

Hydrocarbon

Q# WHAT ARE HYDROCARBON & HOW THEY ARE CLASSIFIED?

Hydrocarbon: Compounds containing carbon and hydrogen only are called Hydrocarbon.

Catenation:-

"The self-linking ability of element to form long chains is catenation".

Carbon has more catenation property than silicon?

- Carbon exhibits smaller size than silicon which makes more strong bond.
- Carbon-carbon bond strength is greater.
- Carbon is more electronegative than H making more protic H while silicon has lower electronegativity resulting more hydridic H.

Flow Chart :-

∴ Hydrocarbons :-

OPEN CHAIN

CLOSE CHAIN

Saturated H.C

unsaturated H.C

Alcyclic H.C

Aromatic H.C

Alkane

e.g.:- CH_4

methane

alkene

e.g.:- $\text{CH}_2 = \text{CH}_2$

ethene

alkynes

e.g.:- $\text{CH} \equiv \text{CH}$

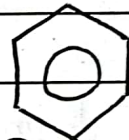
ethyne

e.g.:-



cyclohexane

e.g.:-



Benzene

OPEN CHAIN H.C :-

∴ Also known as Aliphatic and Acyclic hydrocarbon.

∴ Hydrocarbon in which carbon are attached to get-to form open chains are called open chain.

Types :-

1. Saturated

2. Unsaturated

Saturated Hydrocarb	unsaturated Hydrocarb
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Definition

The hydrocarbon in which C-C single bond is present.

The hydrocarbon in which C=C & C≡C double & triple bond is present.

Hybridization

The hybridization followed in sp^3 .

The hybridization followed in double bond is sp^2 & in triple bond is sp .

type of reaction

It undergo substitution rxn.

It undergo addition rxn.

examples:

CH_4 - Methane

$CH_2=CH_2$ - Ethene.

CH_3-CH_3 - Ethane

$CH_2=CH-CH_3$ - Propene

$CH_3-CH_2-CH_3$ - Propane.

$CH \equiv CH$ - Ethyne.

CLOSED CHAIN H.C:-

- Also known as cyclic and ring H.C.
- H.C in which C-atom are attached with each other to form ring.

Types:

- Alicyclic
- Aromatic

Date: _____

Alicyclic H.C (non-aromatic) **Aromatic H.C**

Definition

A closed chain H.C without benzene ring.

A closed chain H.C containing at least one benzene ring.

Alternative name

Non-benzoid

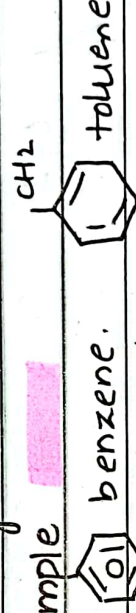
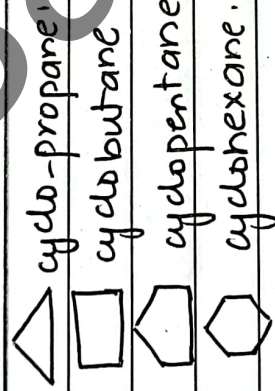
Benzoid

Huckel Rule

Do not obey.

Obey.

example



Trick hybridization

Group Hybridization

1	s
2	sp
3	sp ²
4	sp ³



* = & ≡ are considered 1 group.

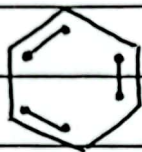
* lone pair is counted as 1 group.

Page #

Teacher's Signature: _____

Huckel rule

- If a aromatic compound follows :- $4n+2 = \pi e^-$
 $n=1, 2, 3, \dots$ whole number
- It verifies that it's a aromatic compound.



$$\rightarrow 4n+2 = 6e^-$$

$$4n = 6 - 2$$

$$4n = 4$$

$$n = 1 \text{ (Huckel rule } \checkmark)$$

Q# Why benzene is aromatic?

Originally benzene was considered aromatic becoz of its 'aromatic' odour. But later it was verified that it follows Huckel rule.

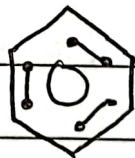
$$\rightarrow 4n+2 = \pi e^-$$

$$4n+2 = 6e^-$$

$$4n = 6 - 2$$

$$4n = 4$$

$$n = 1 \text{ (✓) (Huckel Rule proved)}$$



Date: 19 July 24

homologous series

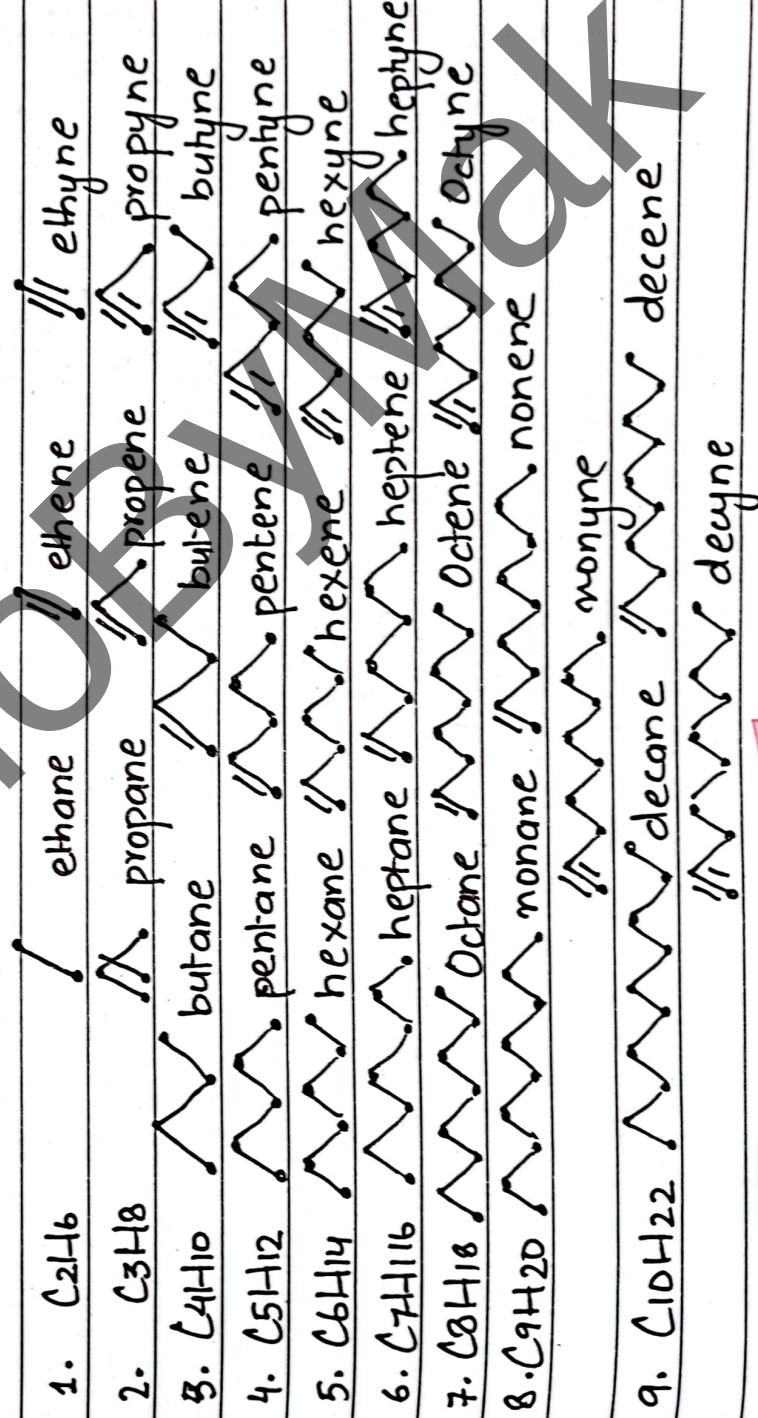
Series of organic compounds in which two adjacent members differ by $-CH_2$ group.

example



representation

Structural line representation of alkane can be done as :-



Page #

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Date: _____

alkyl radical (-R)

When one H is removed from any alkane group form is called alkyl radical.

Donate:

-R

Name rule:

ane $\rightarrow$ yl (methane $\rightarrow$ methyl)

formula:



homologue series of -R

NAME	M.F	Abbreviation	$\rightarrow$ used instead of drawing structure
Methyl	-CH ₃	Me	
Ethyl	-C ₂ H ₅	Et	
butyl	-C ₃ H ₇	Bu	
Propyl	-C ₃ H ₇	Pr	
Pentyl	-C ₅ H ₁₁	Pe	
Hexyle	-C ₆ H ₁₃	Hex	
Hephyle	-C ₇ H ₁₅	Hep	
Octyle	-C ₈ H ₁₇	Oc	
Nonyle	-C ₉ H ₁₉	No	
Decyle	-C ₁₀ H ₂₁	De	

Page #

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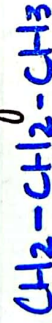
difference

Alkane	Alkene	Alkyne
• Paraffins (inert)	• Olefins (oil making)	-
• C-C	• C=C	• C≡C
• Saturated	• Unsaturated	• Unsaturated
• Substitution rxn	• Addition rxn	• Addition rxn
• Hexane	• Hexene	• Hexyne
• C_nH_{2n+2}	• C_nH_{2n}	• C_nH_{2n-2}

alkyl group common name

→ n, 1°, Primary

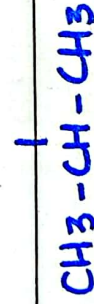
When following structure is straight only or when carbon connected to only 1 C.



n-Propyl

→ secondary, 2°, iso

When the following carbon from which H has been removed is connected with 2 carbons. or when branch is one 2 C.



iso-Propyl



n-butyl

iso-butyl

1° butyl

2° butyl

Page #



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→ When following carbon from which H is removed is connected with 3 C.

Common name of alkane

- CH_4 — marsh gas
- iso- • When branch is one 2nd carbon
- neo- • When two branches are present on 2nd carbon



iso-pentane

neo-pentane

n- • When an alkane is present in the form of a straight chain.



n-pentane.

IUPAC

Rules in easy words

1. Consider a long chain taking it as straight or branch that is not substituent by counting no. of C atoms.
2. Two equal chains of same length, consider chain containing more branches.
3. ~~Name~~ Start numbering from the end closer to substituent.
4. When 2 identical substituent at equal distance is present, consider number by adding C-no at which branch is present.
5. The position of substituent indicated by considering the number of Carbon at which it's present.

number - alkyl group

6. Name of alkyl group written in alphabetical order.
7. If common alkyl group is present 2, 3 times then use :-

2(di), 3(tri), 4(tetra)

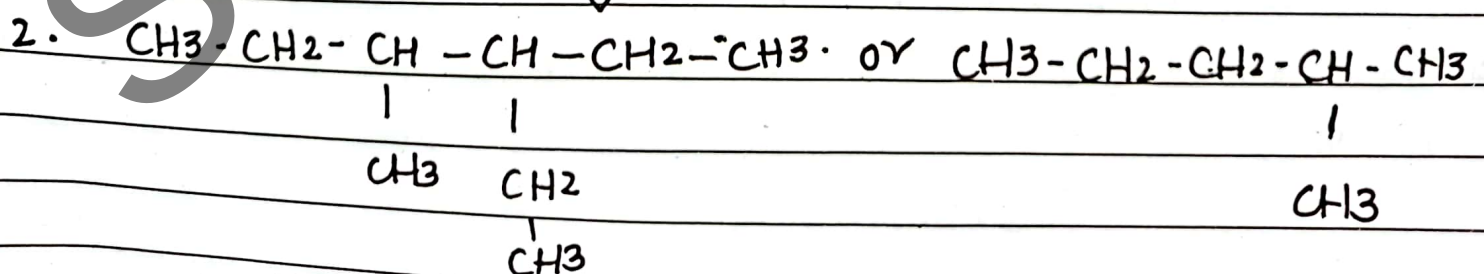
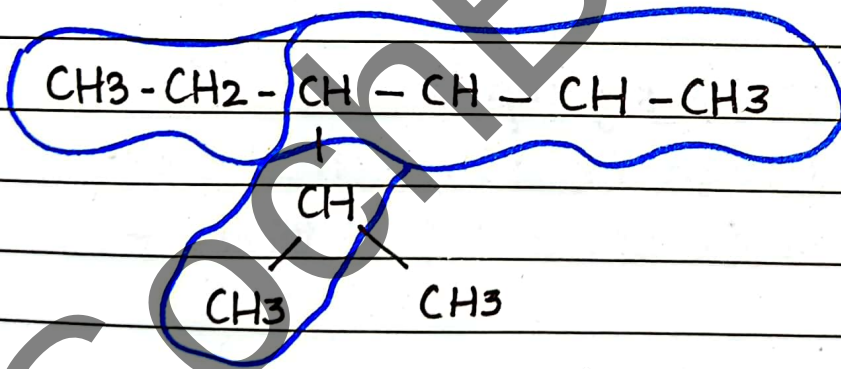
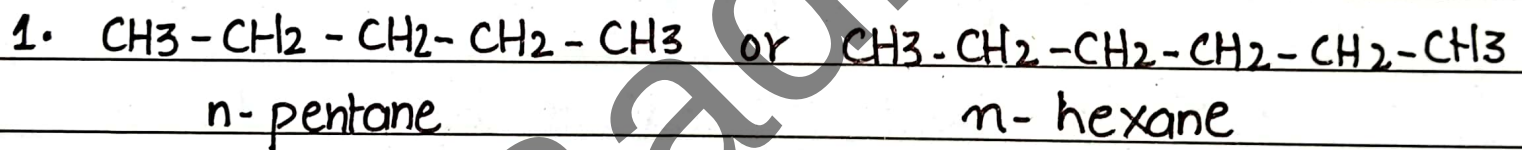
8. If two -R group present on same C-atoms name is written by adding (,).

ethyl, methyl

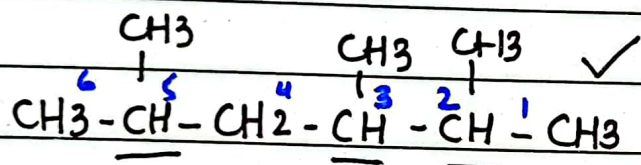
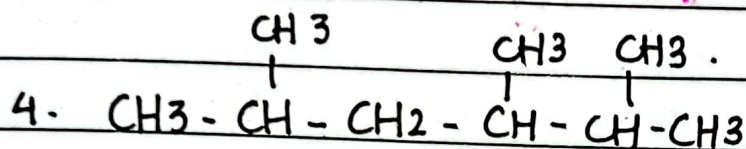
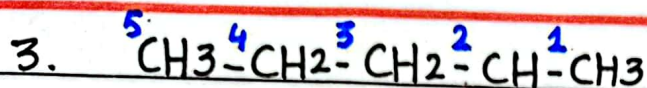
- - number - R group Parent chain
- - number - (di, tri, tetra) R - group Parent chain
- - number - R group
- - number, number - R group parent chain.

applied form

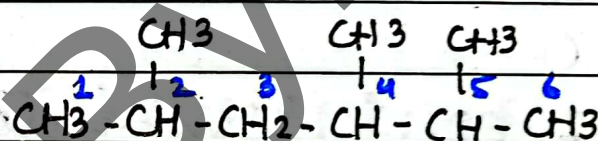
Substituent is a type of branch that can't be straightened to form the part of continuous long chain.



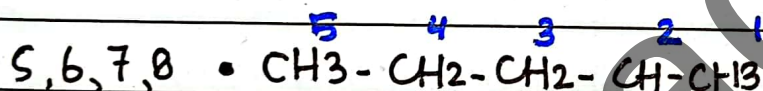
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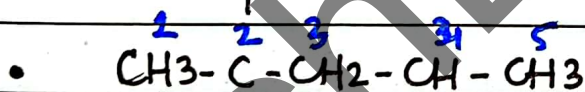
$2+3+5 = 10 \rightarrow \text{min.}$



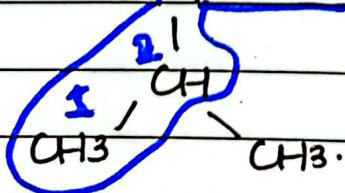
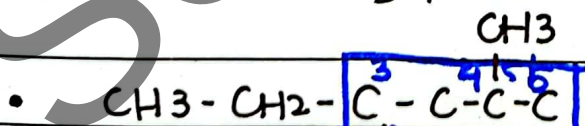
$2+4+5 = 11 \rightarrow \text{max.}$



2-Methylpentane



2, 2, 4-TriMethyl pentane.



3-Ethy-2,5Methylhexane

Physical Properties

State

- 1 - C₄ = colorless, odourless gases
- 5 - C₁₇ = colorless, odourless liquids
- 18 - C_n = waxy solids (colorless, odourless).

Solubility

Non-polar Linkages or weakly polar due to functional groups are soluble in polar solvents (water) and soluble in non-polar solvents (benzene, ether, CCl₄ etc).

M.P and B.P

The M.P, B.P and density etc increases with increase in C-atom.

