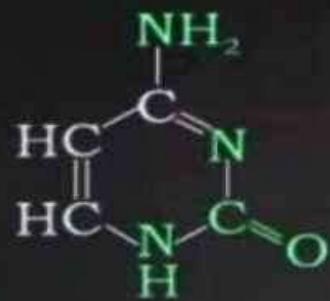
1. DNA adenine (A), guanine (G), cytosine (C) and thymine (T).
2. RNA adenine (A), guanine (G), cytosine (C) and uracil (U).



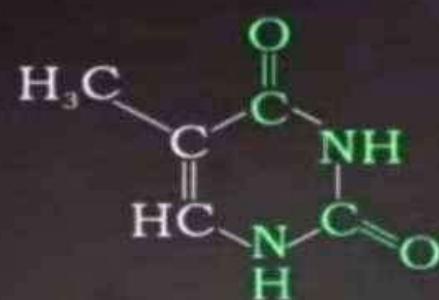
Adenine (A)



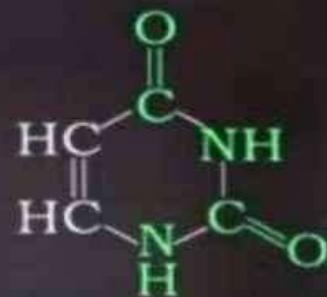
Guanine (G)



Cytosine (C)



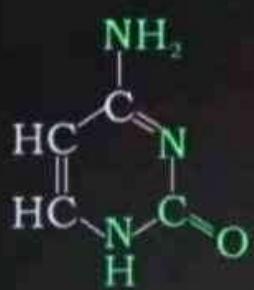
Thymine (T)



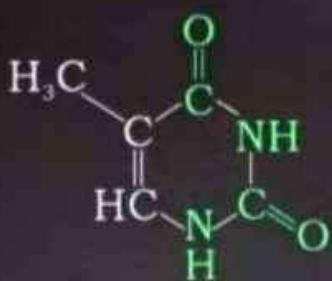
Uracil (U)

Bases in DNA & RNA

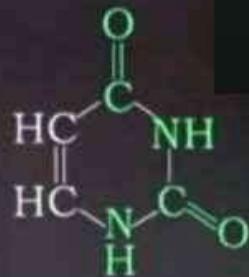
1. DNA adenine (A), guanine (G), cytosine (C) and thymine (T)
2. RNA adenine (A), guanine (G), cytosine (C) and uracil (U).



Cytosine (C)



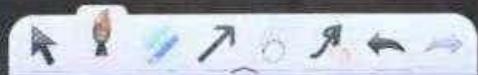
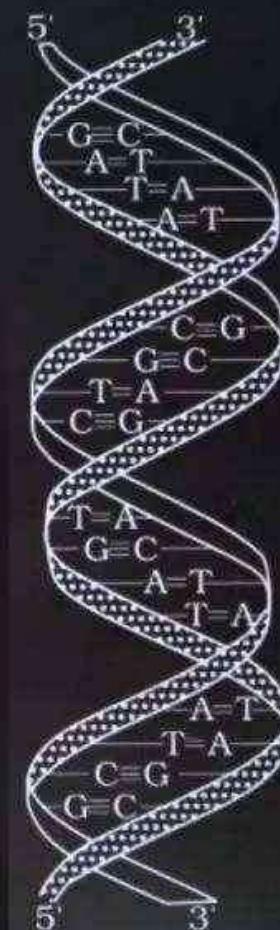
Thymine (T)



Uracil (U)

Double strand helix structure for DNA

1. Nucleic acids have a secondary structure also.
2. Two nucleic acid chains are wound about each other and held together by hydrogen bonds between pairs of bases.
3. The two strands are complementary to each other because the hydrogen bonds are formed between specific pairs of bases.
4. Adenine forms 2 hydrogen bonds with thymine whereas cytosine forms 3 hydrogen bonds with guanine.



Fat Soluble Vitamins

- Vitamin K
- Vitamin E
- Vitamin D
- Vitamin A (Retinol)
-  B₁₂

Body
main
store

KEDA
B12

Water Soluble Vitamins

Vitamin	Name
B ₁	Thiamine
B ₂	Riboflavin
B ₃	Niacin
B ₅	Pantothenic Acid
B ₆	Pyridoxine
B ₇	Biotin
B ₉	Folate
C	Ascorbic Acid

Sl. No.	Name of Vitamins	Sources	Deficiency diseases
1.	Vitamin A	Fish liver oil, carrots, butter and milk	Xerophthalmia (hardening of cornea of eye) Night blindness
2.	Vitamin B ₁ (Thiamine)	Yeast, milk, green vegetables and cereals	Beriberi (loss of appetite, retarded growth)
3.	Vitamin B ₂ (Riboflavin)	Milk, eggwhite, liver, kidney	Cheilosis (fissuring at corners of mouth and lips), digestive disorders and burning sensation of the skin.
4.	Vitamin B ₆ (Pyridoxine)	Yeast, milk, egg yolk, cereals and grams	Convulsions
5.	Vitamin B ₁₂	Meat, fish, egg and curd	Pernicious anaemia (RBC deficient in haemoglobin)
6.	Vitamin C (Ascorbic acid)	Citrus fruits, amla and green leafy vegetables	Scurvy (bleeding gums)
7.	Vitamin D	Exposure to sunlight, fish and egg yolk	Rickets (bone deformities in children) and osteomalacia (soft bones and joint pain in adults)
8.	Vitamin E	Vegetable oils like wheat germ oil, sunflower oil, etc.	Increased fragility of RBCs and muscular weakness
9.	Vitamin K	Green leafy vegetables	Increased blood clotting



Enzymes

1. Enzymes are high molecular mass proteins
2. Also known as biochemical catalyst
3. One enzyme can catalyse million of the reactions
4. Highly active under optimum temperature and pH
5. Highly specific in nature



Hormones

1. Hormones are molecules that act as intercellular messengers.
2. These are produced by endocrine glands in the body and are poured directly in the blood stream which transports them to the site of action.
3. Some of these are steroids, e.g., estrogens and androgens; some are poly peptides for example insulin and endorphins and some others are amino acid derivatives such as epinephrine and norepinephrine.
4. Hormones have several functions in the body. They help to maintain the balance of biological activities in the body.
5. The role of insulin in keeping the blood glucose level within the narrow limit is an example of this function. Insulin is released in response to the rapid rise in blood glucose level.

6. Hormone glucagon tends to increase the glucose level in the blood.
7. Steroid hormones are produced by adrenal cortex and gonads (testes in males and ovaries in females).
8. Hormones released by the adrenal cortex play very important role in the functions of the body.
9. Testosterone is the major sex hormone produced in males.
10. It is responsible for development of secondary male characteristics (deep voice, facial hair, general physical constitution).
11. Estradiol is the main female sex hormone.
12. It is responsible for development of secondary female characteristics and participates in the control of menstrual cycle.
13. Progesterone is responsible for preparing the uterus for implantation of fertilized egg.

QUESTION (JEE Mains 1st Feb 2024, Morning Shift)

If one strand of a DNA has the sequence ATGCTTCA, sequence of the basis in complementary strand is:

TACGAAGT

AGCT

- A CATTAGCT
- B TACGAAGT
- C GTACTTAC
- D ATGCGACT

QUESTION (JEE Mains 4th April 2024, Evening Shift)

Match List I with List II.

	LIST I		LIST II
A.	α -Glucose and α -Galactose	I.	Functional isomers
B.	α -Glucose and β -Glucose	II.	Homologous
C.	α -Glucose and α -Fructose	III.	Anomers
D.	α -Glucose and α -Ribose	IV.	Epimers

Choose the correct answer from the options given below:

A A – III, B – IV, C – II, D – I

B A – III, B – IV, C – I, D – II

C ✓ A – IV, B – III, C – I, D – II

D A – IV, B – III, C – II, D – I

QUESTION (JEE Mains 27th January 2024, Morning Shift)

Two nucleotides are joined together by a linkage known as:

- A Phosphodiester linkage
- B Glycosidic linkage
- C Disulphide linkage
- D Peptide linkage

3' & 5'

QUESTION (JEE Mains 29 January 2024, Morning Shift)

Type of amino acids obtained by hydrolysis of proteins is:

- A β
- C δ

- B α
- D γ

QUESTION (JEE Mains 31 January 2024, Evening Shift)

From the vitamins A, B₁, B₆, B₁₂, C, D, E and K, the number vitamins that can be stored in our body is 5.

QUESTION (JEE Mains 30 January 2024, Morning Shift)

Sugar which does not give reddish brown precipitate with Fehling's reagent is:

- A** Sucrose
- C** Glucose

- B** Lactose
- D** Maltose

QUESTION (NCERT Exemplar)

Proteins are found to have two different types of secondary structures viz. α -helix and β -pleated sheet structure. α -helix structure of protein is stabilized by:

- A** Peptide bonds
- B** van der Waals forces
- C** Hydrogen bonds
- D** Dipole-dipole interactions

QUESTION (NCERT Exemplar)

DNA and RNA contain four bases each. Which of the following bases is not present in RNA?