Solubility decreases with increase in mass. (↑ non-polar content)

The boiling point of branch chain is lower because : ↓ Van's waal forces & reduce in point of contact).

isomerism

"The compounds having molecular formula but diff structural formula."

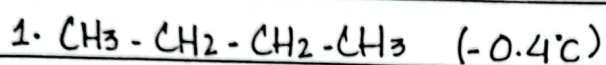
IMP:-

methane, ethane, propane has no isomers becoz they have only 1 possible structure.

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Butane

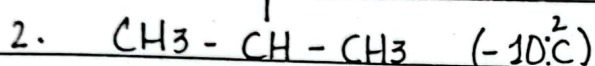
B.P:-



n-butane

CH_3

B.P:



(C.N: iso-butane)

(IUPAC: 2-Methyl propane).

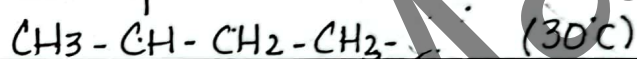
Pentane



n-Pentane

2.

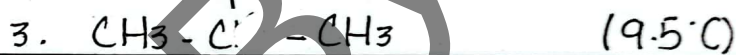
CH_3



(C.N: iso-Pentane)

(IUPAC:- 2-Methyl Butane)

CH_3



(C.N: neo-Pentane)

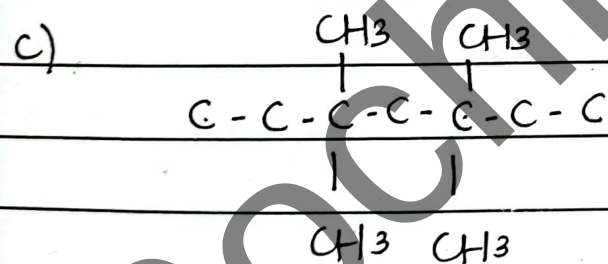
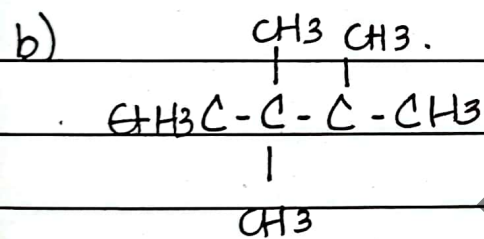
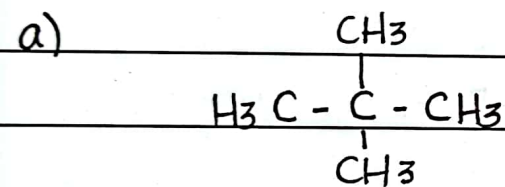
(IUPAC: 2,2-Dimethyl propane)

Activity

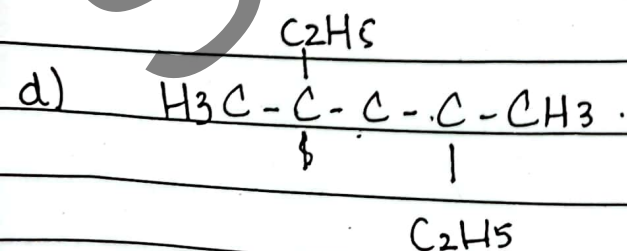
Question 1

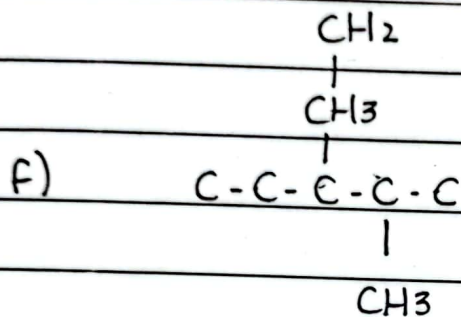
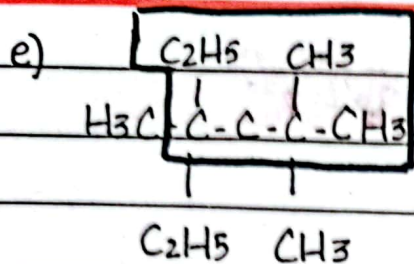
- 2,5-Dimethylhexane
- 2,2,4-Trimethylpentane.
- 2,4-Dimethylhexane.
- 3-Methylpentane.

Question 2



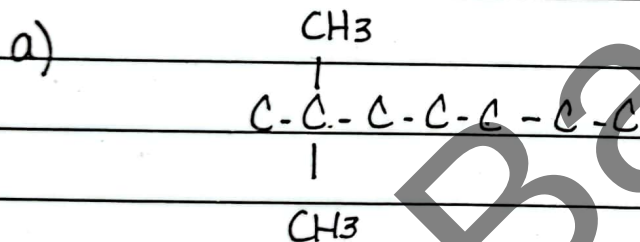
3,3,5,5-tetramethylheptane.



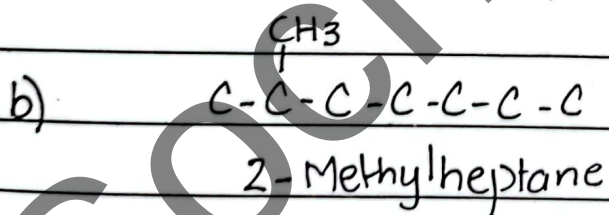


3-Ethyl-4-Methylpentane

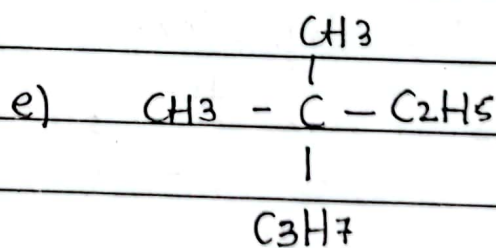
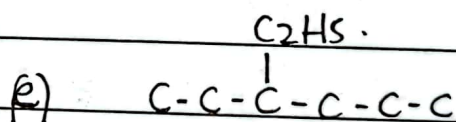
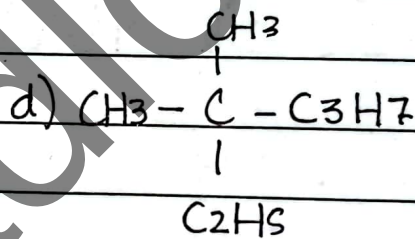
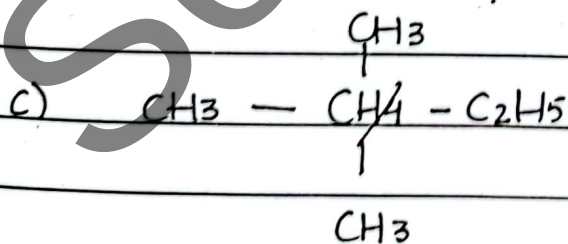
Question 3



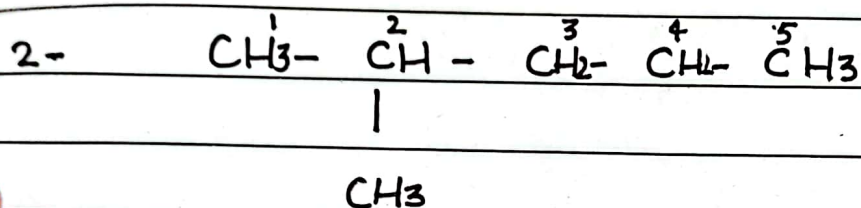
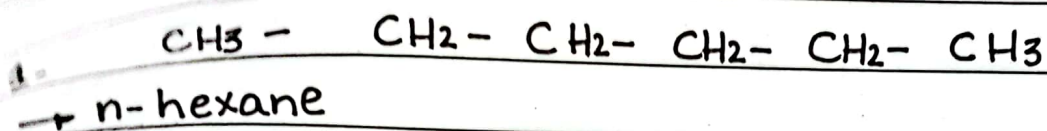
2,2-Dimethylheptane.



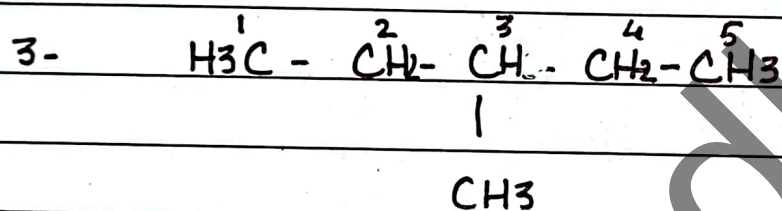
2-Methylheptane



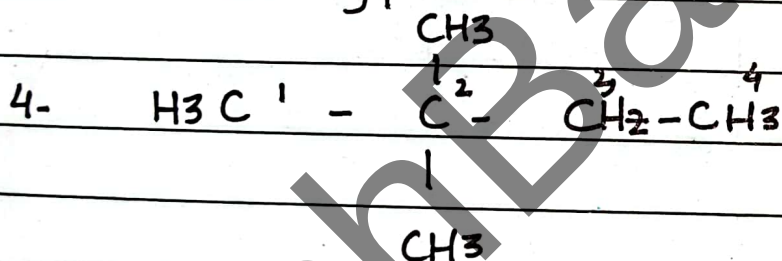
Isomers of hexane (5)



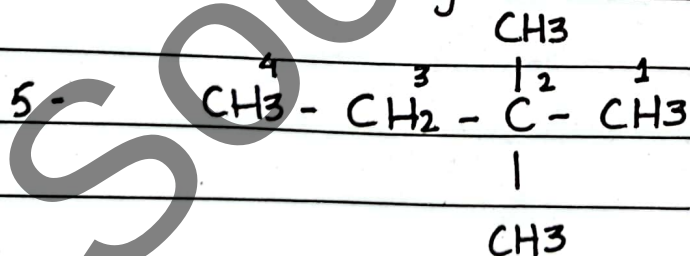
→ 2-Methylpentane.



→ 3-Methylpentane.



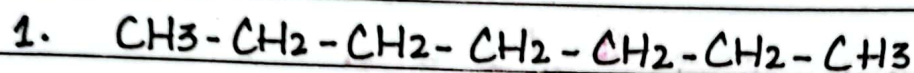
→ 2,2-Dimethylbutane.



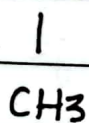
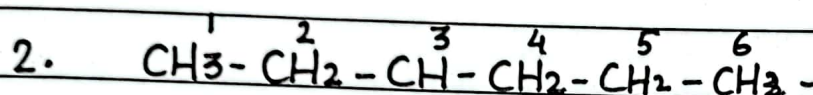
3,3-Dimethylbutane.

heptane

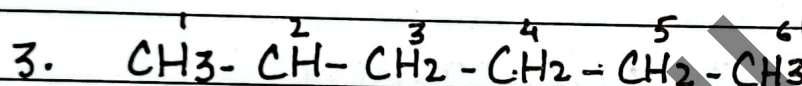
(9)



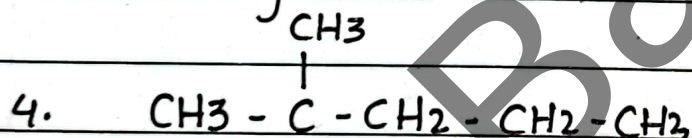
• n-heptane



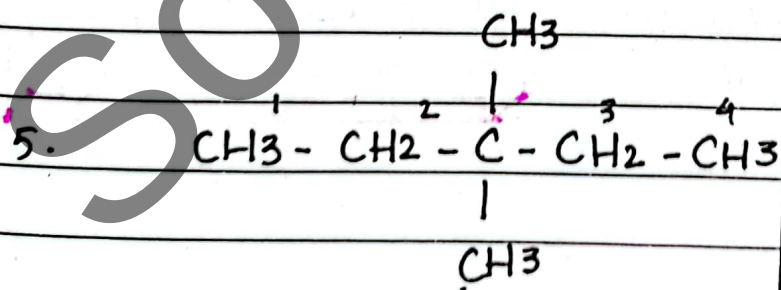
• 3-Methylhexane.



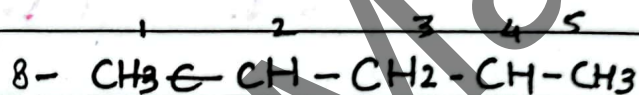
• 2-Methylhexane.



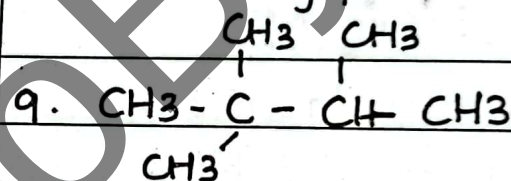
• 2,2-Dimethylpentane.



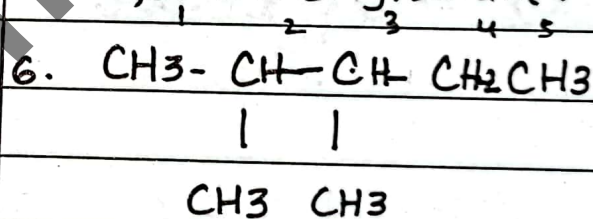
• 3,3-Dimethylpentane.



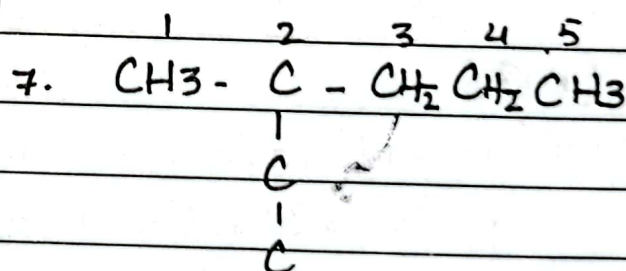
2,4-Dimethylpentane.



2,3-Trimethylbutane.



• 2,3-Dimethylpentane.



• 2-Ethylpentane.

Radical Substitution Reaction

Halogenation

Replacement of H-atom by a halogen is called halogenation.
(X, Cl, Br, F, I)

Conditions

- Halogenation take place :
- presence of Sunlight • UV radiation • high temperature

Reactivity order



Chlorine → Chlorination

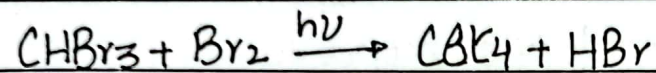
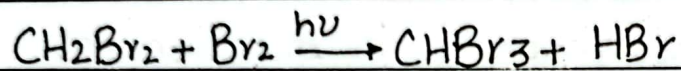
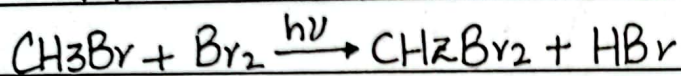
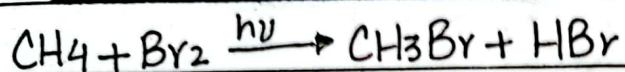
Bromine → Bromination

for halogenation, F_2 is not suitable becx it's very violent causing blast & produce large heat.

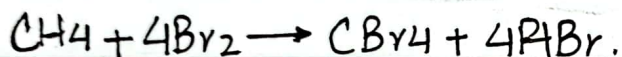
Steps

- Initiation → formation of radical
- Propagation → both side radical (R.P)
- termination → reactant radical

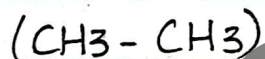
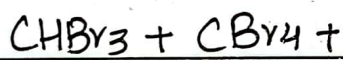
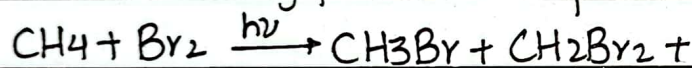
for halogenation, I_2 is not suitable becx it's very slow & reversible.

normal rxn

↓
carbon tetra bromide

overall rxnSol

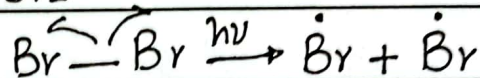
Q# how many products are possible?



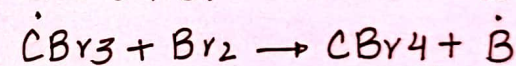
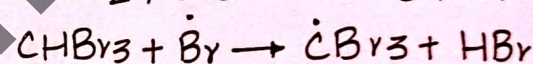
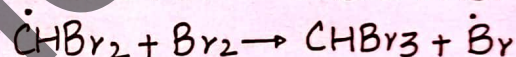
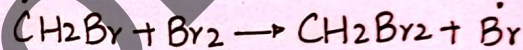
↓ any end radical

initiation - 1

• $h\nu$ causes homolytic catalses of Br_2 .

Propogation - 2

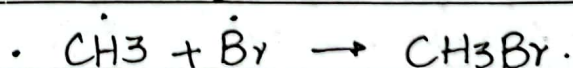
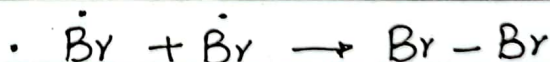
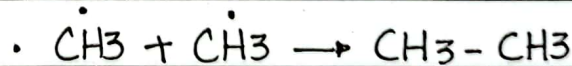
• $\dot{\text{Br}}$ attacks of H of CH_4 producing $\text{HBr} + \dot{\text{CH}}_3\text{Br}$ radical and a chain rxn starts.



carbon
tetra
Bromide.

termination - 3

At end, free radical are terminated



Structural isomerism

Date: 25-7-24

Different compounds having same molecular formula but different structures are called Structural Isomers and phenomena is called structural isomers.

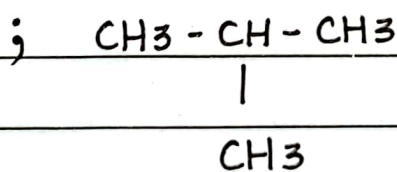
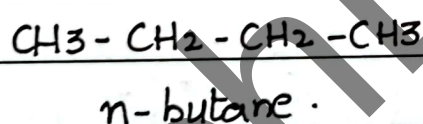
Types

- Chain isomerism
 - Position isomerism
 - Functional group isomerism
 - Metamerism
 - tautomerism
- } Short O/s

1- Chain isomerism

Different compounds having same molecular formula but different Carbon chains.

examples:



iso-butane / 2-Methylpropane

2- Position isomerism

Different compounds having same molecular formula but different arrangement of functional groups.

Page #



Teacher's Signature: _____

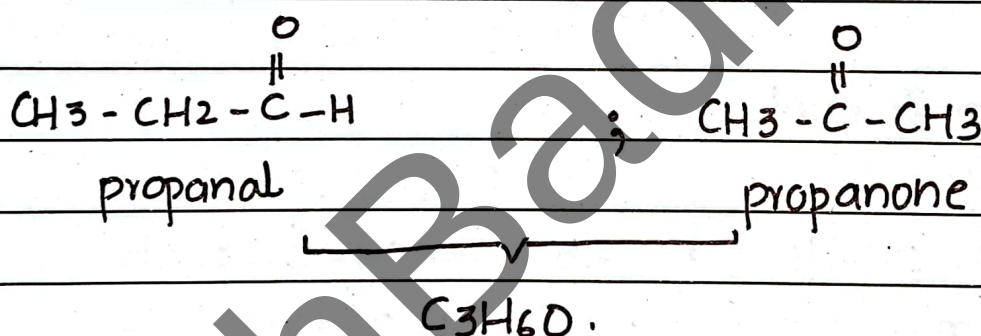
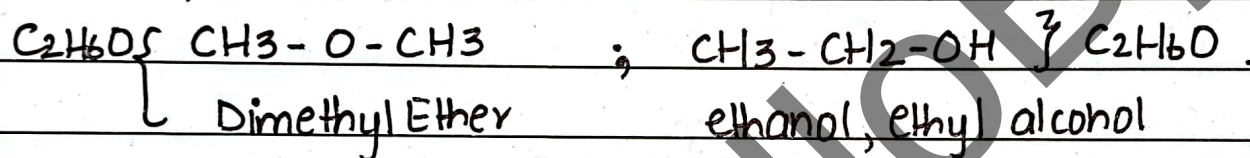
example:

- $\text{CH}_3 - \text{CH}_2 - \text{CH} = \text{CH}_2$; $\text{CH}_2\text{Cl} - \text{CH}_2 - \text{CH}_3$
 1-butene . 1-chloropropane
- $\text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$; $\text{CH}_3 - \text{CH}(\text{Cl}) - \text{CH}_3$
 2-butene 2-chloropropane .

3. Functional group

Different compounds having same molecular formula but different functional groups.

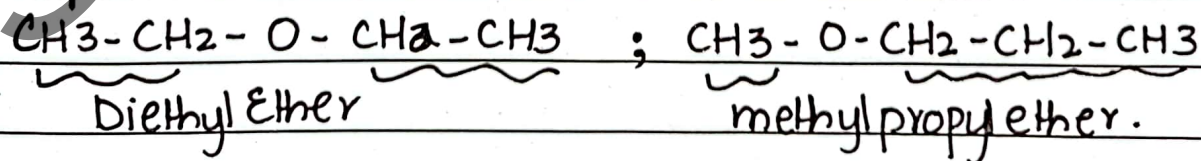
example:



4 Metamerism

Different compounds having same Molecular formula but unequal distribution of carbon atom on either side of functional group.

example:



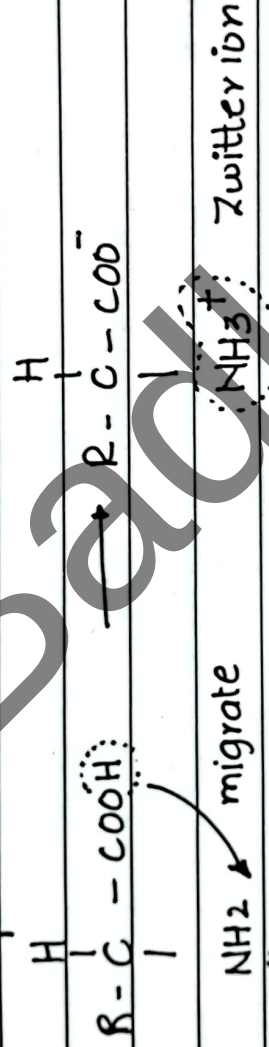
Date: _____

- $\text{CH}_3 - \text{CH}_2 - \text{NH}_2 - \text{CH}_2 - \text{CH}_3$; $\text{CH}_3 - \text{NH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$
Diethylamine ; methyl propyl amine.

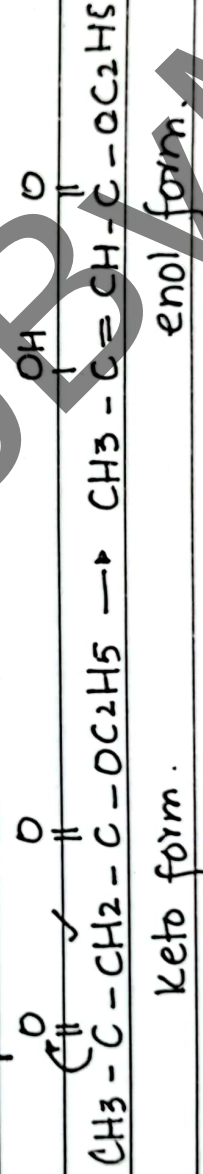
5. Tautomerism

Type of isomer in which 1 isomer is converted in other isomer due to migration of H-ions is called tautomer.

example 1: Zwitter ion



example 2: keto & enol



Date: 26-07-24

Stereoisomerism

Different compounds having same Molecular formula but different arrangement or orientation of atoms or groups in the 3D space are called stereoisomerism.

Types

- 1- Geometrical Stereoisomerisms (cis-trans)
- 2- Optical Stereoisomerism.

Geometrical isomers

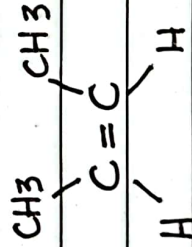
Diff- compounds having same Molecular formula. but different position of identical groups in space.

- restricts rotation about double or single in cyclic comps.
- cis & trans form.

Cis-form: When 2 identical groups lie on same side of = bond.

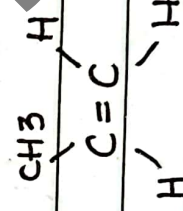
trans-form: When 2 identical groups lie on opp side of = bond.

example: 2-butene



cis-2-butene

$$\mu \neq 0$$



trans-2-butene

$$\mu = 0$$

Date: _____

Stability

The trans isomers are more stable than cis-isomers.

Because:-

Two bulky groups lie on opp side of = bond.

Causing a decrease in steric repulsion.

Hence, less energy, more stability. (dipole moment $\mu=0$)

But in cis:-

Two bulky groups lie on same side of = bond.

• Increase in steric repulsion.

• More energy, less stability. ($\mu \neq 0$).

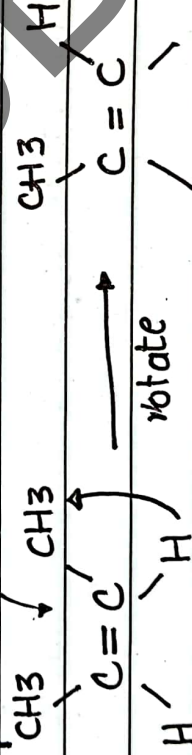
Inter-conversion

• The cis is inter-convertible to trans or vice versa.

→ Heating bond or giving sunlight, breaks π bond.

→ This causes rotation about sigma bond.

example: $h\nu$



cis

H CH₃ trans

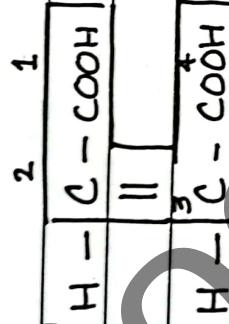
Conditions

• Two groups attached with C-atom must be diff.

• Carbon-carbon bond should not rotate around its axis.

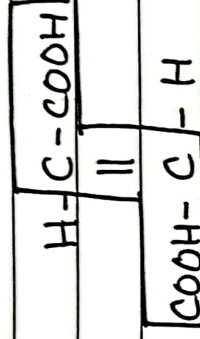
Date: _____

example:



Cis - 2-butene - 1,4-dioic acid

Maleic acid.



trans - 2-butene - 1,4-dioic acid

Fumaric acid.

Those compounds which are optically active and exist in 2 isomeric forms possess the optical isomerism.

Conditions

- Atom should have chiral carbon.
- Atom or Compound should not have plane of symmetry.

1- Chiral centre or chiral carbon asymmetric carbon

Carbon atom which is bonded with 4 different groups or atom is called chiral carbon.

H^① — chiral atom



|

OH ④

Page #



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Date: _____

2- Plane of Symmetry

Plane which divides an obj into symmetric halves is called plane of symmetry.

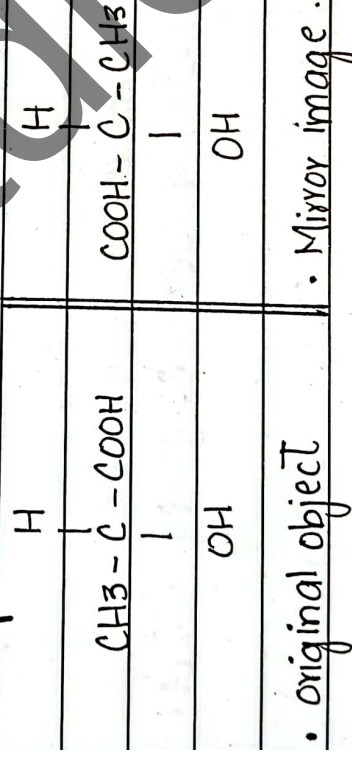
example:

- A person has plane of symmetry
- A glove lacks symmetry.

Conditions for Chiral molecule

- has atleast an asymmetric Carbon
- does not have plane of symmetry
- are not superimposable on their mirror images

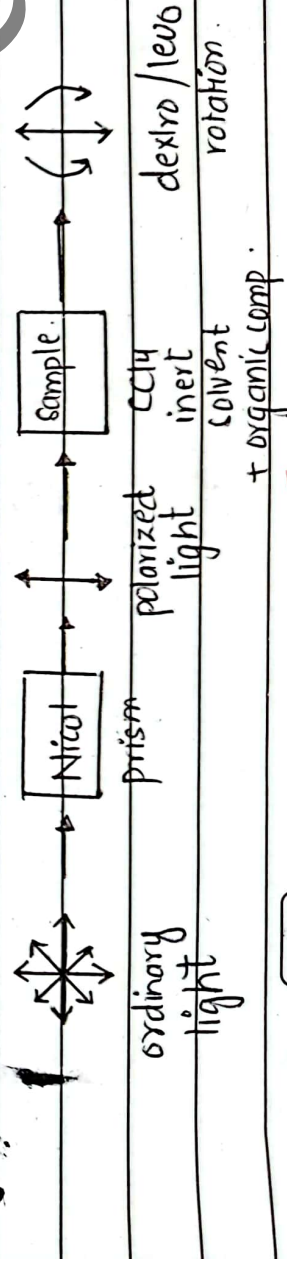
example:



Optical Activity

Some of organic compounds dissolved in an inert sol can rotate plane polarized light to left or right.

diagram:



Date: _____

- Solution of some organic compound have ability to rotate plane of polarized light in opposite direction, this property is called optical activity.

Dextrorotatory

- Rotate the plane polarized light in clockwise direction.
- +ve isomer.

Levorotatory

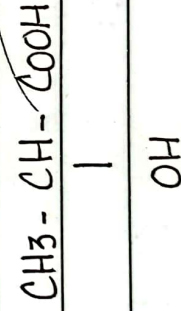
- Rotate the plane polarized light in anti-clockwise direction.
- -ve isomer

Optical isomerism

- Optical active compound exists in 2 isomeric form which rotate plane polarized light opposite direction.
- Dextrorotatory and levorotatory is called entire (enantiomers).

Examples

Lactic acid:



▲ 2-Hydroxy propanoic acid

- 1-asymmetric carbon.

- It has 3 forms, 2 are actively optive and one is inactive.

Date: _____

I:-



II:



(+) lactic acid

(-) lactic acid

III:

Equimolar mixture of (-) and (+) lactic acid. (Racemic mix).

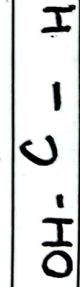
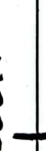
Tartaric acid:



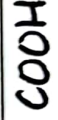
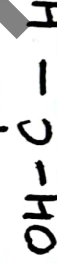
Δ 2,3 Dihydroxy - 1,4 butanedioic acid.

- There are 4 forms.
- 2 optically active (enantiomers)
- 2 optically in-active.

I:



II:



(+) tartaric acid

(-) tartaric acid

Page #



Teacher's Signature: _____

Date: _____

III: $\begin{array}{c} \text{COOH} \\ | \\ \text{OH} - \text{C} - \text{H} \\ | \end{array}$

IV:

$\begin{array}{c} \text{COOH} \\ | \\ \text{OH} - \text{C} - \text{H} \\ | \end{array}$

Equimolar mixture of + & - tartaric acid.

$\begin{array}{c} \text{COOH} \\ | \\ \text{OH} - \text{C} - \text{H} \\ | \end{array}$

(I, II) & (III, IV).

diastereomers

COOH

Meso-tartaric

acid.

• inactive

not mirror images

Map

Isomerism

Stereoisomerism

Optical

- plane polarized light
- anti-clockwise / clockwise
- chiral carbon
- Plane of symmetry

Geometrical

- Alkanes
- Stability through dipole moment
- No relation to π -bond.

Structural

- chain isomerism
- Position isomerism
- function isomerism
- Metamerism
- Tautomerism

Page #



Teacher's Signature: _____

Geometrical isomerism in cyclic compounds

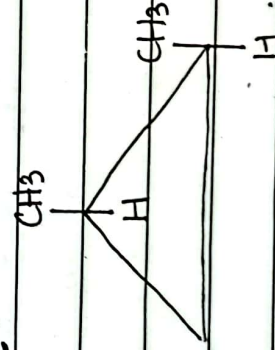
geometrical isomerism also occur in cyclic compounds.

Open chain alkene	alkyne	alkene
Open chain donot show isomerism because it don't fulfills the condition of 2 groups attach but rather 3 groups are attach.	The alkyne donot show any isomerism because only one group can attach to it.	The alkene show the geometrical isomerism because 2 groups can attach to it.

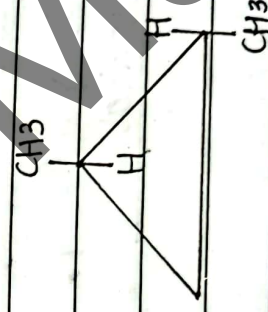
Closed chain alkane

They form geometrical isomerism.

example:



cis - 1,2 dimethylcyclopropane.

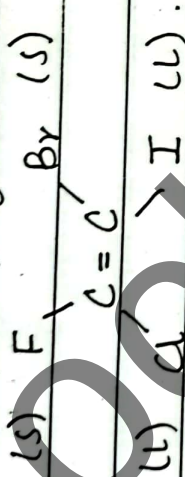


Trans - 1,2 dimethylcyclopropane.

Date: _____

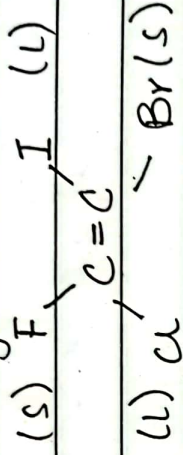
Z-form:

When 4 diff groups attach
is small - large order.



E-form:

When 4 diff groups
attach is small - large &
large - small order.



Question #1

- a) ethene
- b) 3 - Propene
- c) 3 - Hexene
- d) 2-Methyl-1propene
- e) 1,3 - Pentadiene
- f) 2,3 - Hexadiene
- g) 2,3 - Dimethyl - 2-butadiene
- h) 2,2,5,5 - Tetramethyl - 3-hexene.