A Adenine

B Uracil

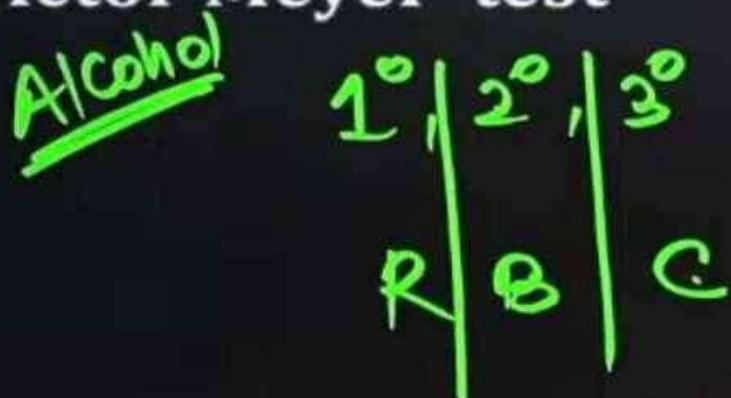
C Thymine ✓

D Cytosine

Practical
Organic
Chemistry

Test of Alcohols

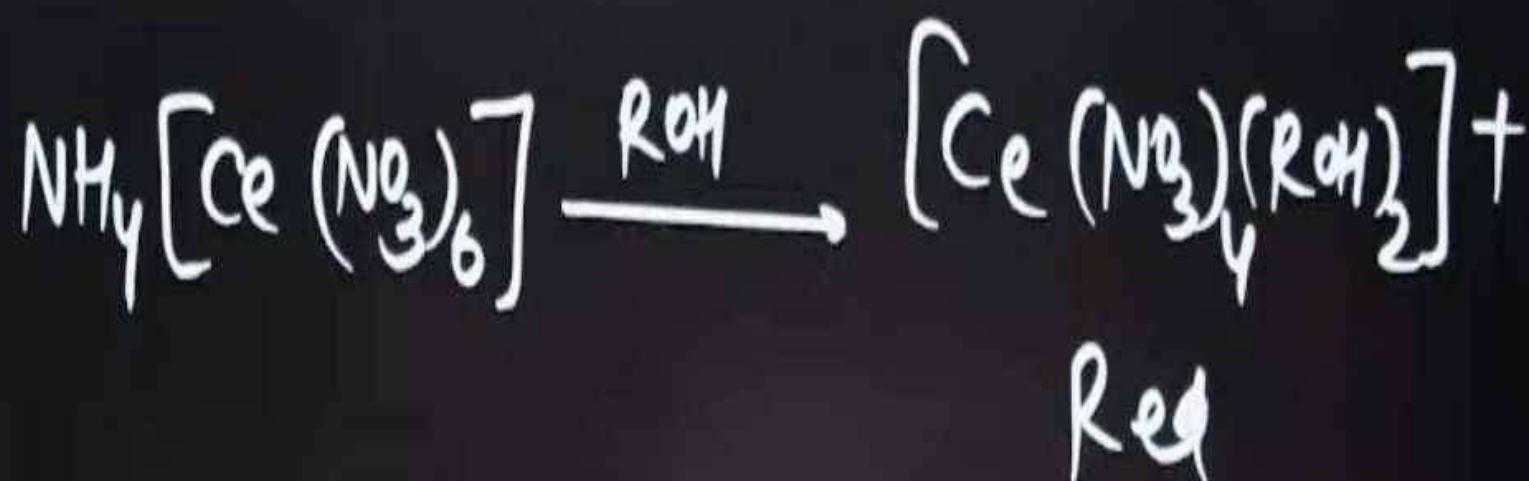
1. Victor Meyer test



Test of Alcohols

2. CAN(Ceric Ammonium Nitrate) test

NH₄NO



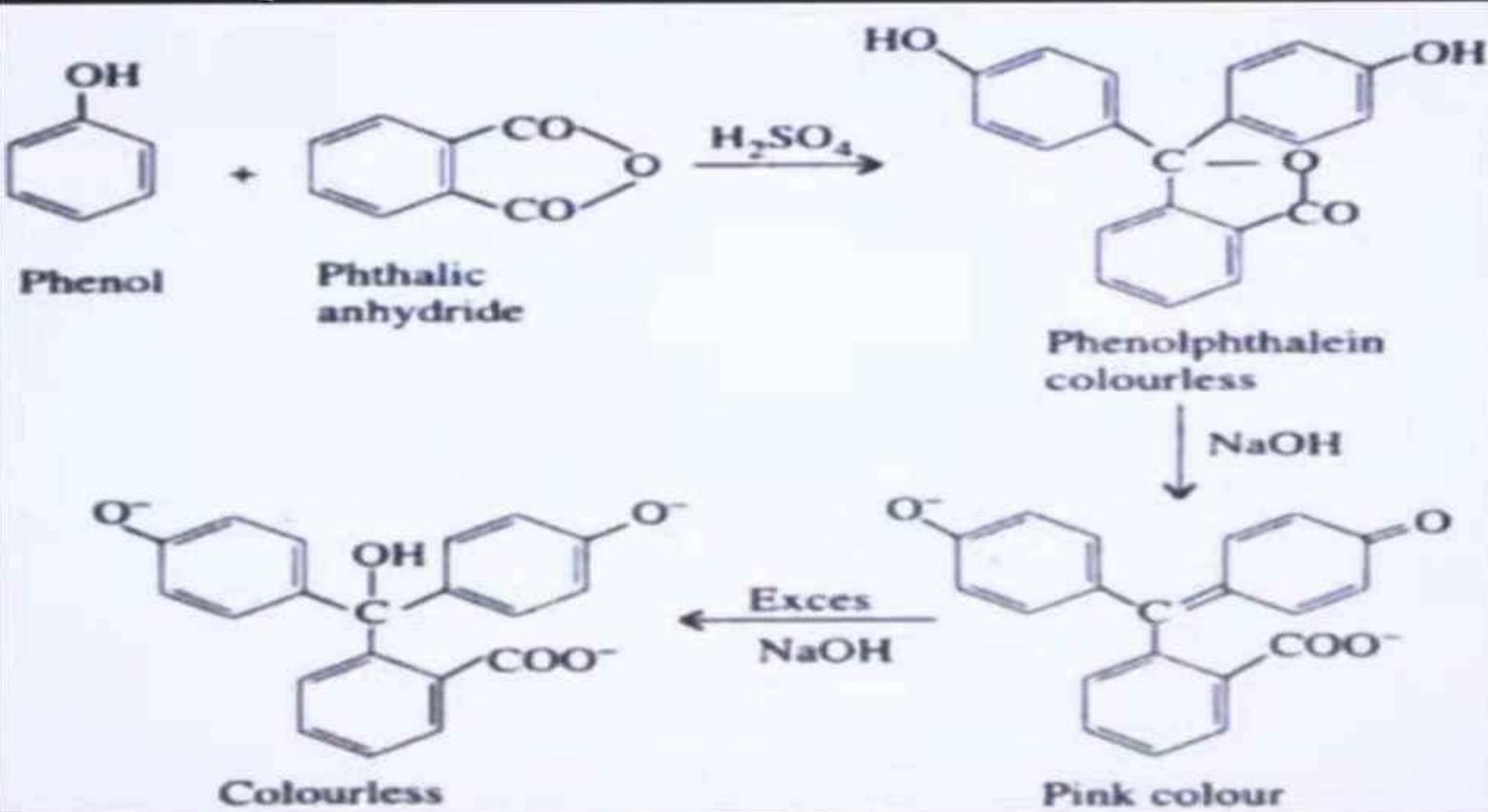
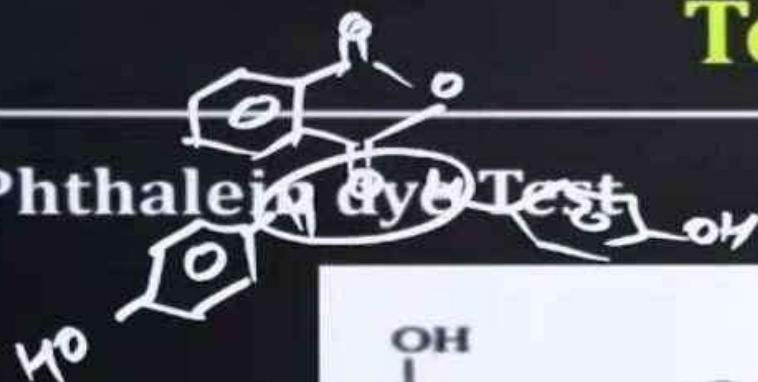
Test of Phenol

1. FeCl_3 test

Violet

Test of Phenol

2. Phthalein dye Test



Test of Carbonyl compounds

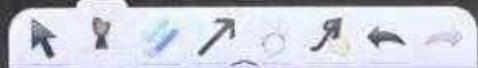


1. Schiff's Test

Schiff's reagent → The reagent is prepared by decolourising aqueous solution of p-rosaniline hydrochloride dye by adding sodium sulphite or by passing SO₂ gas).

Aldehydes → pink colour

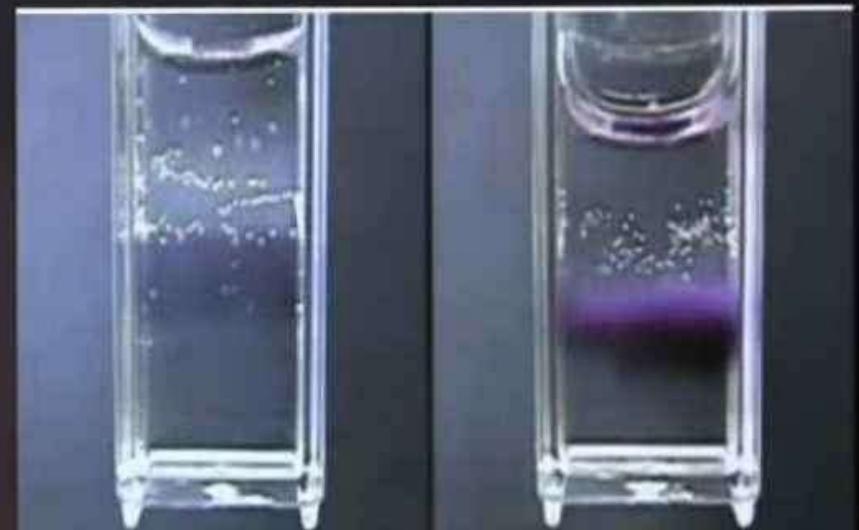
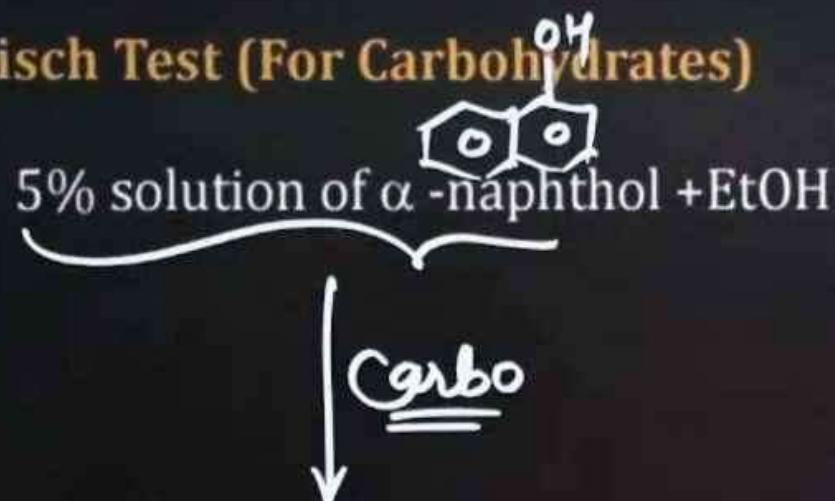
Ketones do not respond to this test.





Test

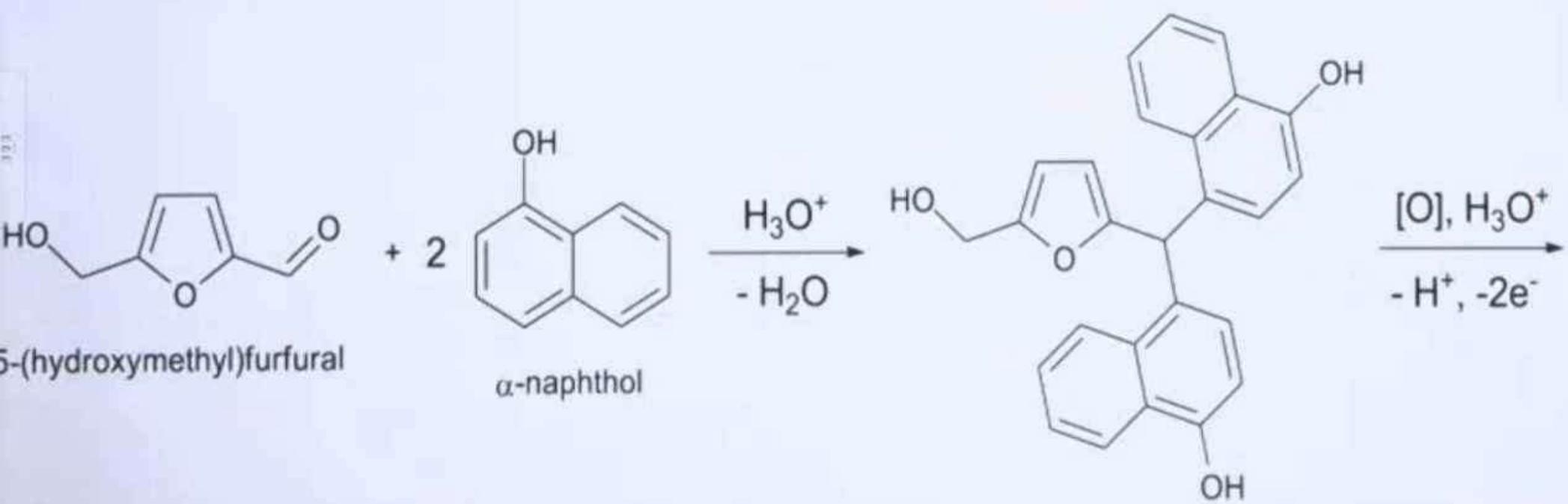
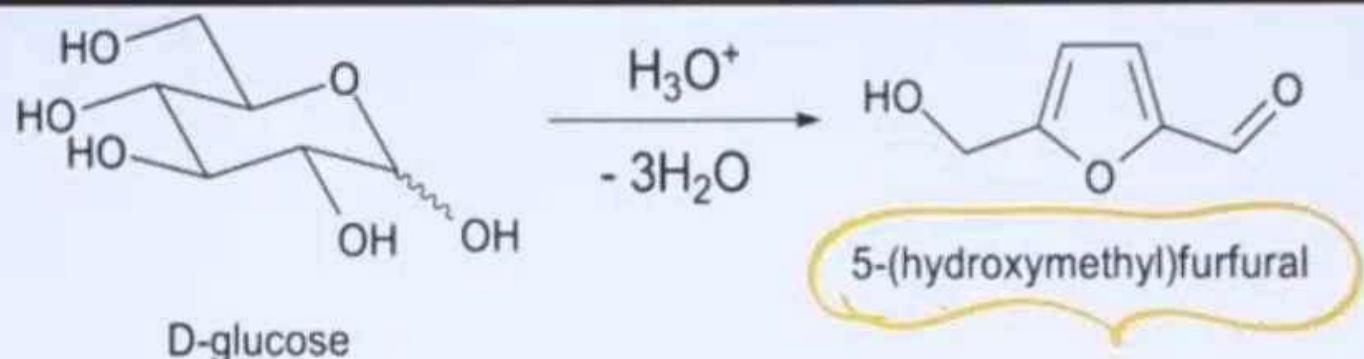
1. Molisch Test (For Carbohydrates)



Purple ring at the junction of two liq.

MONO → FAST

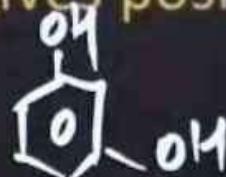
DI or POLY → SLOW



Test

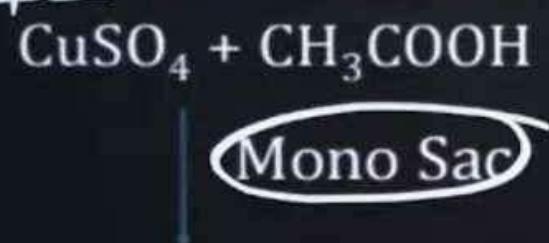
2. Seliwanoff's Test (for ketose)

- This test is to be performed when sample gives positive test for Benedict's or Fehling's test.
- Take Seliwanoff's reagent and add sample.
- Boil for two minutes. Appearance of red to orange colour indicates the presence of fructose.
- If no colour appears in 2 minutes, continue boiling for 5 minutes.
- If faint orange or no colour appears, then it indicates the presence of glucose.

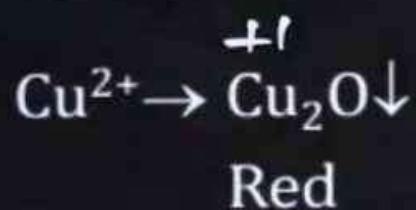


Test

3. ~~+2~~ Barfoed Test (for mono and Disaccharides)

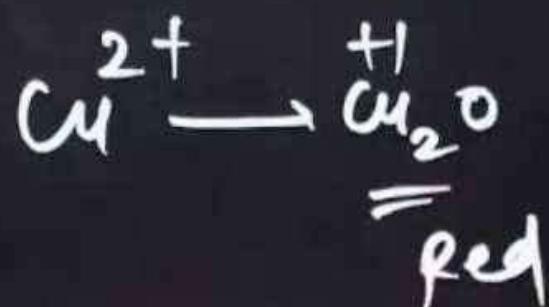
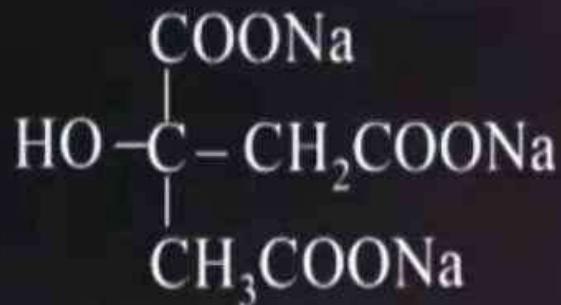


Red ppt



4. Benedict's test (for Reducing sugar)

Aq CuSO₄ + sodium citrate ✓



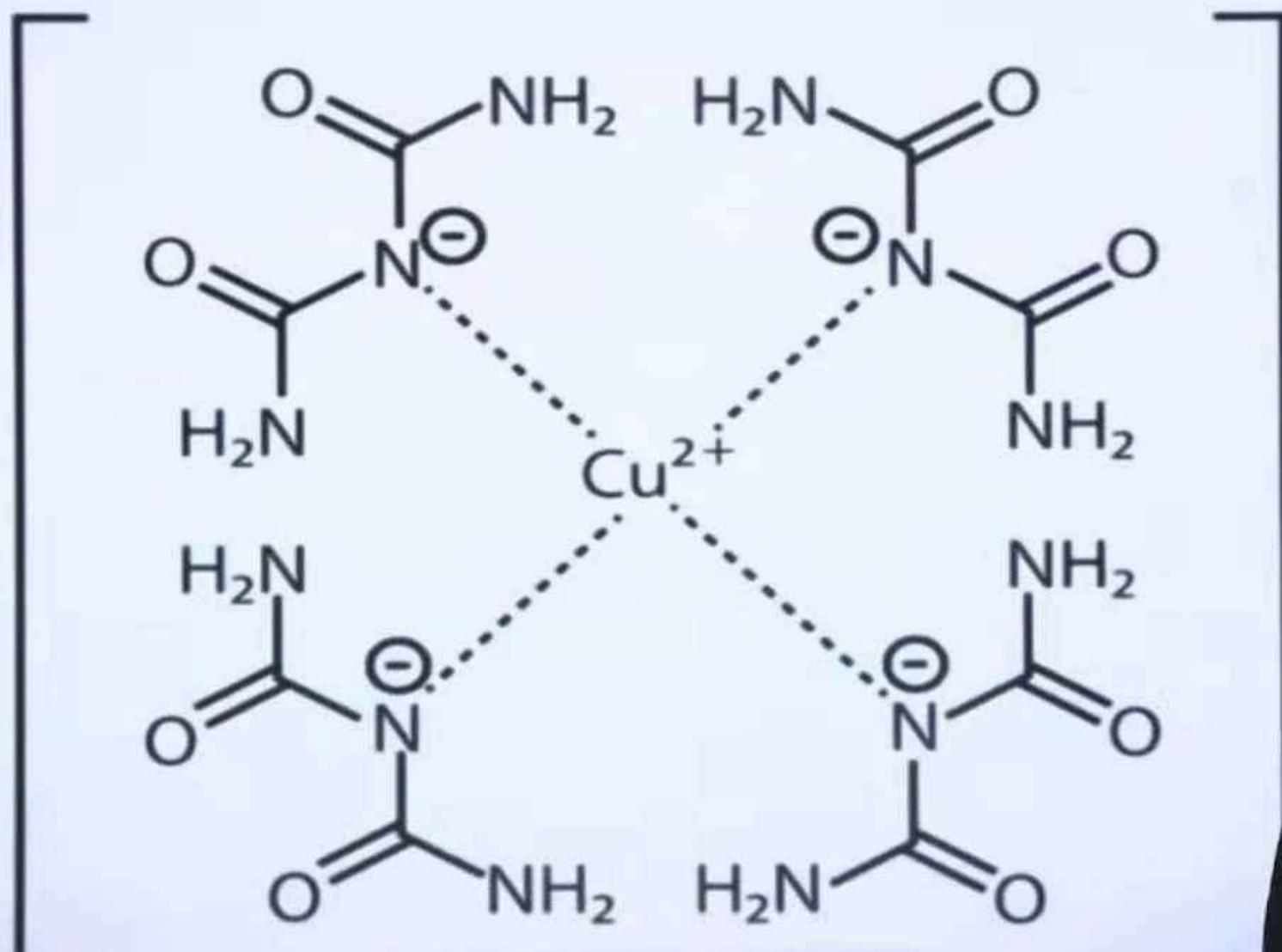
Tests of Proteins

(a) Biuret test

- Take protein solution in a test tube.
- Add NaOH solution and 1 or 2 drops of CuSO₄ solution.
- A violet colour indicates the presence of proteins.
- Biuret test is for peptide bond in the molecule of a protein



Care must be taken that excess of copper sulphate is not added otherwise there will be blue colour instead of violet colour.