Question #2

- a) $\text{CH}_3 = \text{CH} - \text{CH} = \text{CH}_2$
- b) $\text{CH}_2 = \text{C}(\text{CH}_3) = \text{CH} - \text{CH}_2 - \text{CH}_3$
- c) $\text{CH}_3 - \text{HC} = \text{CH} - \text{CH} = \text{CH} - \text{CH}_3$
- d) $\text{CH}_2 = \text{C}(\text{CH}_3) - \text{HC} = \text{CH}_2$

CH₃

- e) $\text{CH}_2 = \text{CH} - \text{C}(\text{CH}_3) = \text{CH} - \text{CH}_3$

Page #

Tonkewat, G...

Structure of alkene

Basic:

- carries sp^2 hybridization
- p-orbitals forms π bond and hybrid orbitals form σ bond.
- The bond length of ethene is much shorter than ethane.
 $\hookrightarrow 1.34 \text{ \AA}$ $\rightarrow 1.54 \text{ \AA}$
- The difference in bond length due to increase in electron charge density.
- Co-planar
- Rotation restricted due to cis & trans structure.

Preparation of alkene

Alkene can be prepared by 2 ways:

- Dehydration of alcohol
- Dehydrohalogenation of alkyl halide.

Date: _____

Dehydration of alcohol

Removal of H_2O from alcohol.

→ **Primary alcohol:**

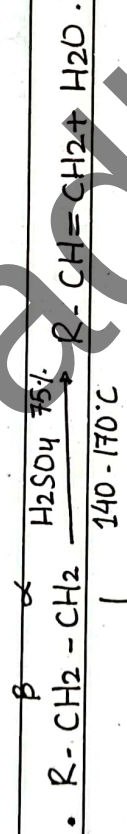
The alpha carbon joined with only 1 another carbon.

example ~



OH

1°-alcohol, primary alcohol.



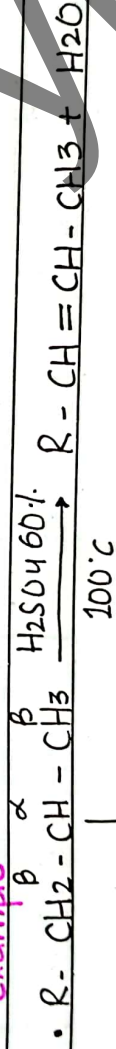
OH

1°-alcohol

→ **Secondary alcohol:**

The alpha carbon joined with 2 another carbon.

example:



OH

2°-alcohol

→ **Tertiary alcohol:**

The alpha carbon joined with 3 another carbon.

elimination Trick :-

Saytzeff rule → $\beta - C$

that has less H will be removed to form =.

dehydrating agent :

Al_2O_3 (alumina),

H_3PO_4 , P_4O_{10} , P_2O_5

H_2SO_4 (best becoz tell

order of reactivity &

fast rxn.

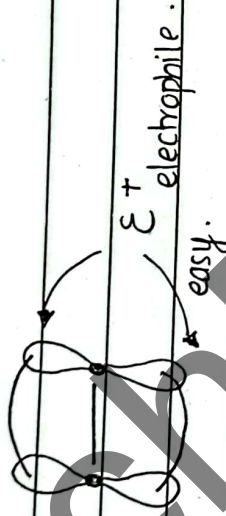
Page #

Teacher's Signature: _____

Date: _____

Reactivity of alkene

- more diffused bond (more e^- density)
- weak π bond
- less energy to break bond.



Electrophilic Addition rxn Alkene

electrophile

- electron loving
- E^+ cation $\rightarrow$ electron deficient
- $BF_3 \rightarrow B^+$

Nucleophile

- Nucleus loving
- Nu^- anion $\rightarrow$ electron rich specie
- OH^- (mostly bases involved).

definition of rxn

1. Halogenation: Addition of H_2 in the molecule of alkene is halogenation.

Page #

Teacher's Signature: _____

Date: _____

Catalyst:

→ Nickel cheap

↳ 200-300°C

Pressure:

• 1-5 atm

↳ usually not mentioned.

→ in place of Ni, we can also use:

Pt/Pd → requires room temp

+ Raney Nickel

↳ fast rxn, also requires very low temp, more reactive than normal Ni.

example: 1

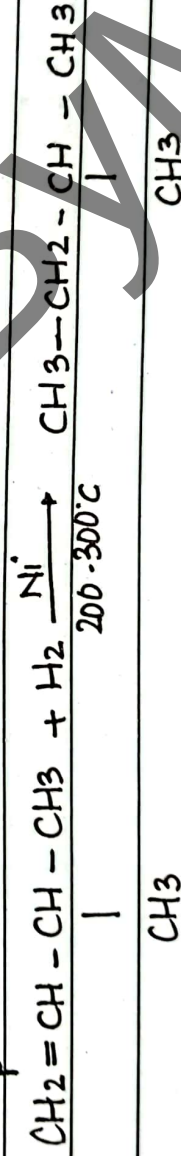


indcat:

Importance:

• used in catalytic hydrogenation for preparing vegetable ghee from vegetable oil.

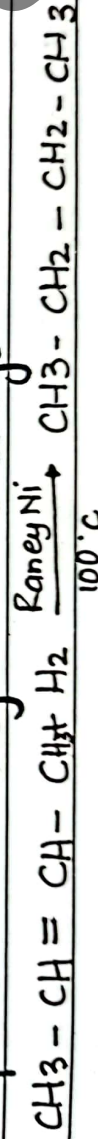
example: 2



3-Methylbutene

3-Methylbutane

example: 3 with Raney Nickel as catalyst



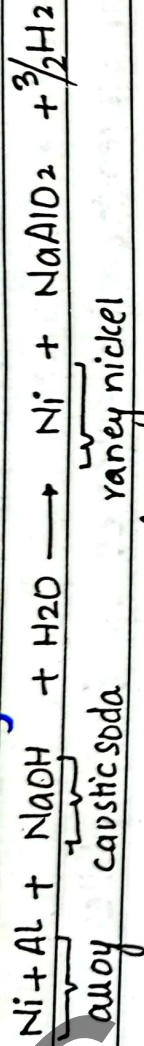
2-butene

butane.

Page #

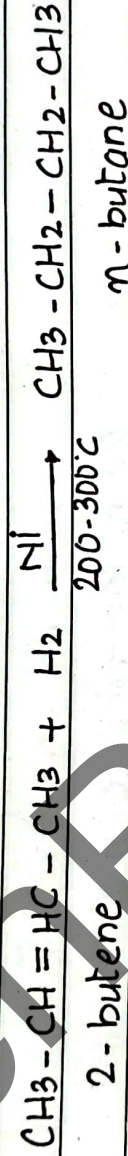
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Formation of Raney Nickel:

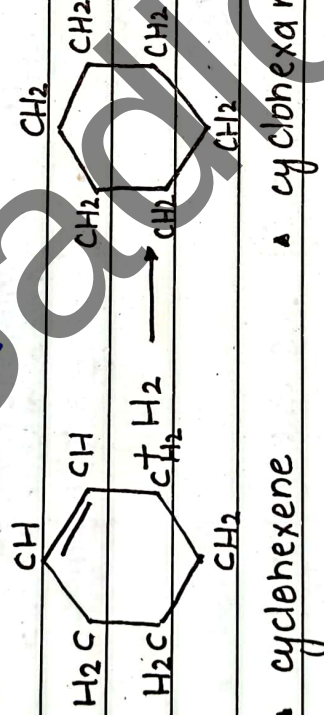


→ Conversion

- 2-butene $\rightarrow$ n-butane

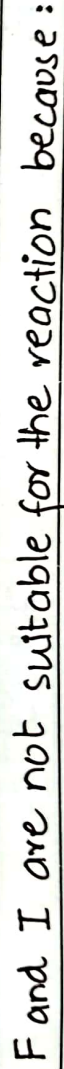


- cyclohexene $\rightarrow$ cyclohexane



Addition of hydrogen and halogen in molecule is called hydrohalogenation.

Reactivity order of halogen Acid



- $F \rightarrow$ highly violent rxn, fast, more electronegative

- $I \rightarrow$ slow, irreversible.

Date: _____

example:



Mechanism or Stereochemical evidence of Electrophile

rxn :-

Step 1 :-



electrophile

carbocation/

carbonium

ion having + charge on carbon atom.

Step 2:

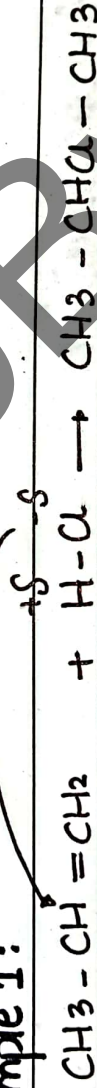


Inorganic hem, the arrow always point from - charge to + charge

Markownikov's rule

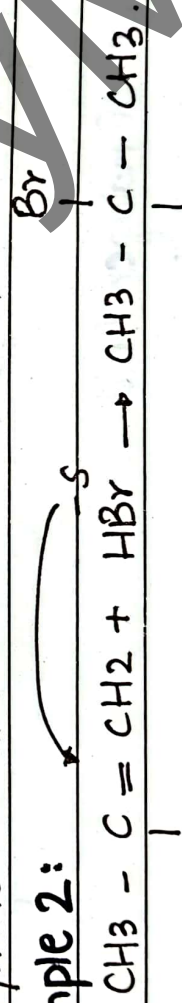
- δ charge will go towards = carbon which has less hydrogen.

example 1:



unsymmetrical alkene

example 2:



CH₃

CH₃

2-Methyl-1-Propane

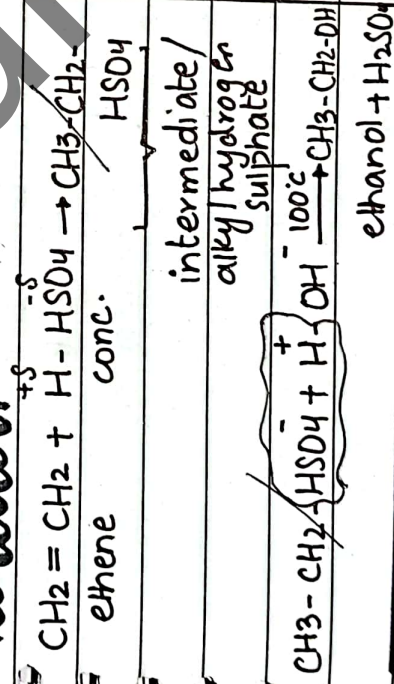
2-Bromo-2-methylpropane

Hydration

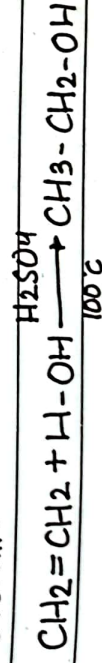
- Addition of water to alkene.
- This addition of water to alkene is not simple.
- Becoz, alkene (non-polar) doesn't dissolve in water (polar).
- For that, we indirectly dissolve/add water by adding H_2SO_4 .

The purpose is to generate polarity.

reaction

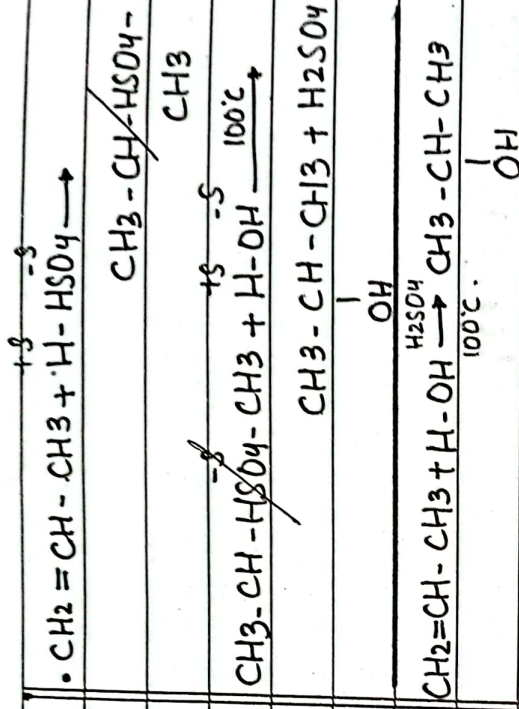


Overall:



- H_2SO_4 is a catalyst.

- Partial synthesis.

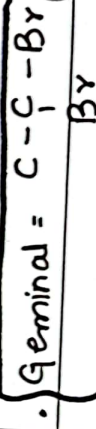
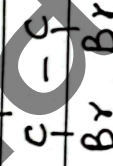


halogenation

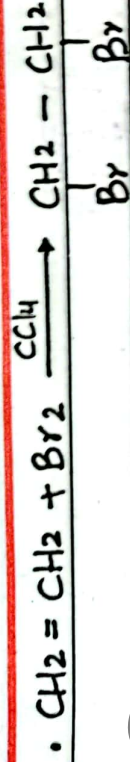
- Partial synthesis
- "test for unsaturation"
- Addition of halogen in a molecule

- alkane halogenation takes place in presence of sunlight.
- alkene halogenation occurs only in presence of inert solvent CCl_4 .

- halogenation of alkene produces Vicinal dihalide.

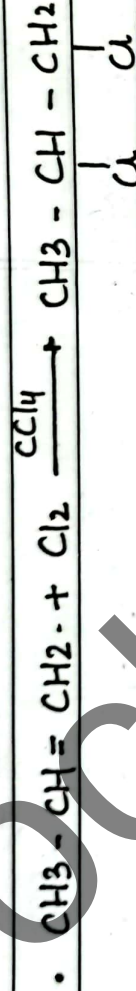


Date: _____



• Vicinal dihalide

• 1,2-Dibromoethane.

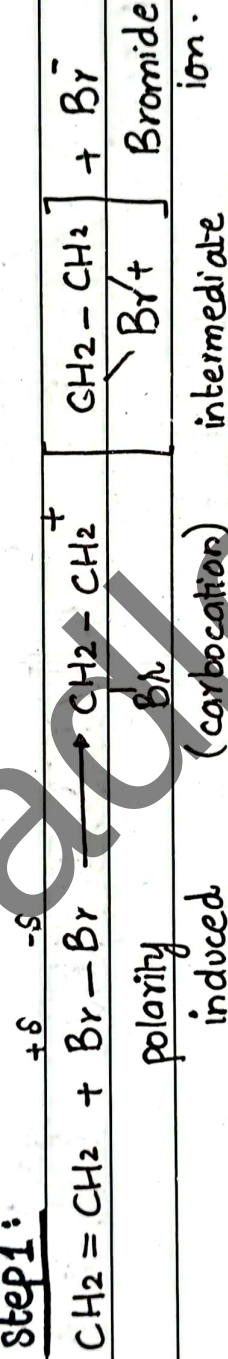


• Vicinal dihalide

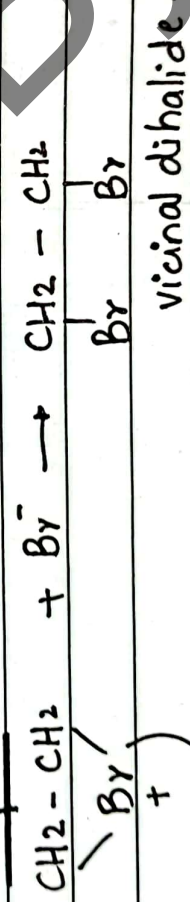
• 1,2-Dichloropropene.

Mechanism

Step 1:



Step 2:

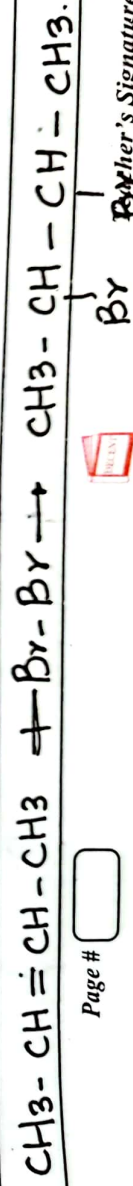


bond breaking

test

$\text{Br}_2 \rightarrow \text{colorless transparent}$
(Brown)

$\rightarrow \text{H.O.W.}$



Page #

Teacher's Signature: _____

Date: 07-08-24

halohydrin

• Addition of hypohalous acid (HOX) is called halohydrin.

→ Water act as solvent & reagent. → molecules of water become reactant too.

Formation of hypohalous acid:



↳ hypohalous acid.