2Na^+  $^{2-}$

Aro Tests of Proteins

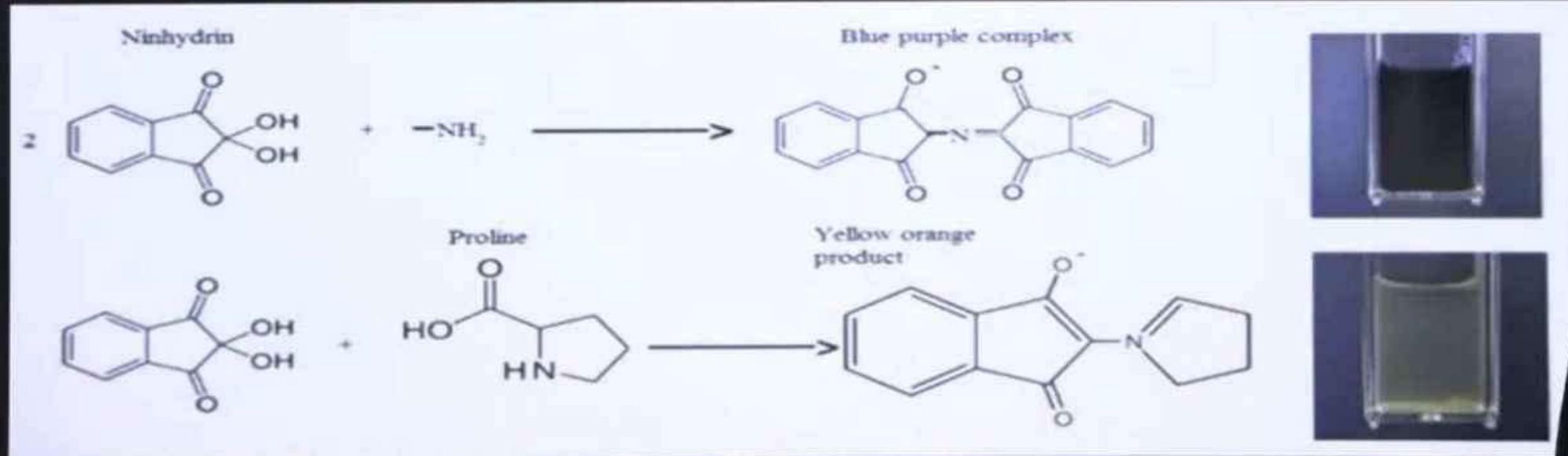
(b) Xanthoproteic test

- Add concentrated HNO_3 to protein solution
- A white precipitate is formed ✓
- Boil the solution and the colour changes to yellow.
- Cool the test tube and add NaOH (or ammonia solution) to make it alkaline.
- The colour changes to orange indicating the presence of proteins.
- Xanthoproteic test is specific for protein containing aromatic amino acids. The benzene ring in the amino acids is nitrated by heating with nitric acid and forms yellow nitro-compounds which turns to orange colour with alkali.

Tests of Proteins

(C) Ninhydrin test

- (i) This test is given by all proteins.
- (ii) When protein is boiled with a dilute solution of ninhydrin, a violet colour is produced Called Ruhemann's Purple
- # In case of Proline Yellow Orange Colour is produced



Tests of Proteins

(d) Millon's Test

Protein solution + Millon's reagent → pink colour

Millon's reagent is solution of mercuric nitrate and nitrite in nitric acid containing traces of nitrous acid.

QUESTION (JEE Mains 5th April 2024, Morning Shift)

Which of the following gives a positive test with ninhydrin ?

A Cellulose

C Polyvinyl chloride

B Starch

D Egg albumin

QUESTION (JEE Mains 30 January 2024, Morning Shift)

Sugar which does not give reddish brown precipitate with Fehling's reagent is:

- A Sucrose ✓
- B Lactose
- C Glucose
- D Maltose

QUESTION (JEE Mains 27th January 2024, Evening Shift)

Phenolic group can be identified by a positive:

- A Phthalein dye test
- B Lucas test
- C Tollen's test
- D Carbylamine test

QUESTION (JEE Mains 8th April 2024, Evening Shift)

Match List-I with List-II.

List-I (Test)

- (A) Bayer's test (IV)
- (B) Ceric ammonium nitrate test (III)
- (C) Phthalein dye test (I)
- (D) Schiff's test (II)

List-II (Identification)

- (I) Phenol
- (II) Aldehyde
- (III) Alcoholic-OH group
- (IV) Unsaturation

Choose the **correct** answer from the options given below:

QUESTION (JEE Mains 9th April 2024, Evening Shift)

Match List I with List II.

List-I (Test)

- A. Br₂ water test (II)
- B. Ceric ammonium nitrate test
- C. Ferric chloride test
- D. 2, 4-DNP test

List-II (Observation)

- I. Yellow orange or orange red precipitate form
- II. Reddish orange colour disappears
- III. Red colour appears
- IV. Blue, Green, Violet or Red colour appear

Choose the correct answer from the options given below:

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

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

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

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



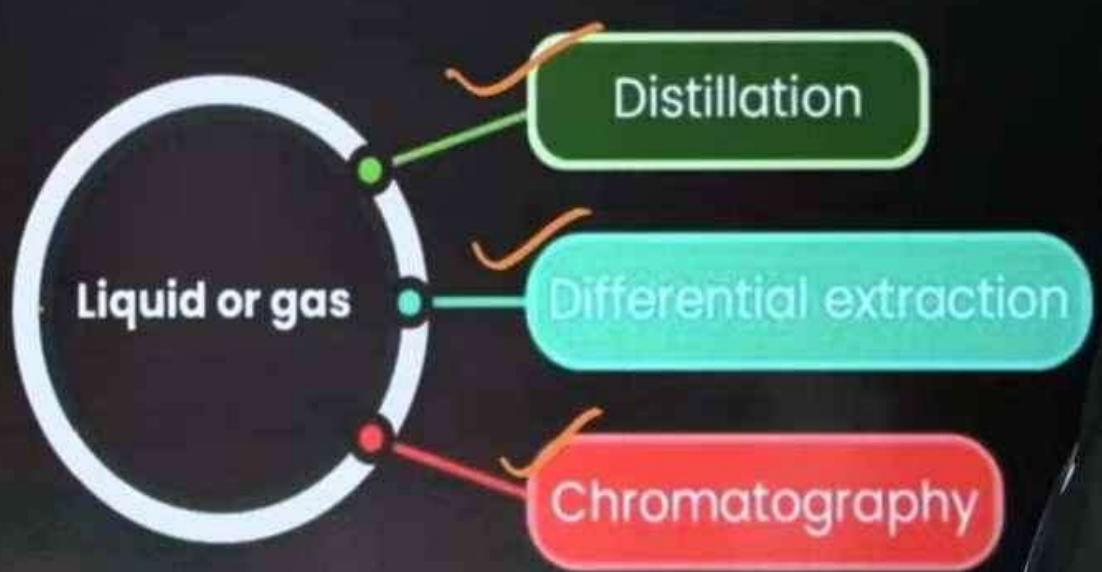
Methods of Purification



Solids

Sublimation

Crystallisation





Crystallization

- Based on the difference in the solubilities of the compound & the impurities in a suitable solvent.
- The impure compound is dissolved in a solvent in which it is sparingly soluble at room temperature but appreciably soluble at higher temperature.
- If the compound is highly soluble in one solvent and very little soluble in another solvent, crystallization can be satisfactorily carried out in a mixture of these solvents.
- e.g: Purification of sugar and purification of potash alum etc.





Sublimation



Solid is converted directly into vapour without undergoing liquid state.

e.g: Purification of iodine, Camphor, Naphthalene, ammonium chloride etc.



Distillation

Principle: Based on difference in B. P. of components of mixture.

➤ **Also used to separate:** Volatile liquids from nonvolatile impurities

Types of Distillations

1. Simple distillation ✓
2. Fractional distillation ✓
3. Vacuum distillation ✓
4. Steam distillation ✓

1. Simple distillation:

To separate liquids which have sufficient difference in B.P. > 20

e.g: chloroform
(334K) & aniline
(457K)

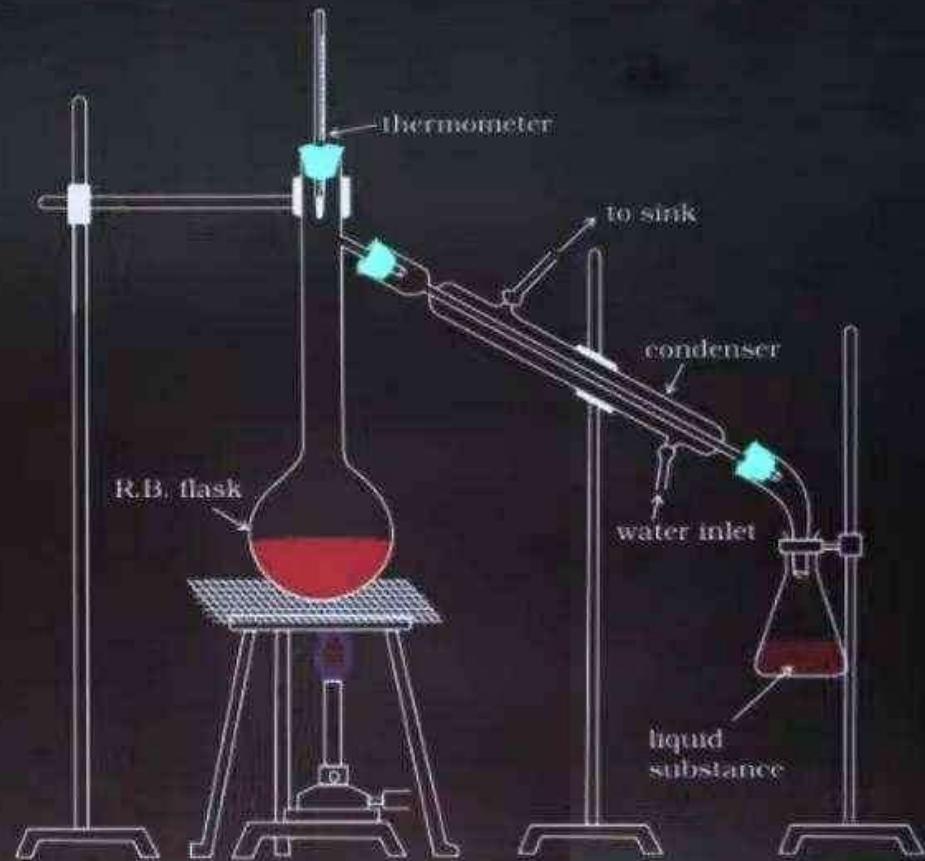


Fig.12.5 Simple distillation. The vapours of a substance formed are condensed and the liquid is collected in conical flask.

2. Fractional distillation:

To separate liquids which have small difference in B.P.

$< 20^{\circ}\text{C}$

e.g: To separate different fractions of crude oil in petroleum industry.