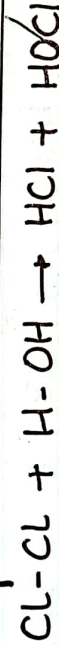
example: 1



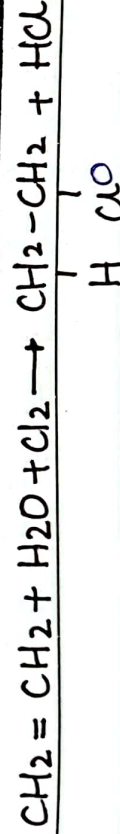
halohydrin.



example: 2



Hypochlorous acid

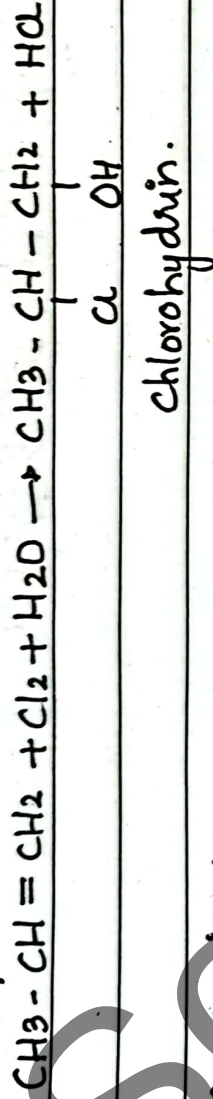


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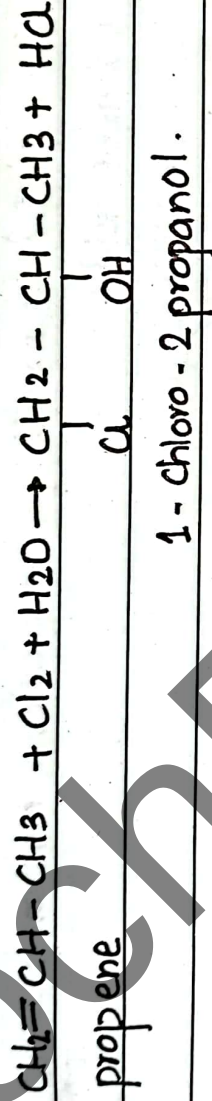
Teacher's Signature

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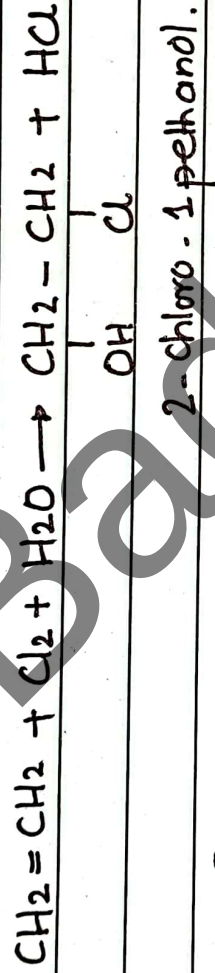
example 3:



Conversion 1:



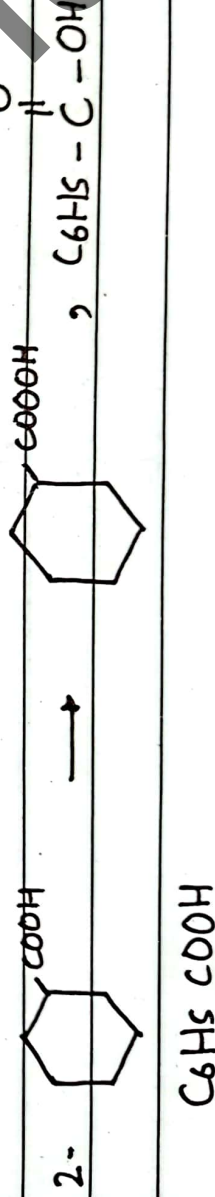
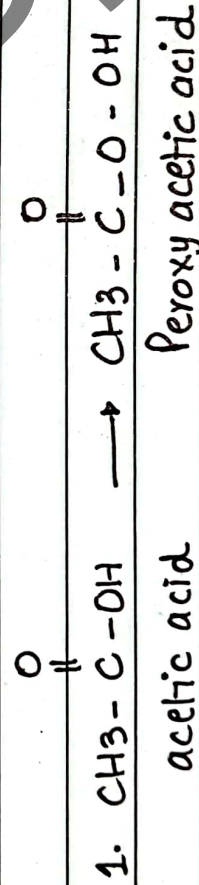
Conversion 2:



epoxidation

→ produces epoxy alkane.

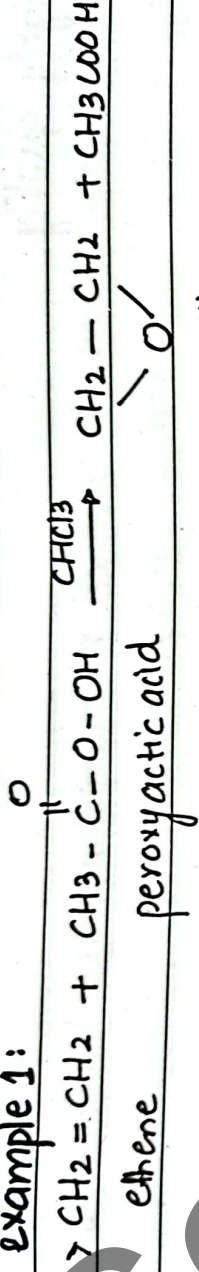
→ Peroxy acids or Peroxides are used: Peroxy acetic acid or Peroxybenzoic acid



benzoic acid Peroxybenzoic acid.

Date: _____

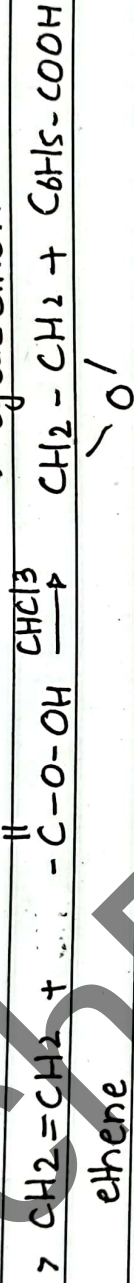
example 1:



• epoxy ether

• Epoxide

• cyclic ether.



• epoxyethane

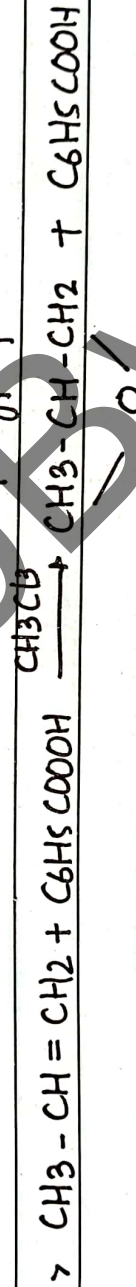
• epoxy ether

• epoxide.

example 2:



• epoxypropane.

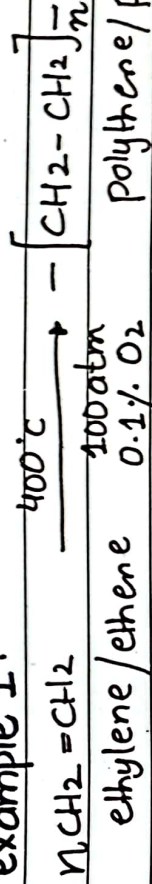


8. polymerization

Small molecule $\rightarrow$ larger molecule

• Process in which small molecules called monomers combine with each other & form large molecule called polymer.

example 1:



Page #

Teacher's Signature: _____

Date: _____

highly quality

ethene is polymerized in presence of aluminium triethyl $Al(C_2H_5)_3$ & titanium tetrachloride ($TiCl_4$).

Ozonolysis

allotrope of $O_2 = O_3$ breaking

Addition of O_3 which causes unsaturated alkene/compound to break.

It produces Carbonyl group $\begin{cases} \rightarrow \text{aldehyde} \\ \rightarrow \text{ketone} \end{cases}$

Used to test the location of $=$ bond.

Steps

1. alkene + $O_3 \rightarrow$ Molozonide
(unstable).

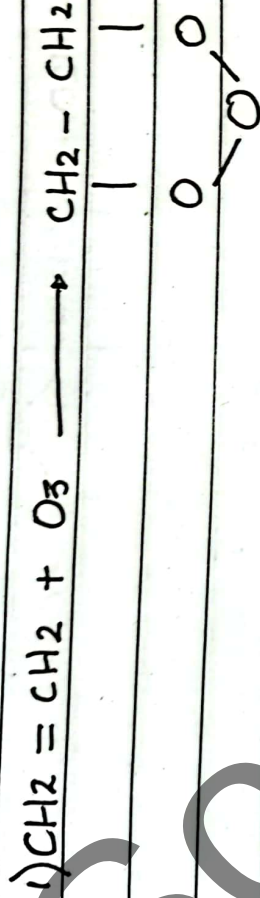
2. Molozonoid $\xrightarrow{\text{rearrange}}$ ozonide
(mild stable).

3. Ozonide + $H_2O \xrightarrow{Zn}$ Carbonyl comp + H_2O_2
 $\downarrow$ reducing
boiling

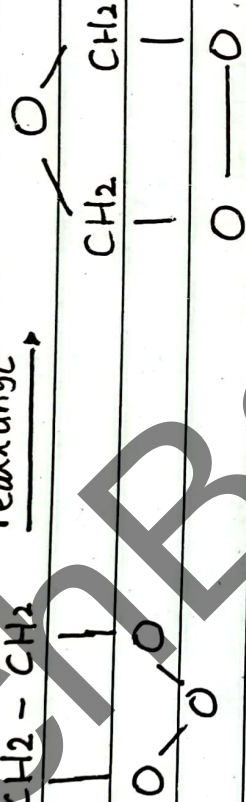
4. $H_2O_2 + Zn \rightarrow ZnO + H_2O$.

Date: _____

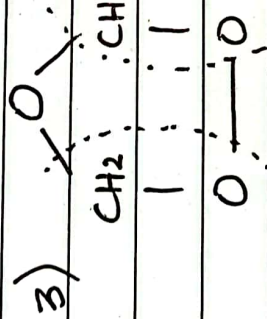
reactions



▲ Molozonide



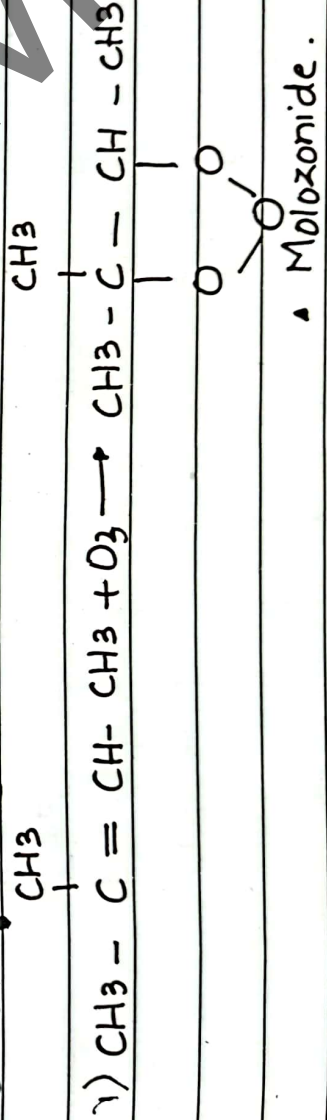
▲ Ozonide.



2 H₂ - C - H₂
(formaldehyde)

4 Methanol.

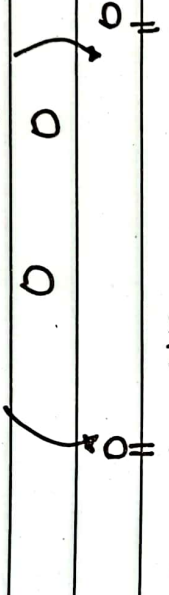
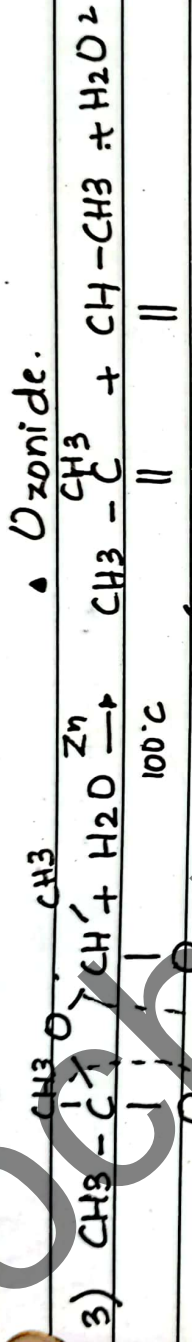
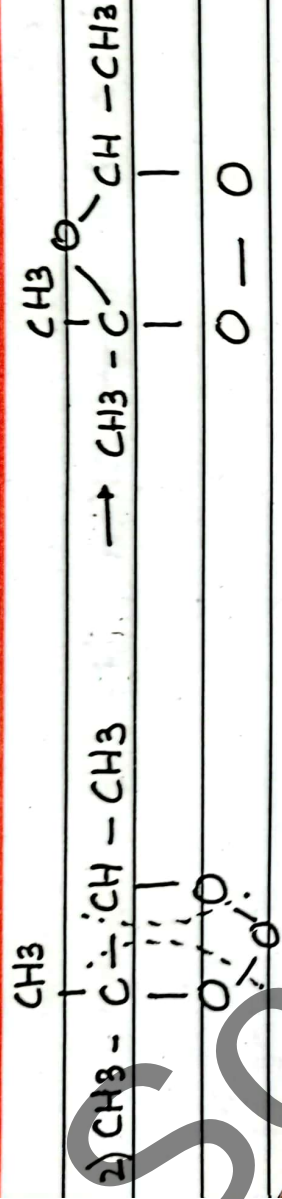
example 1



Page #

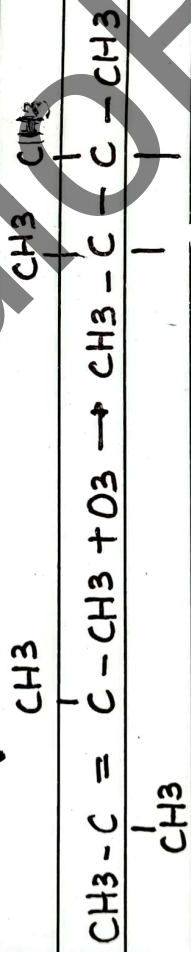
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Date: _____

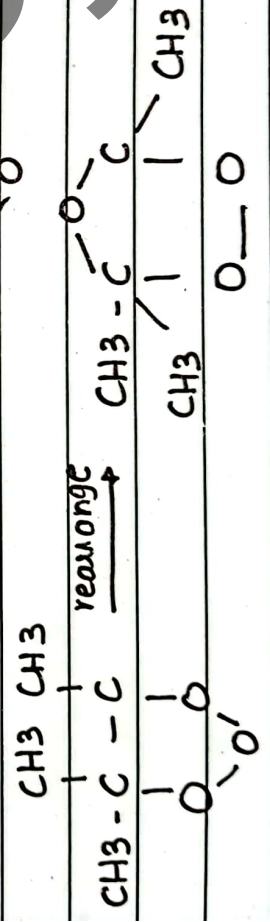


Propanone (acetone) Ethanal (acetaldehyde)

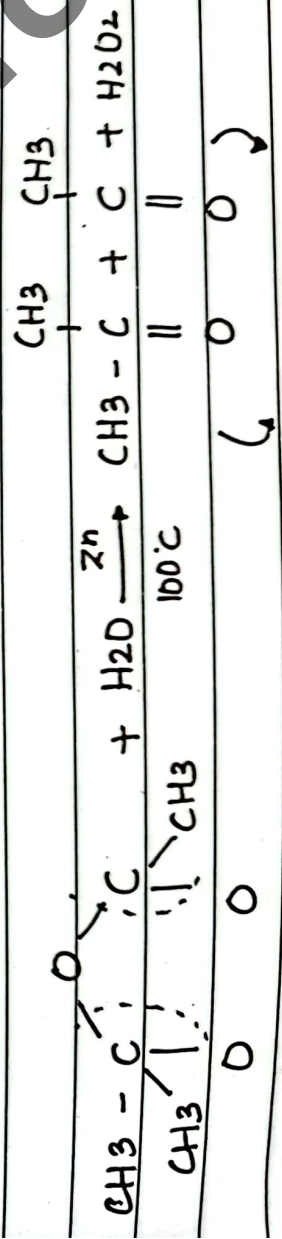
Example 2



molozonide



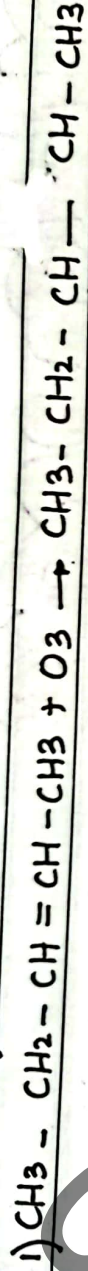
ozonide



Propane (ketone)

Date: _____

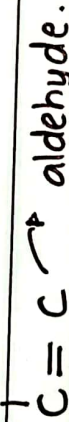
example 3



Trick

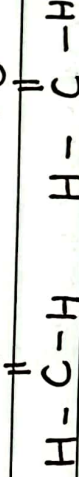
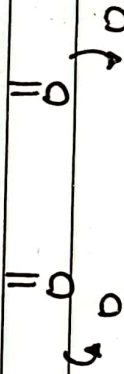
Propanal ethanal.

- alkene which have = carbon branch always form ketone.
- alkene which have = carbon no branch forms aldehyde.



↳ ketone

• Add O₂ to Carbon double bond & see results.



Date: 9-8-2024

Alkyne

Compounds having Triple bond.