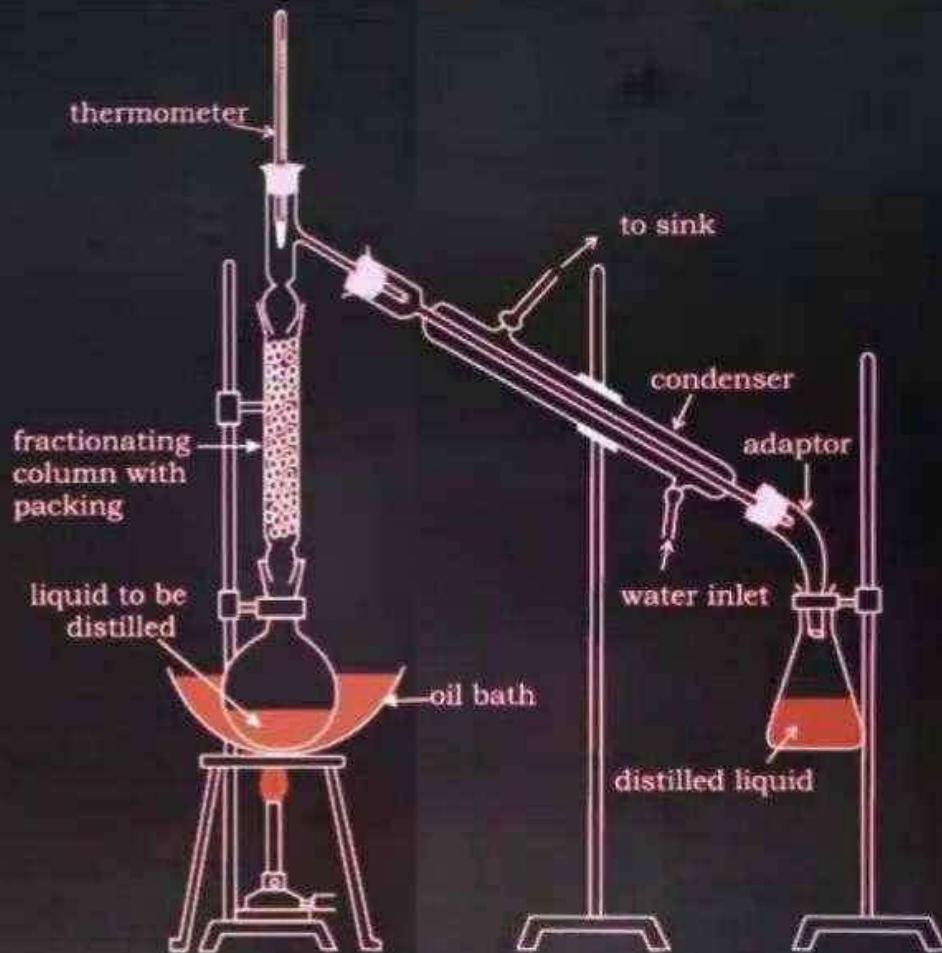


Fig. 12.6 Fractional distillation. The vapours of lower boiling fraction reach the top of the column first followed by vapours of higher boiling fractions.

3. Vacuum distillation (distillation under reduced pressure)

This method is used to purify liquids having very high boiling points but they decompose at or below their boiling points.

e.g: Glycerol is separated from spent - lye in soap industry.

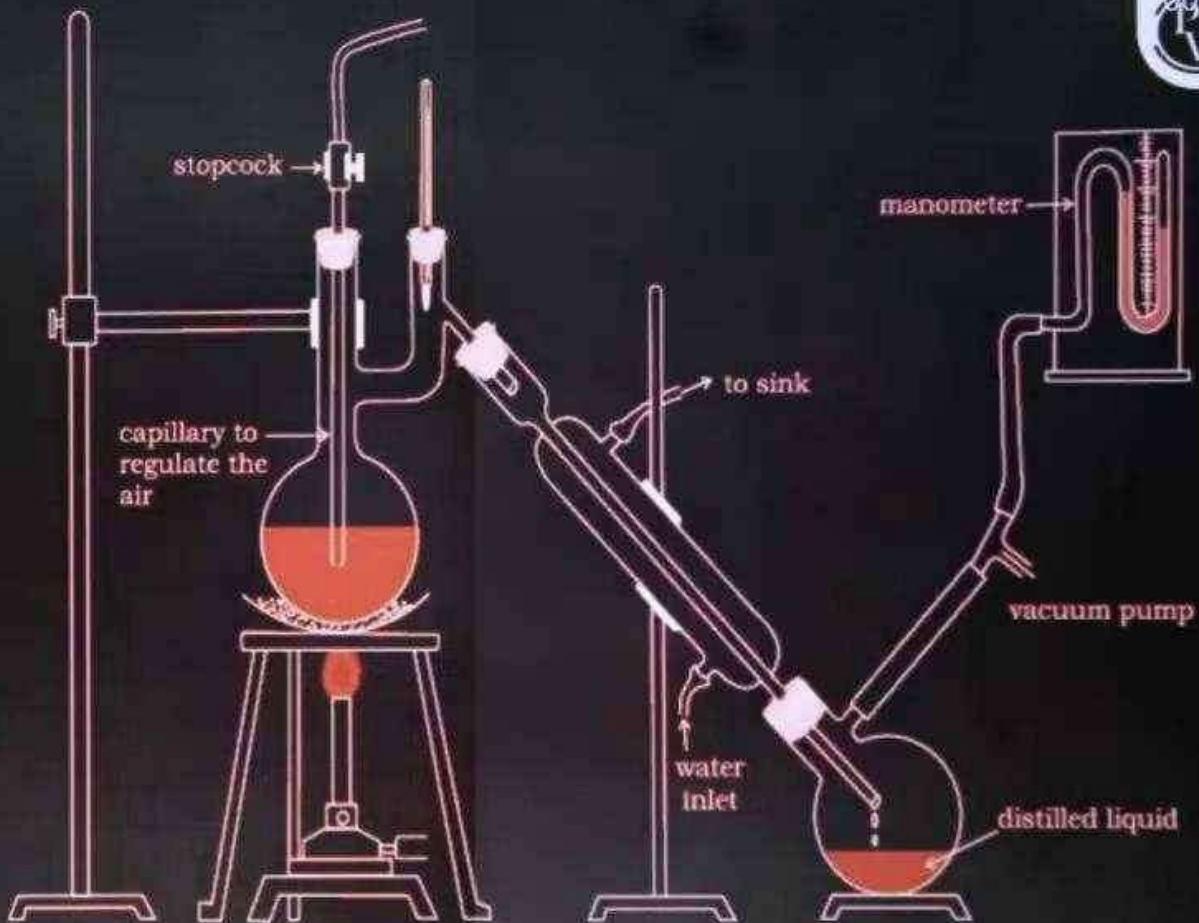


Fig.12.8 Distillation under reduced pressure. A liquid boils at a temperature below its vapour pressure by reducing the pressure.



4. Steam Distillation

- To separate substances which are steam volatile and are immiscible with water.

e.g: **Aniline, Nitrobenzene, o-nitro phenol & etc.**

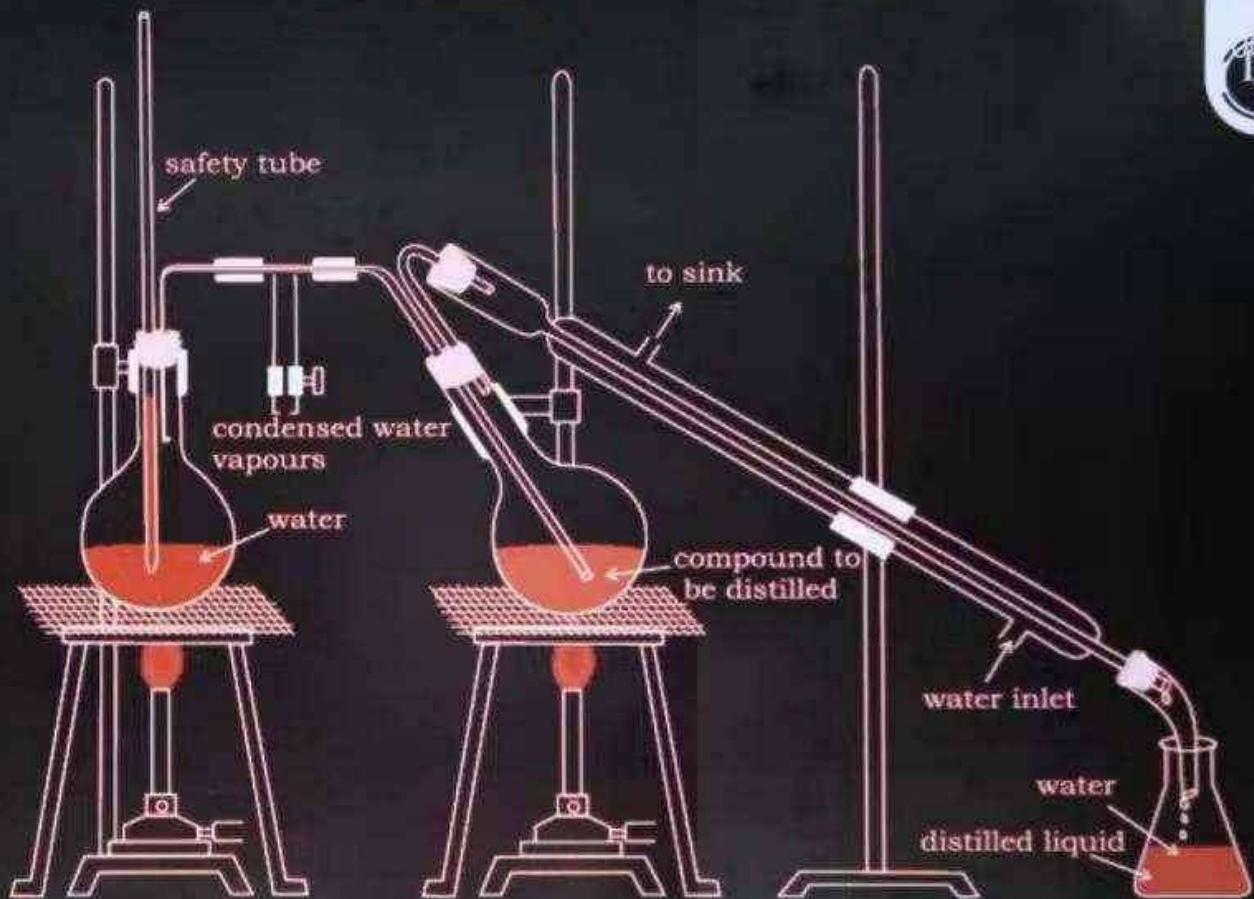
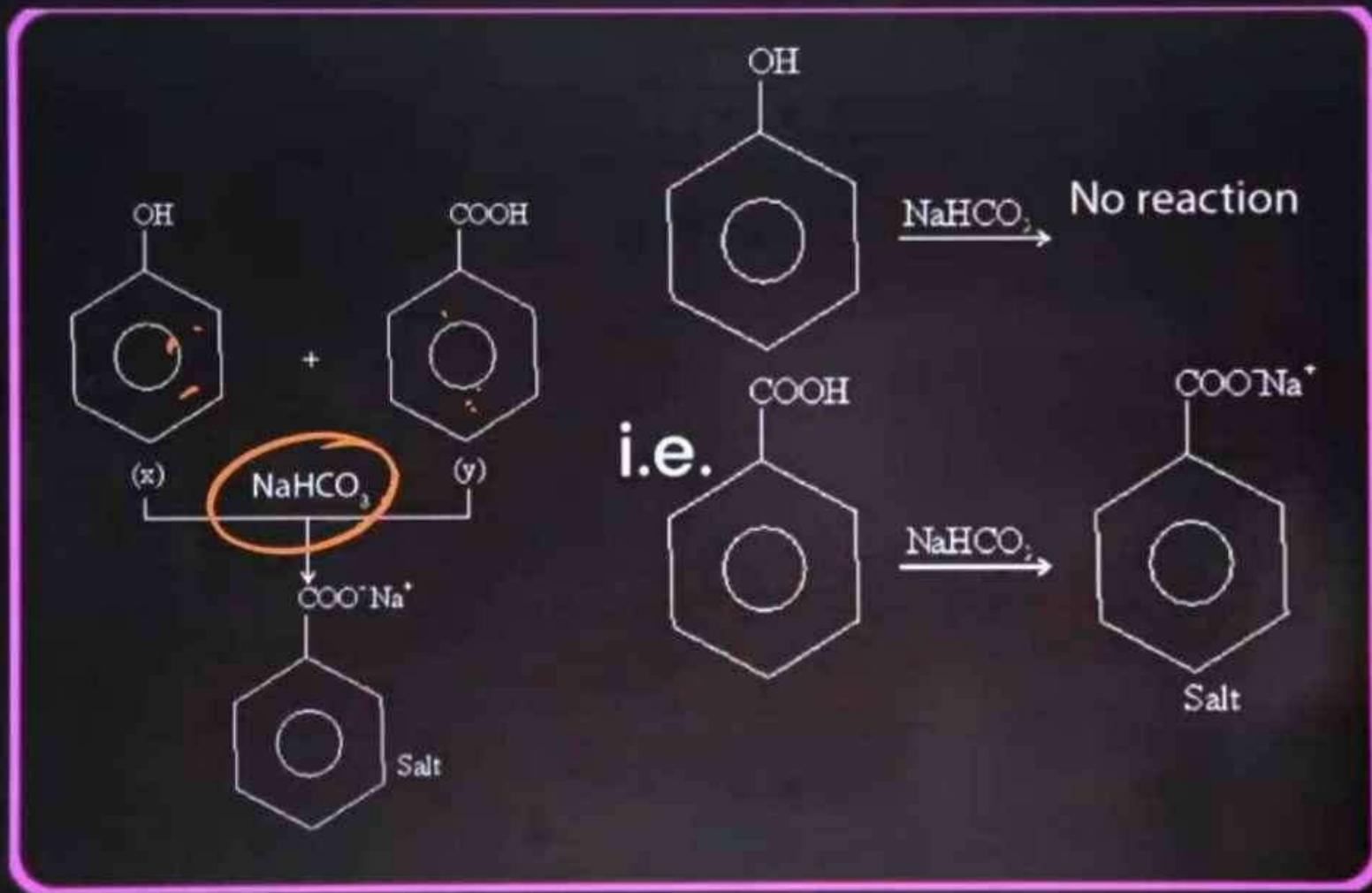