Relative Stability:

alkene are less stable due to 1 pi bond.

alkyne are most stable due to 2 pi bond.

alkane are most stable than any other due to 1 σ bond.

alkane > alkyne > alkene

alkene are most reactive due to 1 pi bond.

alkyne are less reactive due to 2 pi bond, consuming more energy to be broken.

↳ side overlap.

alkane are inert due to σ bond, consuming $\uparrow$ energy than any other.

↳ head overlap.

→ Have more charge density

alkene > alkyne > alkane

• Stability $\propto$ 1

reactivity

Date: _____

Example of energies:

For 1-Hexyne = 290 kJ/mole & ΔH of 1-Hexene = 126 kJ/mole .

Structure

hybridization

is 50% s-character & 50% of p.

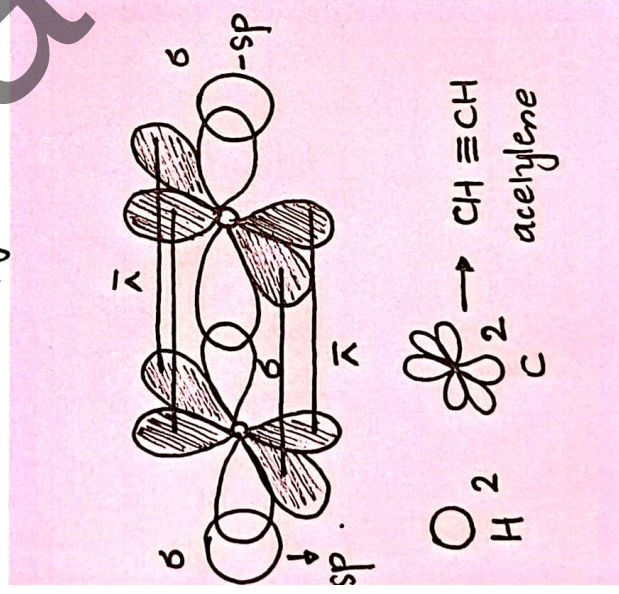
2-sp² orbitals linked by σ -bond.

hybrid p-orbitals linked by π -bond.

→ 2-2 → unhybrid p of another carbon.

unhybrid p of one carbon.

Head of π -e⁻ is cylindrical to σ -bond axis.



Physical Properties

alkynes are non-polar. • increase in s-character causes $\uparrow$ in E.N of carbon.

alkynes are insoluble of water & soluble in organic solvent.

alkynes are colorless, odourless except acetylene → garlic odour

I.P, B.P, density $\uparrow$ with $\uparrow$ in C-atom.

2-C₄ → gas & C₅-C₁₂ → liquids & higher are solid at 25°C.

Page #

Teacher's Signature: _____

Sticly

IUPAC Name:



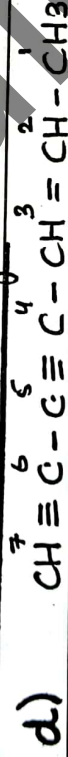
1-Butyne.



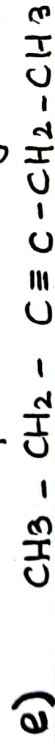
1,4-Butadiyne



1-Butene - 4-yne.



2-Heptene - 4,7-diyne.



3-hexyne.

Preparation of alkyne

Elimination

1- Dehydrohalogenation:



• Removal of HX from alkene, alkane molecule to form alkyne.

→ Reagent = alcoholic KOH (elimination) (100-200°C).

= NaNH₂ + Liq NH₃ (-33°C).



Geminal dihalide

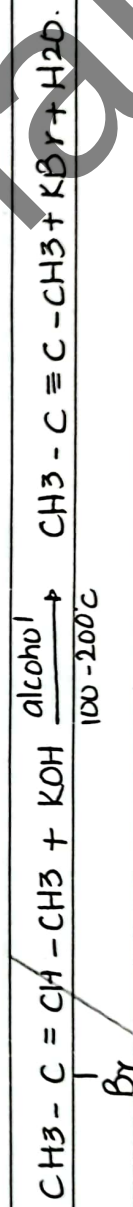
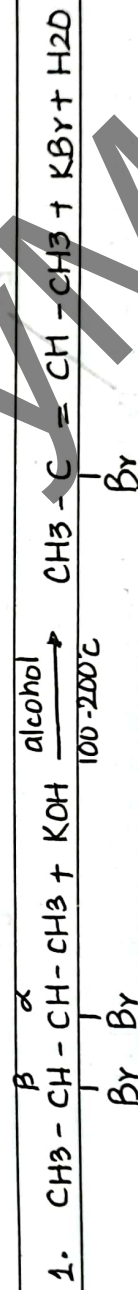
vicinal dihalide

Dihalide

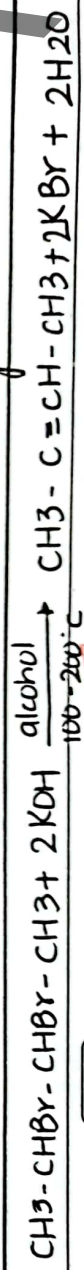
Vinyl halide.

A Vicinal dihalide:-

example:-



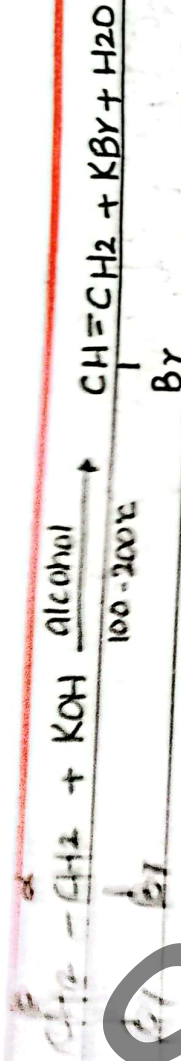
2-Butyne.



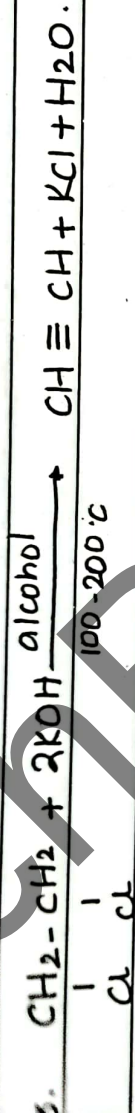
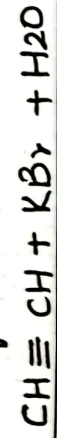
Page #

Teacher's Signature: _____

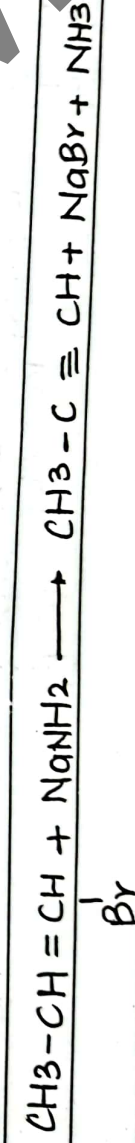
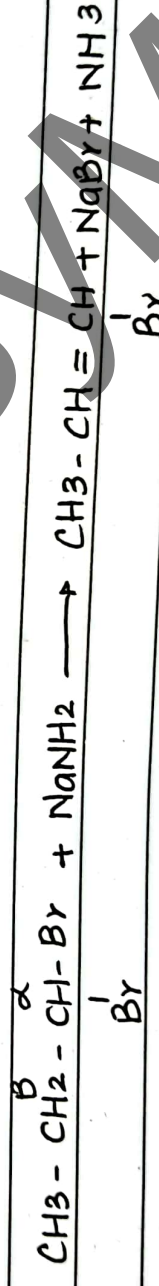
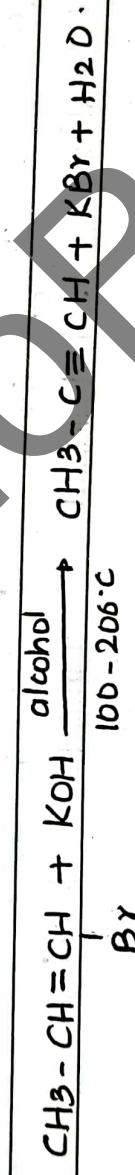
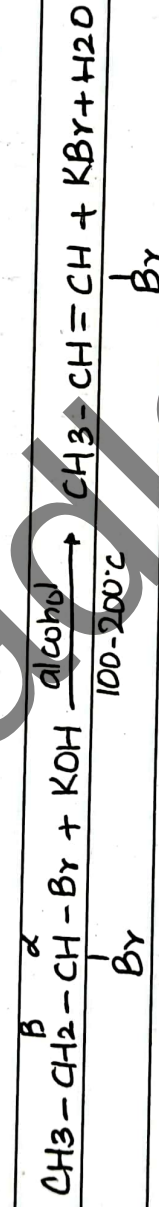
Date: _____



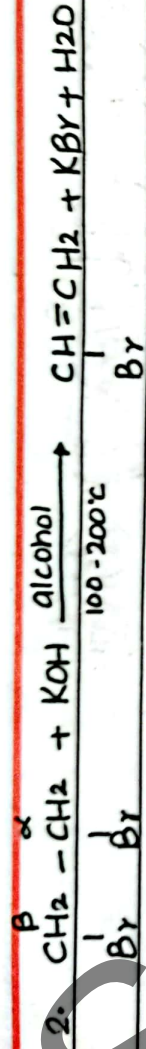
Vinyl bromide.



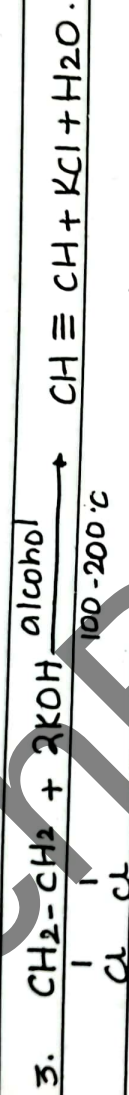
3) Geminal dihalide:



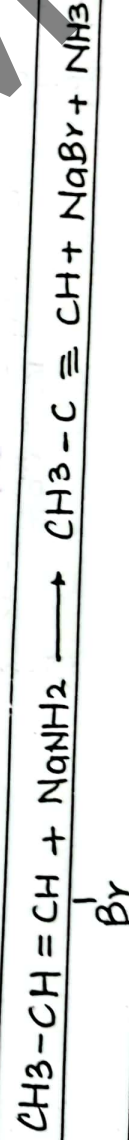
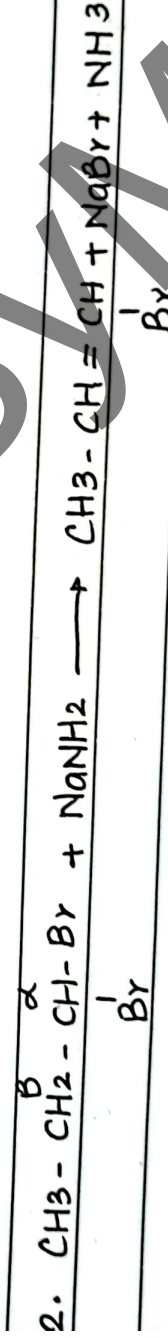
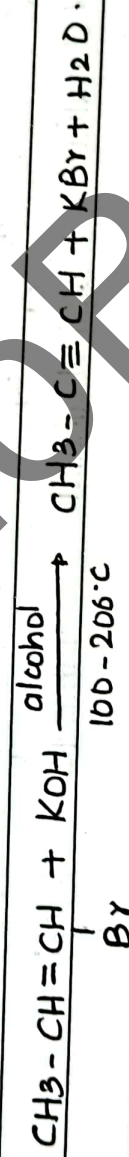
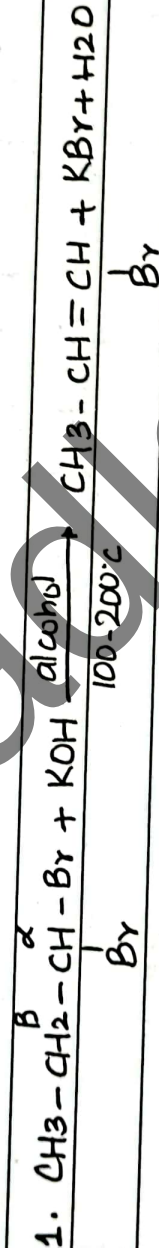
Date: _____



Vinyl bromide.



B) Geminal dihalide:



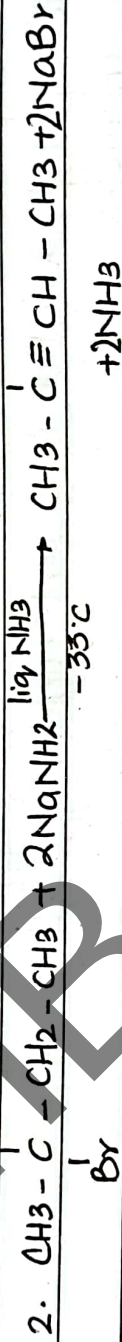
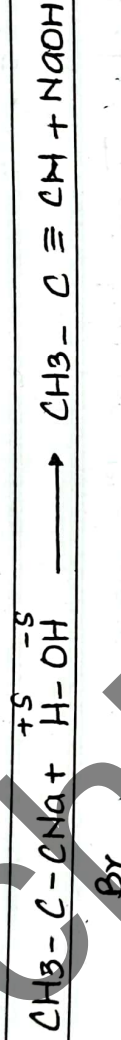
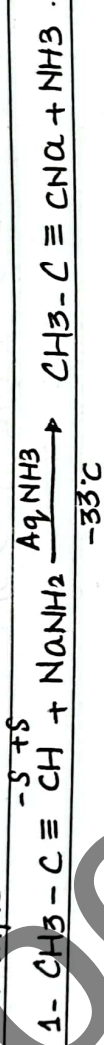
Date: _____

terminal alkynes :-

terminal alkyne are those in which

$\equiv$ bond is after 1st carbon (H) is acidic.

example :-



Reactivity

- alkyne is unsaturated hydrocarbon, shows addition rxn.
- It might undergo substitution rxn. due to easy cleavage of C-H bond.
- The π -bonds are cylindrically symmetrical about sigma bond.
- The removal of terminal hydrogen is possible.
- electrophilic substitution rxn possible in 1-alkyne.

alkene > alkyne > alkane.

1.34A⁺ 1.20A⁺ 1.54A⁺

C=C C $\equiv$ C C-C.

less e⁻ density
more e⁻ density
 π -bond not covered.
 π -bond covered.

Page #



Teacher's Signature: _____

terminal alkyne

alkyne whose $\equiv$ bond is after the first C-atom.

- $\text{CH} \equiv \text{CH}$
- $\text{CH} \equiv \text{C} - \text{CH}_2 - \text{CH}_3$

Reason

In ethyne and other terminal alkyne like propyne, the sp -hybridization is present containing 50% s-character.

The more s-character, the more polarity of C.

The C-atom of terminal will attract paired e^- more towards it, becoming strong acidic.

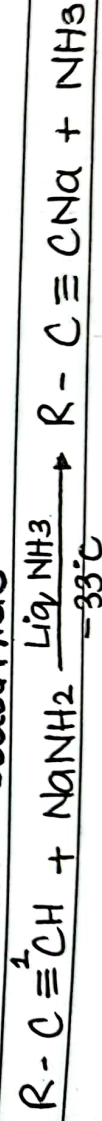
and H with it becoming electron deficit & weak acid. More capable of doing electrophilic rxns.

by reacting with mild base.

electrophilic substitution rxn

one +s, other +s
removed add

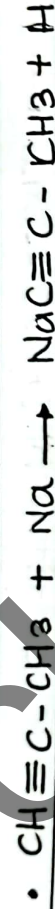
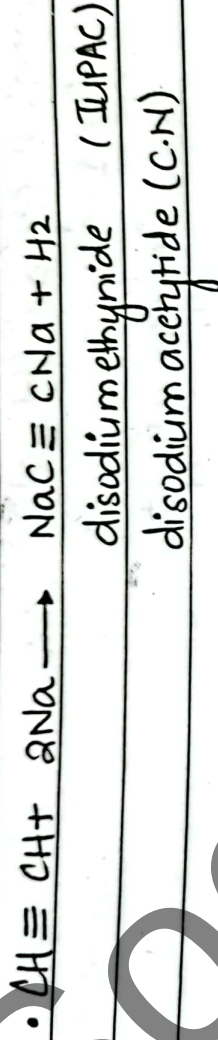
Reaction with Sodamide :-



Sodium alkynide.