Fig. 12.9 Steam distillation. Steam volatile component volatilizes, the vapours condense in the condenser and the liquid collects in conical flask.

Example





Chromatography

Latest technique

To purify
compound ✓

Chromatography
is used ✓

To separate
mix ✓

To test purity
of compound ✓



Chromatography

Latest technique

Stationary
phase

Solid/liq.

In
Chromatography
there are
2 phases

Mobile
phase

Pure solvent
or
mix. of solvents
or
gases



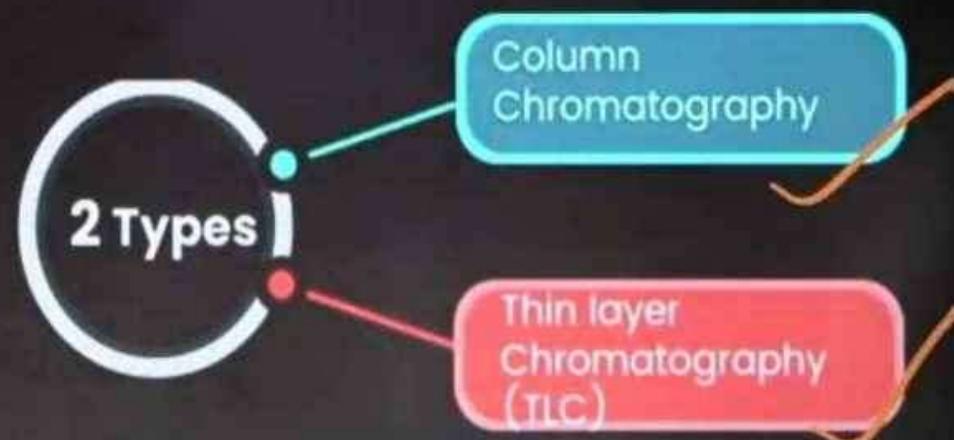
Types of Chromatography

1) Adsorption Chromatography:

Based on the fact that different components of a mixture have different degrees of adsorption on adsorbent (silica gel or alumina)

Stationary phase - solid ✓

Mobile phase - liquid/gas ✓



a) Column Chromatography

- Involves separation of a mixture over a column of adsorbent (stationary phase) packed in a glass tube.
- Component of the mixture which is more soluble in stationary phase is adsorbed first than the component which is less soluble in stationary phase.
- The most readily adsorbed substances are retained near the top and others come down to various distances in the column.

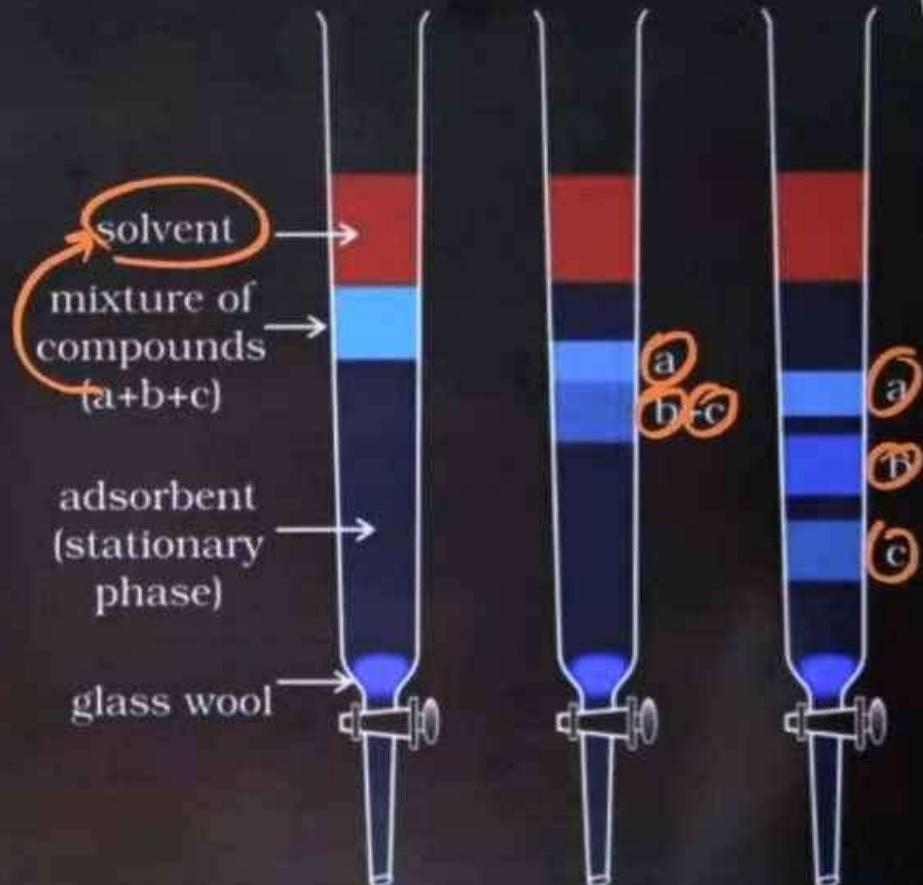


Fig.12.11 Column chromatography. Different stages of separation of components of a mixture.

b) Thin layer chromatography (TLC):

- Involves separation of substances of a mixture over thin layer of an adsorbent coated on glass plate.
- The components of the mixture move up along with the eluant to different distances depending on their degree of adsorption and separation takes place.

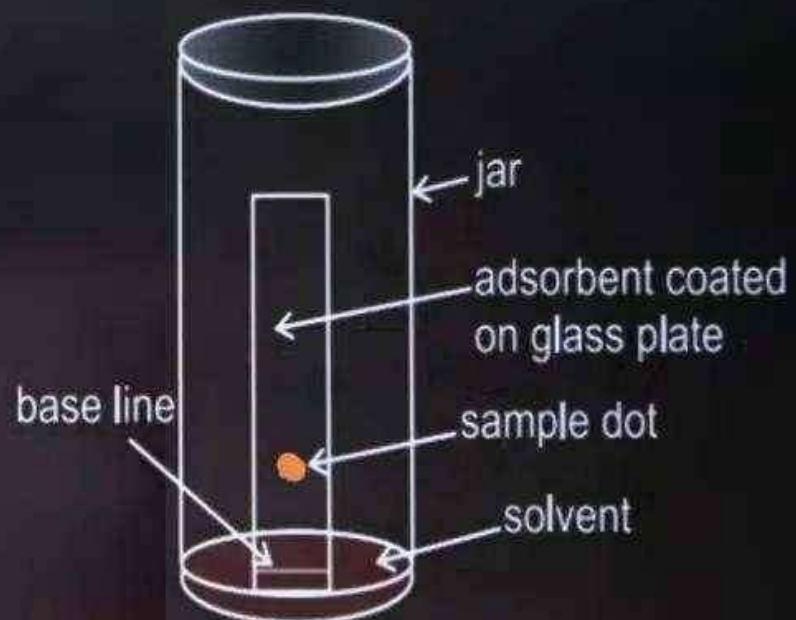


Fig.12.12 (a) Thin layer chromatography.
Chromatogram being developed.

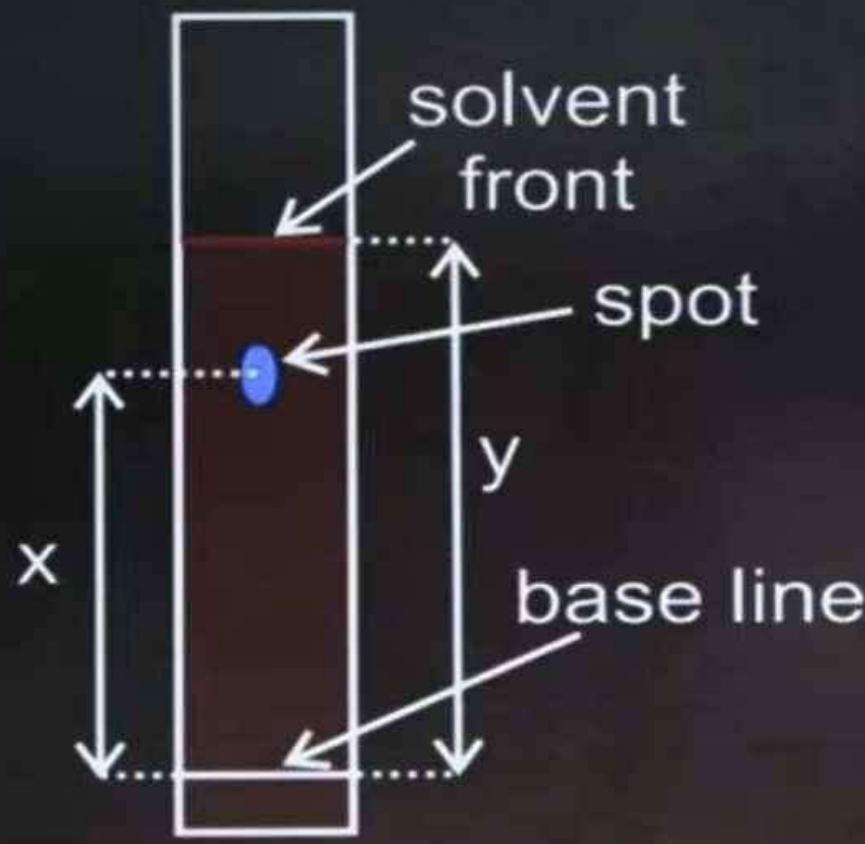


Fig.12.12 (b) Developed chromatogram.

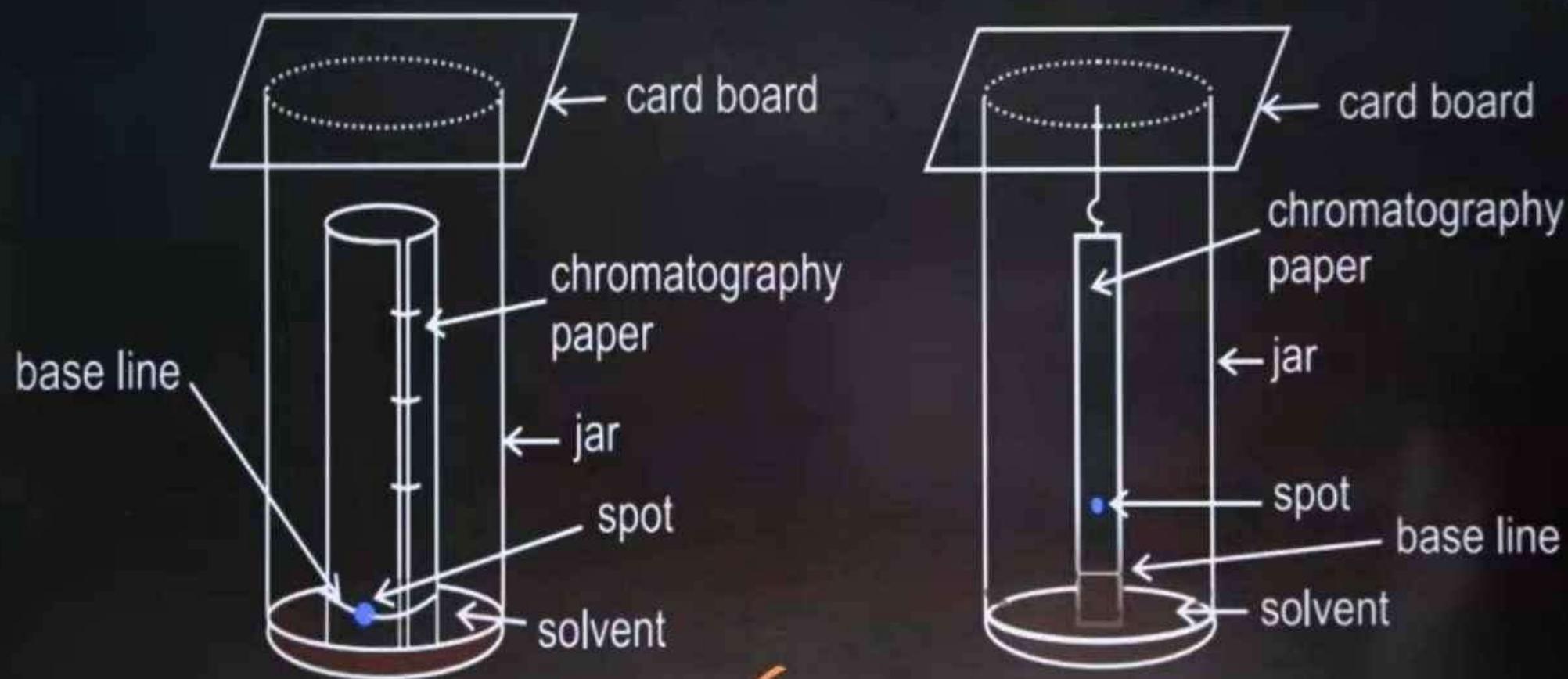


Fig. 12.13 Paper chromatography.
Chromatography paper in two different sizes.

Retardation factor:

express degree of adsorption of each Component of mixture.

$$R_f = \frac{\text{distance moved by component of mixture from base line}}{\text{distance moved by solvent (mobile phase) from base line.}} = \frac{X}{Y}$$

$$\alpha < \gamma$$

QUESTION (JEE Mains 9th April 2024, Morning Shift)

Methods used for purification of organic compounds are based on:

- A neither on nature of compound nor on the impurity present.
- B nature of compound only.
- C nature of compound and presence of impurity
- D presence of impurity only.

QUESTION (JEE Mains 30th January 2024, Morning Shift)

On a thin layer chromatographic plate, an organic compound moved by 3.5 cm, while the solvent moved by 5 cm. The retardation factor of the organic compound is × 10^{-1}

$$r_f = \frac{3.5}{5}$$

QUESTION (NCERT Exemplar)

During hearing of a court case, the judge suspected that some changes in the documents had been carried out. He asked the forensic department to check the ink used at two different places. According to you which technique can give the best results?

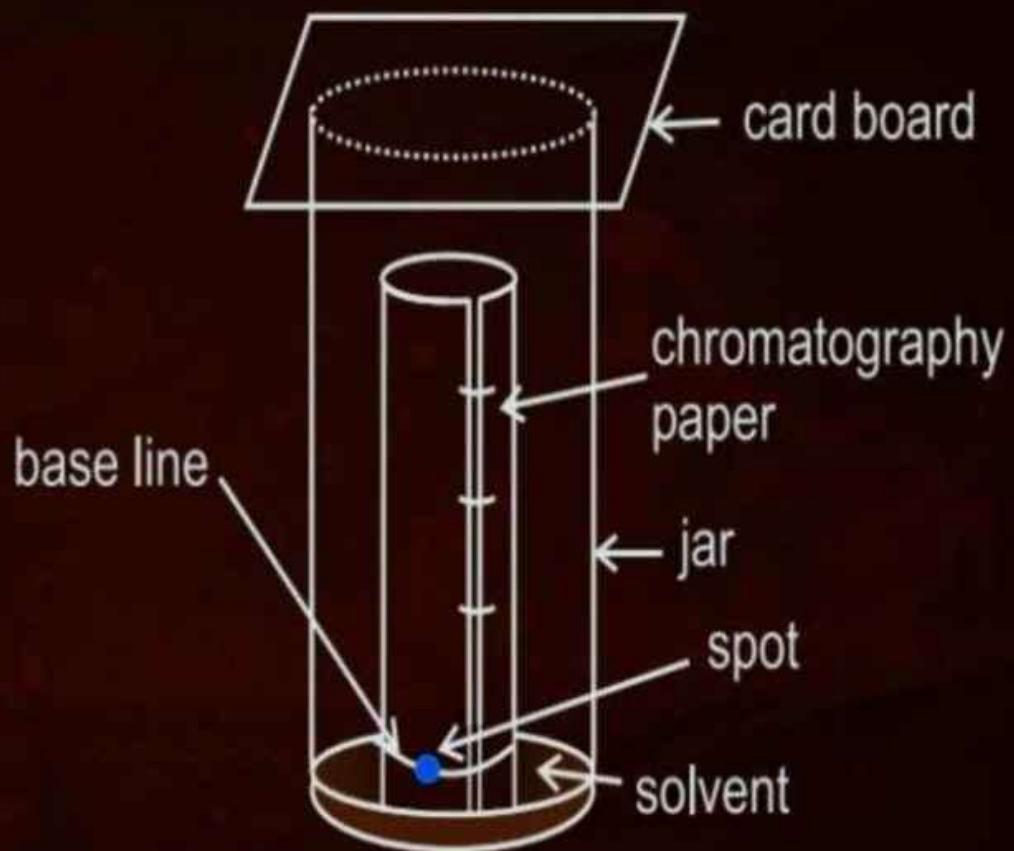
- A Column chromatography
- B Solvent extraction
- C Distillation
- D Thin layer chromatography

QUESTION (NCERT Exemplar)

The principle involved in paper chromatography is:

- A Adsorption
- B Partition
- C Solubility
- D Volatility

- Moving phase is a solvent or a mixture of solvents in which spotted chromatography paper is suspended.
- The solvent rises up the paper by capillary action and flows over the spot. The paper selectively retains different components according to their differing partition in the two phases. The paper strip so developed is called Chromatogram.



QUESTION (JEE Mains 9th April 2024, Morning Shift)

Methods used for purification of organic compounds are based on:

- A** neither on nature of compound nor on the impurity present.
- B** nature of compound only.
- C** nature of compound and presence of impurity ✓
- D** presence of impurity only.

QUESTION (JEE Mains 30th January 2024, Morning Shift)

On a thin layer chromatographic plate, an organic compound moved by 3.5 cm, while the solvent moved by 5 cm. The retardation factor of the organic compound is ___ × 10⁻¹

$$R_f = \frac{3.5}{5}$$

QUESTION (JEE Mains 31st January 2024, Evening Shift)

The fragrance of flowers is due to the presence of some steam volatile organic compounds called essential oils. These are generally insoluble in water at room temperature but are miscible with water vapour in vapour phase. A suitable method for the extraction of these oils from the flowers is:

- A** crystallisation
- B** distillation under reduced pressure
- C** distillation
- D** steam distillation

QUESTION (JEE Mains 31st January 2024, Morning Shift)

'Adsorption' principle is used for which of the following purification method?

- A** Extraction
- B** Chromatography ✓
- C** Distillation
- D** Sublimation

QUESTION (NCERT Exemplar)

During hearing of a court case, the judge suspected that some changes in the documents had been carried out. He asked the forensic department to check the ink used at two different places. According to you which technique can give the best results?