Date: _____

Reaction with Na metal:



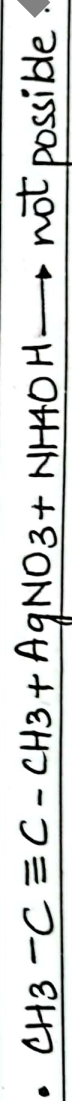
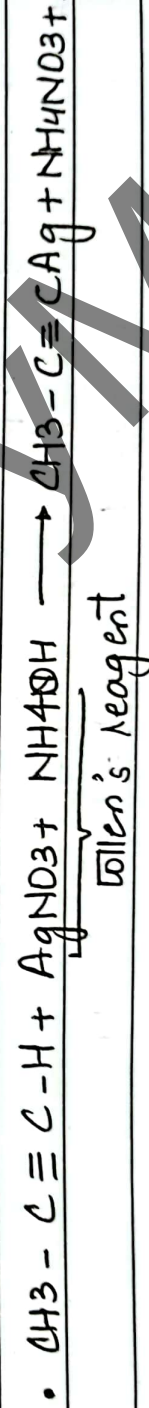
Reaction with ammonical silver nitrate: OR

Identification test for 1 alkyne

↳ when reaction $\text{AgNO}_3 + \text{NH}_4\text{OH}$, forms white ppt.



↳ This rxn is used for testing but 1 & 2 are not. The reason is that it's not soluble in water so we can differentiate.



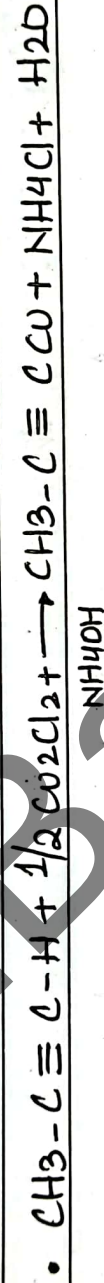
Date: _____

Reaction with Ammonical cuprous chloride $\xrightarrow{Cu^+}$ or
identification test for 1-alkyne

↳ give red-ppt

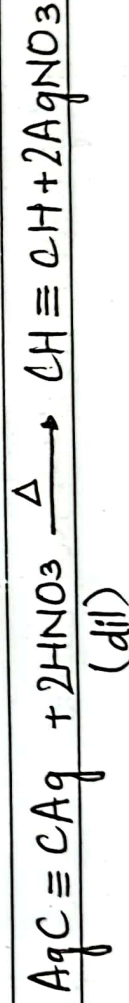
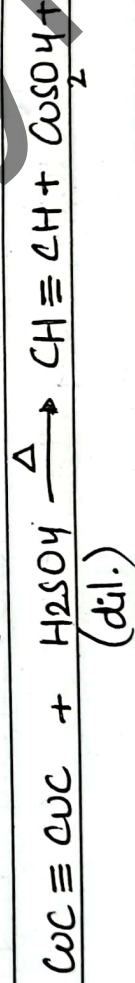
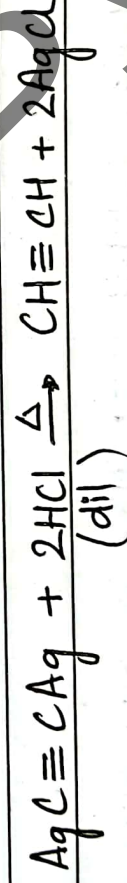


di-copper ethynide.



Uses of alkynide

- Preparation
- Separation
- identification
- Purification.



Date: _____

addition rxn

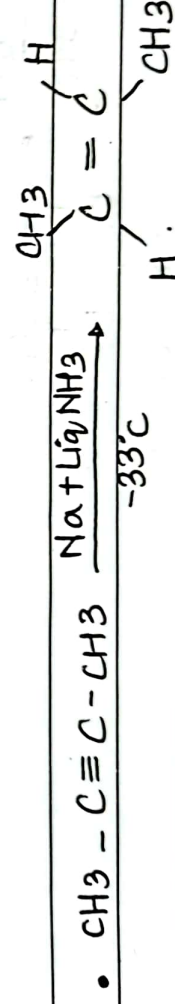
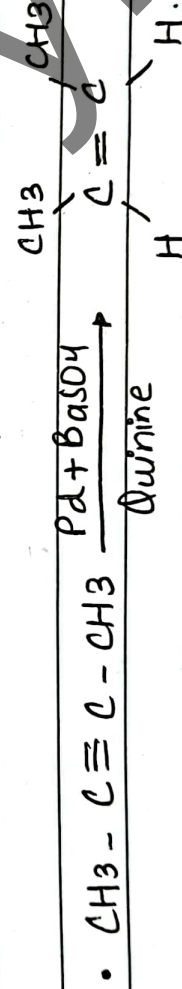
addition of E^+ .

1. Hydrogenation:

- addition of H_2 .
- by using catalyst $\left[\begin{array}{l} \xrightarrow{Ni} (200-300^\circ C) \\ \xrightarrow{Pt, Pd} (Room temp 25^\circ C) \end{array} \right]$
- alkyne $\rightarrow$ alkene $\rightarrow$ alkane.
- $CH \equiv CH + H_2 \xrightarrow[Ni]{200-300^\circ C} CH_2 = CH_2$ } in steps.
- $CH_2 = CH_2 + H_2 \xrightarrow[Ni]{200-300^\circ C} CH_3 - CH_3$.
- $CH \equiv CH + 2H_2 \xrightarrow[Ni]{200-300^\circ C} CH_3 - CH_3$ } direct

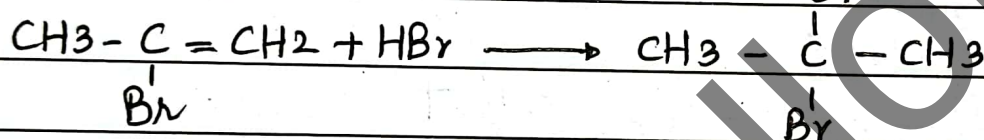
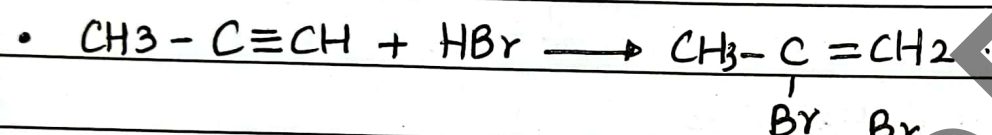
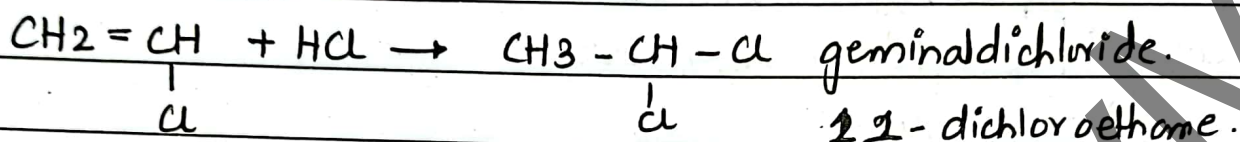
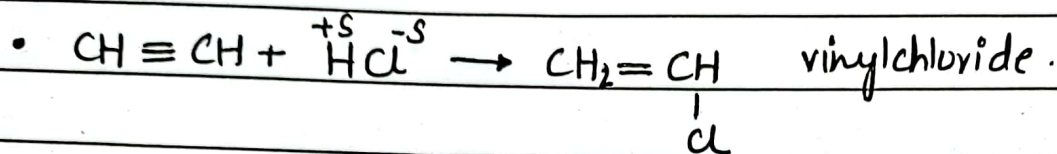
2. Partial hydrogenation:

- cis-2butene ($Pd + BaSO_4 + Quinine$) $\rightarrow$ Lindlar catalyst
- Trans 2-butene ($Na + LiqNH_3$) $\rightarrow -33^\circ C$.



3. Hydrohalogenation: $\rightarrow \text{HX}$

↳ form dihaloalkanes.



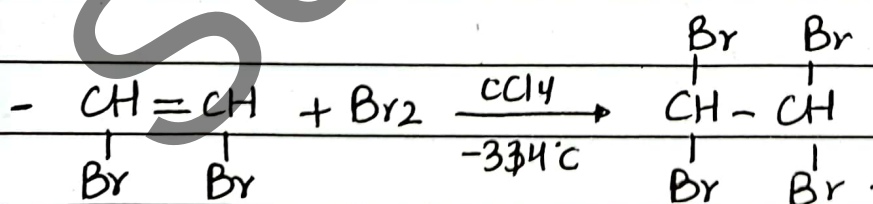
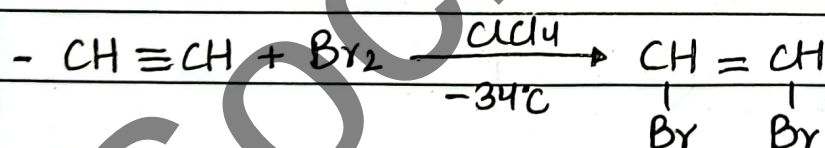
2,2-dibromopropane.

4. Bromination:

↳ vicinal dihalides form.

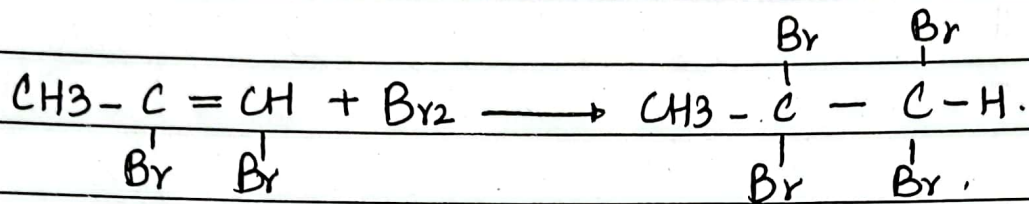
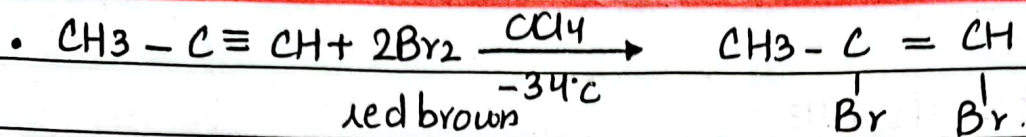
• addition of Br_2

• inert CCl_4 .

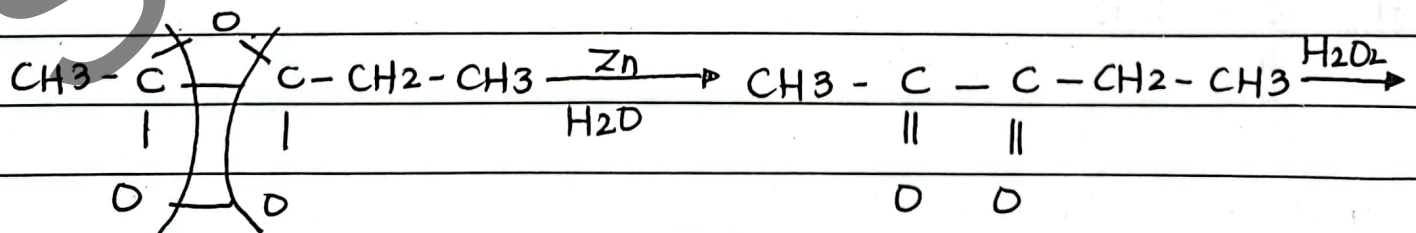
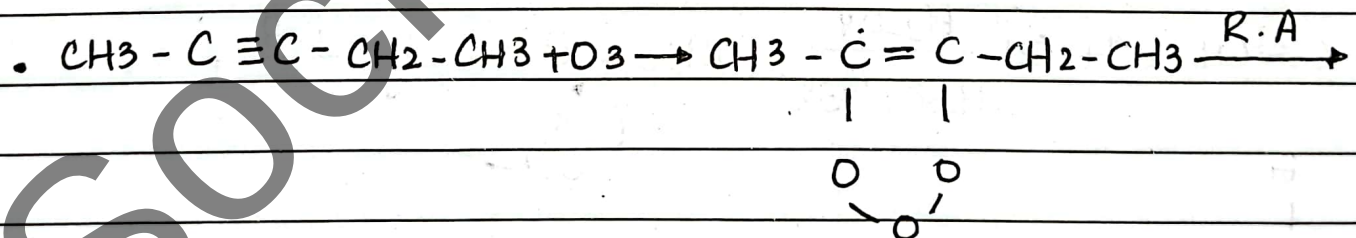
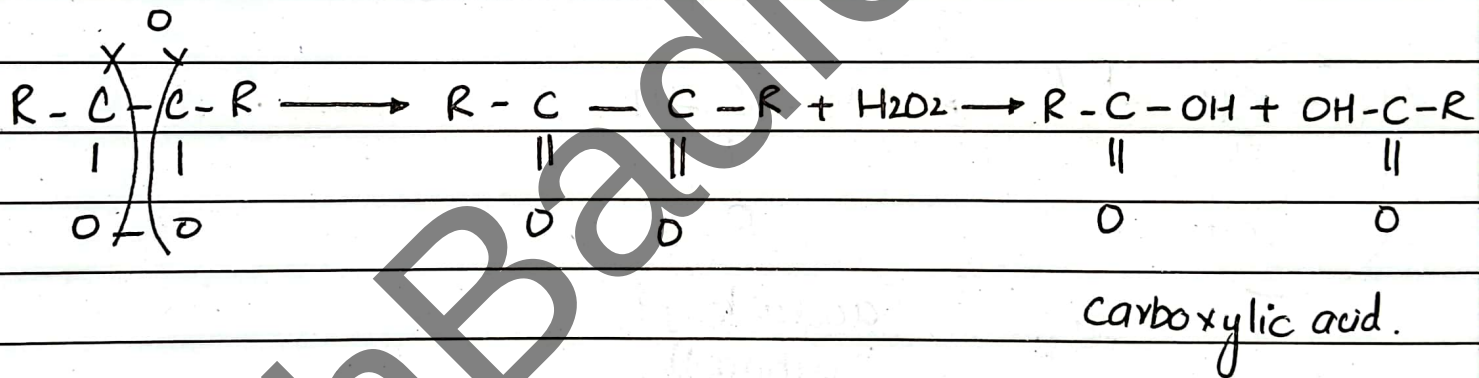
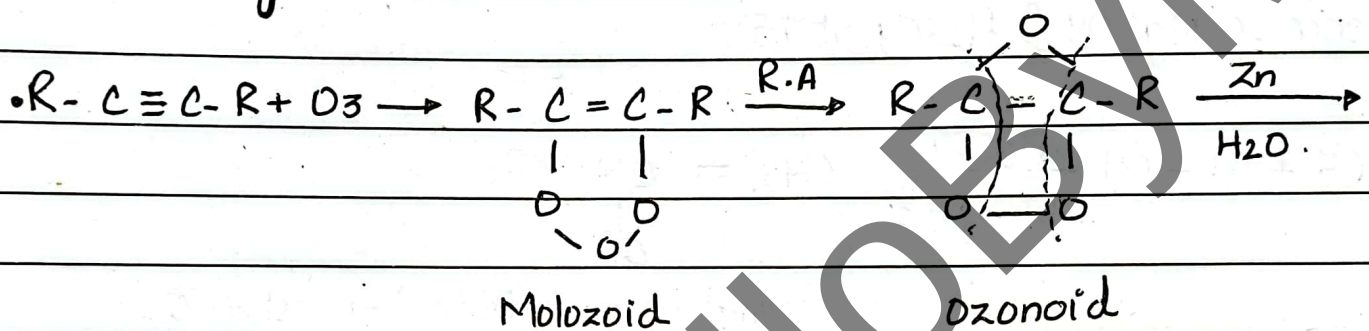


1,1,2,2-Tetrabromoethane

Date: _____



5. Ozonolysis:

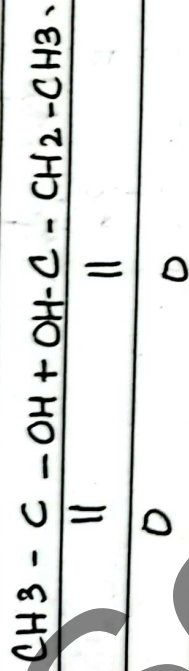


Page #



Teacher's Signature: _____

Date: _____



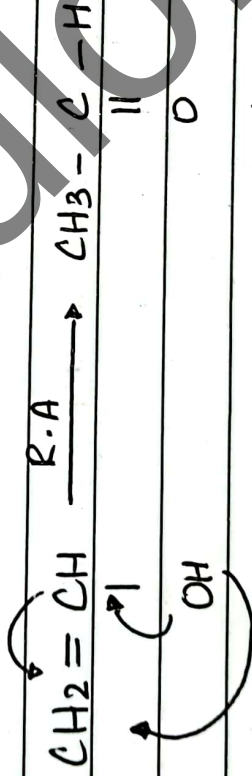
6. Hydration:

- Addition of H_2O

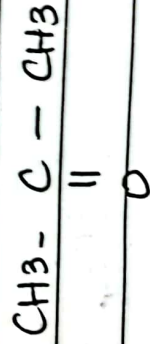
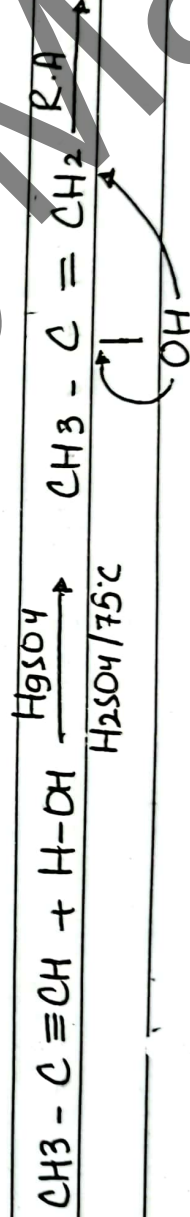
- presence of HgSO_4 & H_2SO_4 at 75°C .