- A** Column chromatography
- B** Solvent extraction
- C** Distillation
- D** Thin layer chromatography

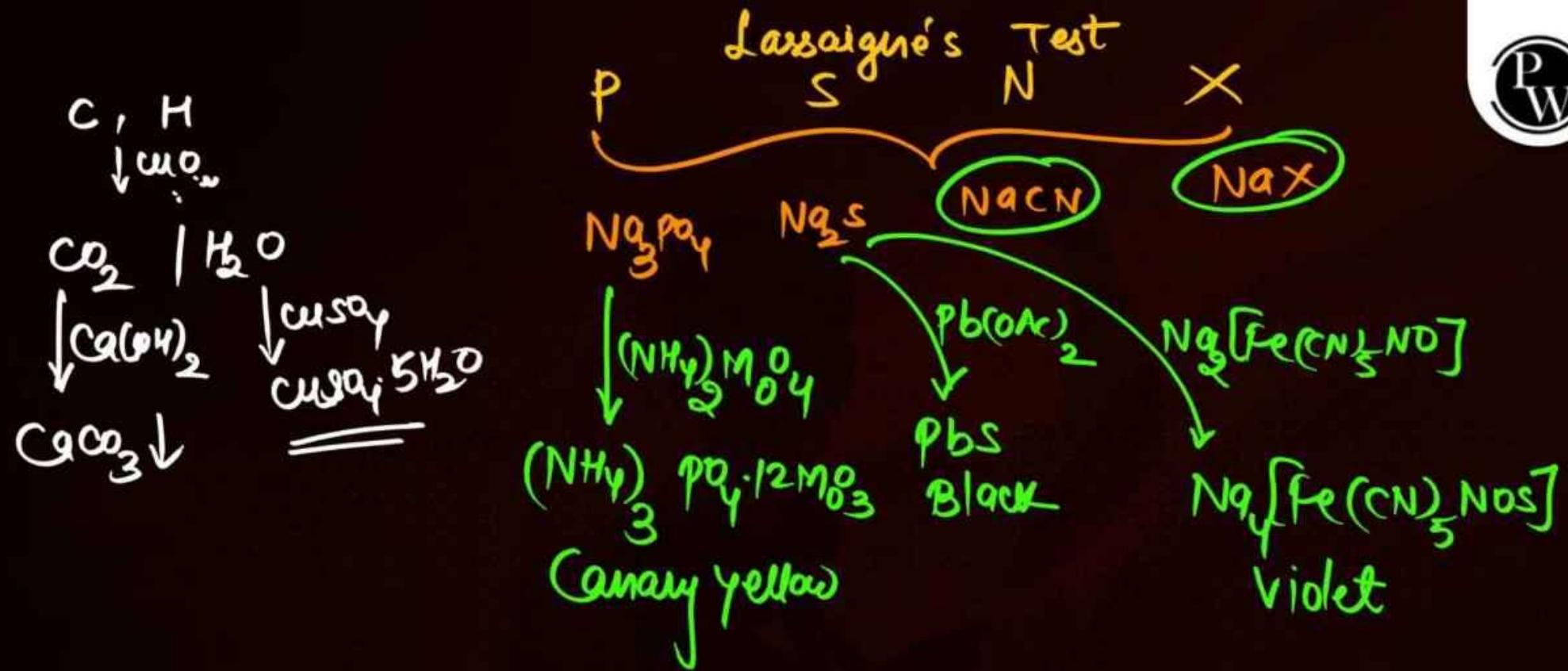
QUESTION (NCERT Exemplar)

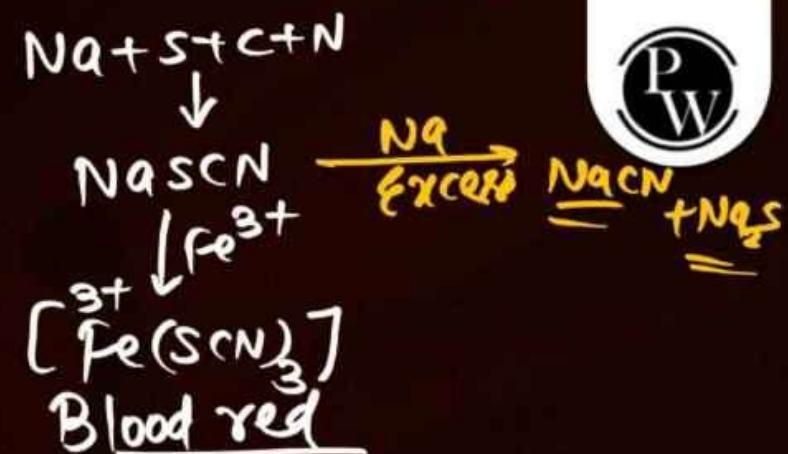
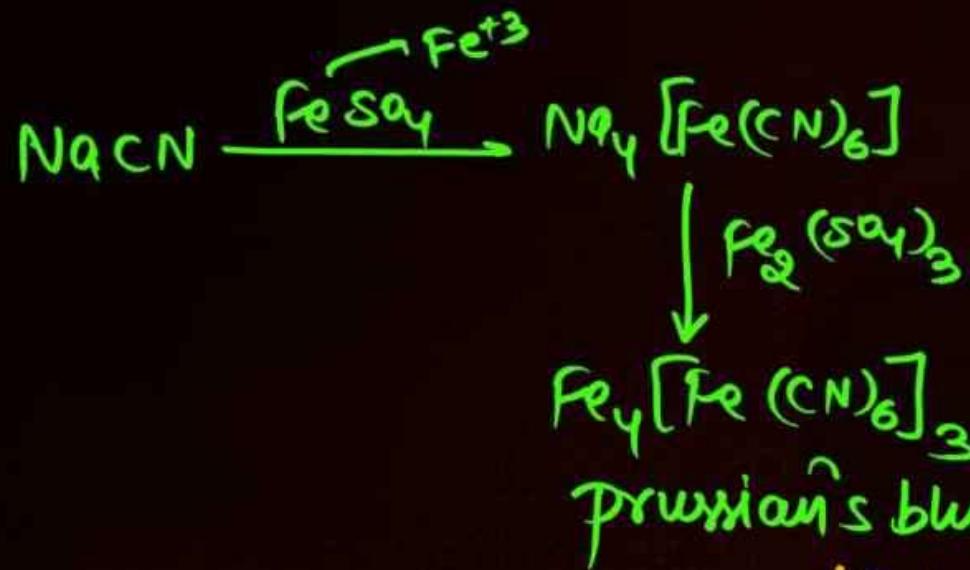
The principle involved in paper chromatography is:

- A** Adsorption
- B** Partition ✓
- C** Solubility
- D** Volatility



Qualitative & Quantitative Analysis







Quantitative Analysis of O.C

- Estimation of Carbon and Hydrogen:

O.C = $\frac{w_1}{\omega} \times 12$ O.H = $\frac{w_2}{\omega} \times 2$
Carbon and hydrogen are estimated by Liebig's combustion method.

$$\therefore C = \frac{12 \times w_1}{44 \times \omega} \times 100 \quad \therefore H = \frac{2 \times w_2}{18 \times \omega} \times 100$$

Cardsus
method P



$$I.P = \frac{31}{1877} \times \frac{\omega_1}{\omega} \times 100$$



$$I.P = \frac{62}{222} \times \frac{\omega_1}{\omega} \times 100$$

S
BaSO₄

$$I.S = \frac{32}{233} \times \frac{\omega_1}{\omega} \times 100$$

X

Ag X

$$I.X = \frac{A\omega_X}{M_{AgX}} \times \frac{\omega_1}{\omega} \times 100$$



N

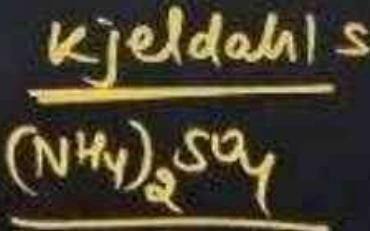
Dumas

$$\therefore N = \frac{28}{224} \times \frac{V_2 \text{ (mL)}}{W}$$

Prob after

$$\frac{(P - P_1)V_1}{T_1} = \frac{P_2 V_2 \text{ (mL)}}{T_2}$$

760
273K



$$\therefore N = \frac{1.4}{W} \times \underbrace{N \times V \text{ (mL)}}_{\text{Acid}}$$



Kjeldahl's Method

- In this method nitrogen present in the organic compound is converted into ammonia (NH_3).
- Kjeldahl's method is not applicable to compounds containing nitro (NO_2),

Nitroso (NO), azo group ($\text{-N} = \text{N-}$), azoxy compound ($\text{-N}^{\text{O}} = \text{N-}$) and nitrogen present in the ring (pyridine, quinoline) because nitrogen present in these compound is not quantitatively converted into ammonium sulphate.



QUESTION (JEE Mains 1st Feb 2024, Evening Shift)

Lassaigne's test is used for detection of:

- A** Nitrogen and Sulphur only
- B** Nitrogen, Sulphur and Phosphorous only
- C** Phosphorous and halogens only
- D** Nitrogen, Sulphur, phosphorous and halogens



QUESTION (JEE Mains 1st Feb 2024, Morning Shift)

In Kjeldahl's method for estimation of nitrogen, CuSO_4 acts as:

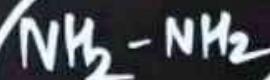
- A Reducing agent
- B Catalytic agent
- C Hydrolysis agent
- D Oxidising agent

QUESTION (JEE Mains 4th April 2024, Morning Shift)

Which of the following nitrogen containing compound does not give Lassaigne's test?

- A** Phenyl hydrazine
- C** Urea

- B** Glycene
- D** Hydrazine



QUESTION (JEE Mains 08 April 2024, Evening Shift)

Given below are two statements:

Statement (I): Kjeldahl's method is applicable to estimate nitrogen in pyridine.

Statement (II): The nitrogen present in ~~pyridine~~ can easily be converted ammonium sulphate in Kjeldahl's method.

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

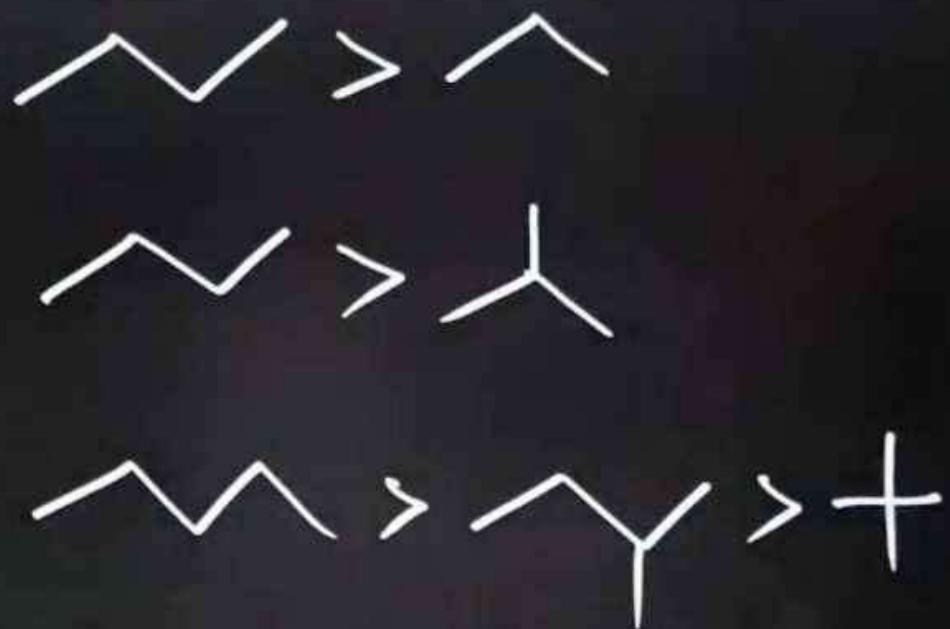
- A** Both Statement I and Statement II is false.
- B** Statement I is false but Statement II is true.
- C** Both Statement I and Statement II is true.
- D** Statement I is true but Statement II is false.

B.P

B.P \propto No. of 'C'

No of 'C' same

B.P \propto $\frac{1}{\text{Branch}}$



QUESTION (NCERT Exemplar)

Arrange the following in decreasing order of their boiling points.

- (A) *n*-butane (B) 2-methylbutane
(C) *n*-pentane (D) 2,2-dimethylpropane

- A A > B > C > D
- B B > C > D > A
- C D > C > B > A
- D C > B > D > A ✓

PSS**PW**