Vinyl alcohol (enol) $\rightarrow$ unstable



acetaldehyde
(ethanal).



acetone (ketone).

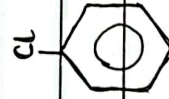
Date: 15-8-2024

nomenclature of benzene

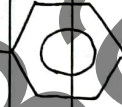
- also known as Arenes.

rules

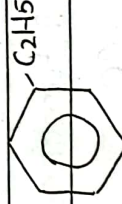
- Parent name is benzene.
- Substituent is placed before benzene.



Chlorobenzene

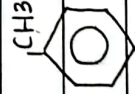


Nitrobenzene



ethylbenzene

- Special names are included in TUPAC.



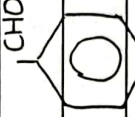
Toluene



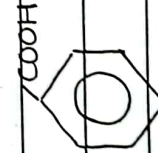
Phenol



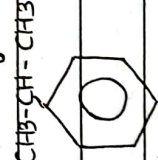
Arilibe



Benzaldehyde.



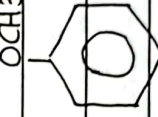
benzoic acid



Cumene

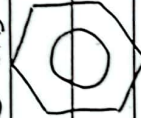


Shirens



Anisol

- When 2 groups are attached on benzene, then it will be numbered.



CH3 ②

1,2-Dimethylbenzene.

Page #

Teacher's Signature:

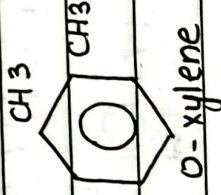
Date: _____

• Relative position is given by special prefixes.

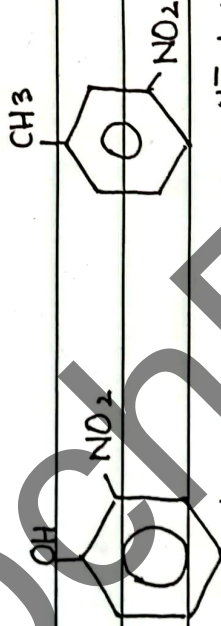
1. ortho (o) $\rightarrow$ 1-2

2. meta (m) $\rightarrow$ 1-3

3. para (p) $\rightarrow$ 1-4.



o-xylene



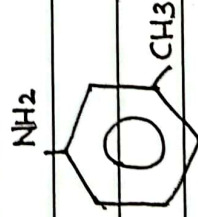
o-nitrophenol

m-nitrotoluene.

• Priority order of different functional group.

$-\text{COOH}$, $\text{C}\equiv\text{N}$, CHO , CO , OH , NH_2 , $-\text{OR}$, R (alkoxy)

aldehyde $\rightarrow$ ketone



3-methyl aniline.



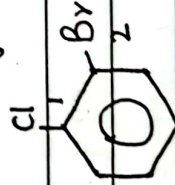
2,4,6-Triphenol

(picric acid)

2,4,6-Terinitrotoluene

(TNT)

• When no group is listed then follow alphabetical order.



2-Bromo-1-chlorobenzene.

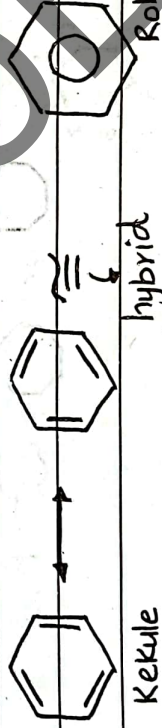
Date: _____

Activity

- a) Chlorobenzene
- b) 1, 3, 4 - Trichlorobenzene
- c) Styrene / vinylbenzene
- d) 2-Bromo-1-chlorobenzene
- e) 1-ethyl-4-Iodobenzene
- f) 3, 5 - Dinitrotoluene.

Structure Of Benzene

- Molecular formula = C_6H_6



hybrid
↳ mixture
2 things.

Special feature

- 1- Resonance (to come repeatedly)
- 2- Electrophilic substitution
- 3- Conjugation (movement of bonds)

2- It has dual nature. (follow less addition and more substitution)

↳ Resonance

3. All C-C bond length are equal to $1.4 \text{ \AA}$.

↳ C-H = $1.09 \text{ \AA}$

↳ Bond angle = 120°

↳ πe^- in benzene are delocalized evenly among six carbon atom via resonance.

4. Less reactive.

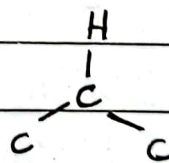
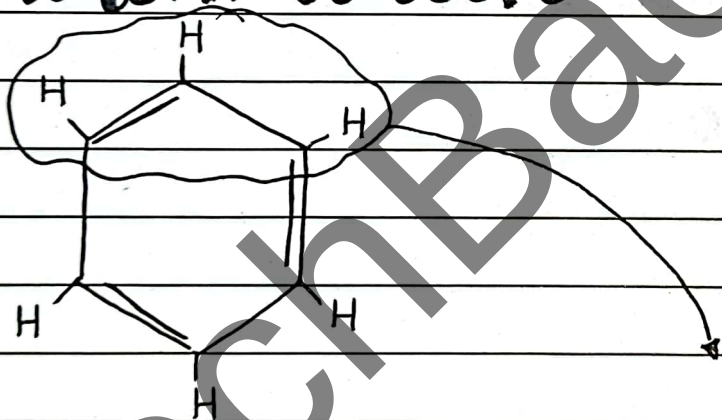
↳ (alkene, alkyne, benzene, alkane)

↳ due to aromaticity

↳ delocalized πe^-

↳ can't react truly with electrophiles.

Modern Concept



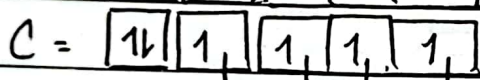
- benzene has sp^2 hybridization.
- Each carbon has 3 hybrid orbital.
- Each carbon has 1 unhybrid orbital.
- Hybrid orbitals for σ bond. (s, p_x, p_y)
 - ↳ 12 σ bond.
- delocalized π bond
 - ↳ p_z .
- Unhybrid orbitals form π bond. (p_z)

Date: 19-Aug-24

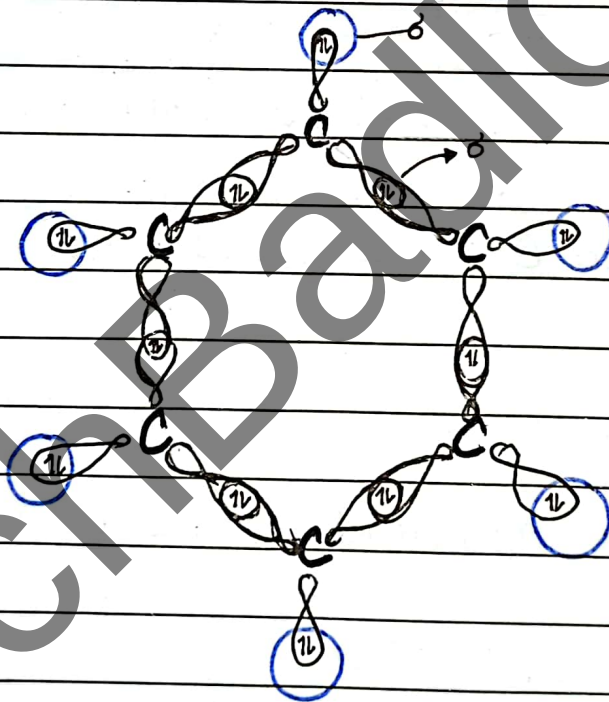
molecular Orbital treatment of benzene

configuration

$$C = 1s^2 2s^2 2p^2$$

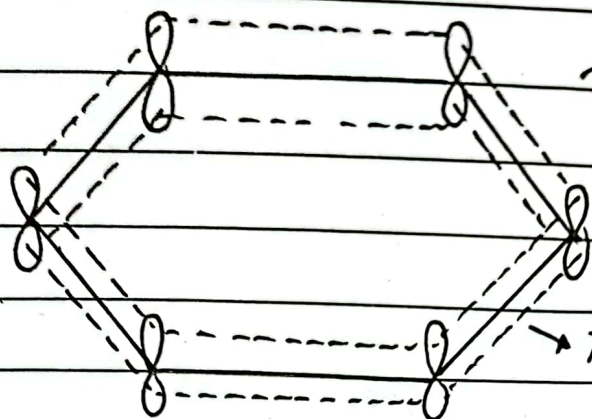


$\underbrace{\quad\quad\quad}_{\sigma\text{-bond}} \quad \underbrace{\quad\quad\quad}_{\pi\text{-bond}}$



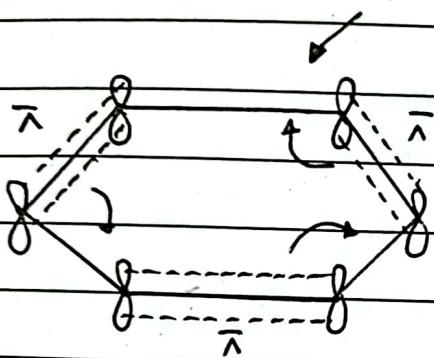
▲ Framework of σ -bond



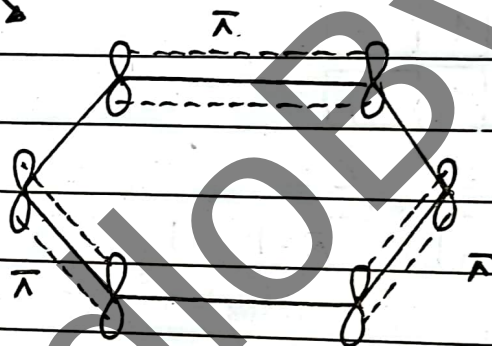


→ This structure is a mixture of Kekulé both structure

→ π - delocalized bond.

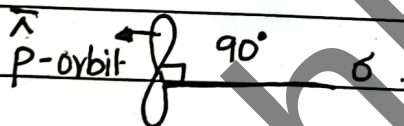


1-Kekulé structure.

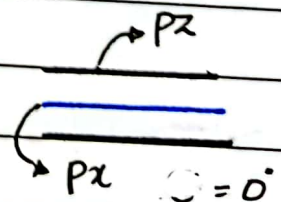
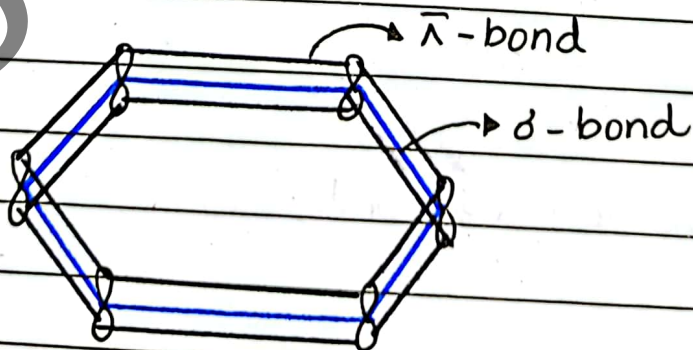


2-Kekulé structure.

- The six- p-orbitals one each C-atom is $\perp$ to σ -bond.



- Each p is in a position to overlap parallel manners with neighbouring orbitals.



- The p_z - π orbitals form continuous sheath of $-ve$ charges up & down.
- It results in extensive π -bond spreading over all carbon nuclei.
- The delocalized p -orbitals forms sandwich like structure over the ring.
- This reduce energy due to continuous movement.

• Benzene are stable.

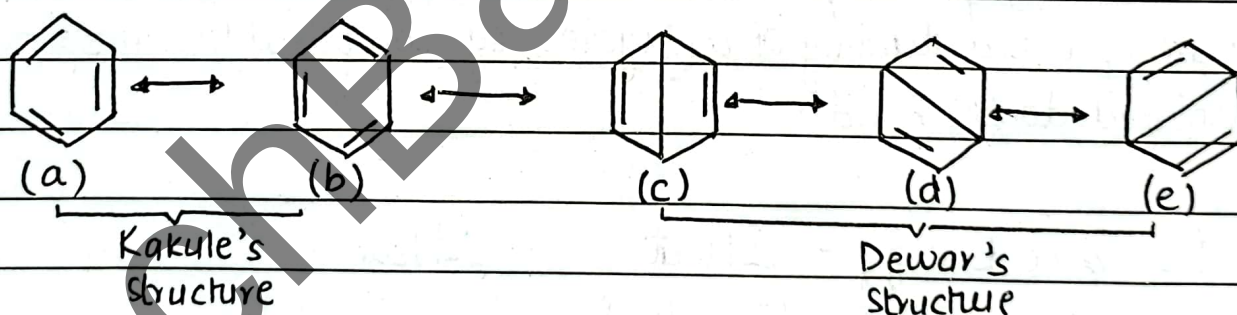
resonance

"The possibility of different pairing schemes of valence e^- of an atom within the molecule."

"The arranged structures are Resonance or Canonical structures."

resonance $\propto$ stability structure
--

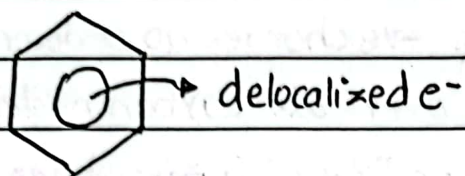
Structure



• Kakule's structure = stable = a, b. (80%)

• Dewar's structure = unstable = c, d, e. (20%)

↳ becoz the difference in bond length makes them unstable & thermally unstable.



▲ Robinson's structure

why benzene is stable?

- delocalized π bond
- due to resonance structure
- due to high resonance energy (152 kJ/mole).

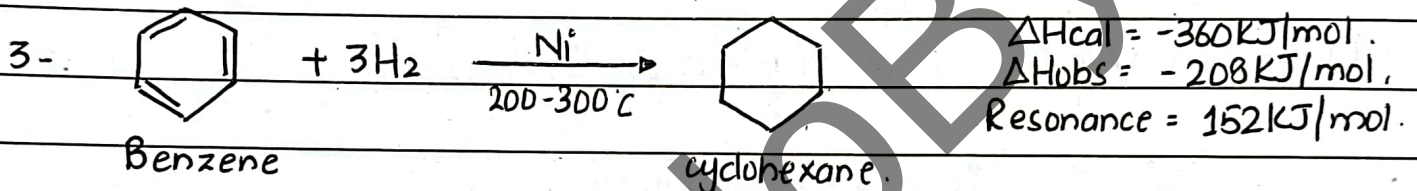
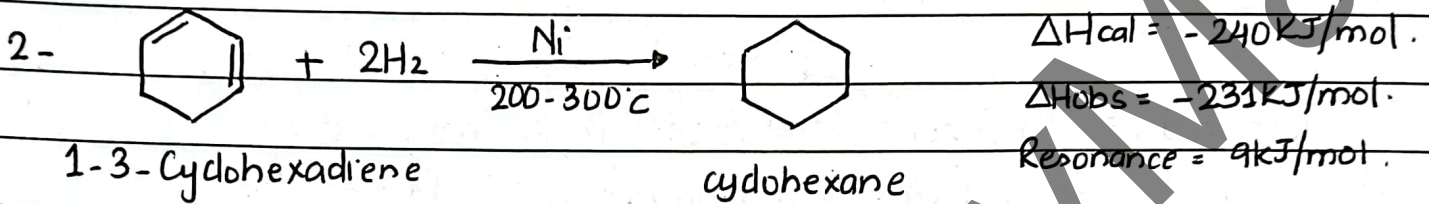
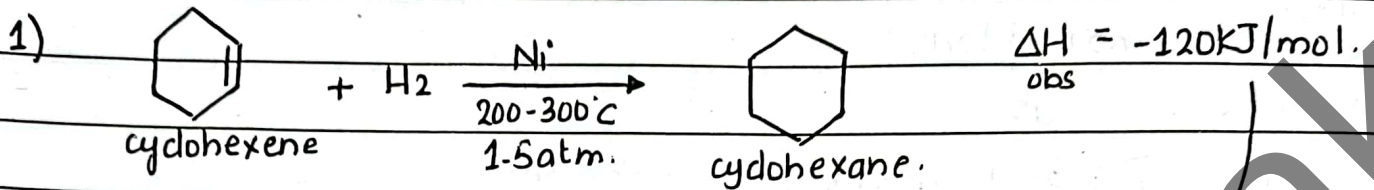
Resonance Energy

- Decrease in energy due to resonance is called Resonance Energy.
- Difference between heat of hydrogenation of calculated and heat of hydrogenation of observed is Resonance energy.
- This refers to conjugated system.
- measure of extra stability of conjugated sys compared to corresponding no. of isolated double bond.

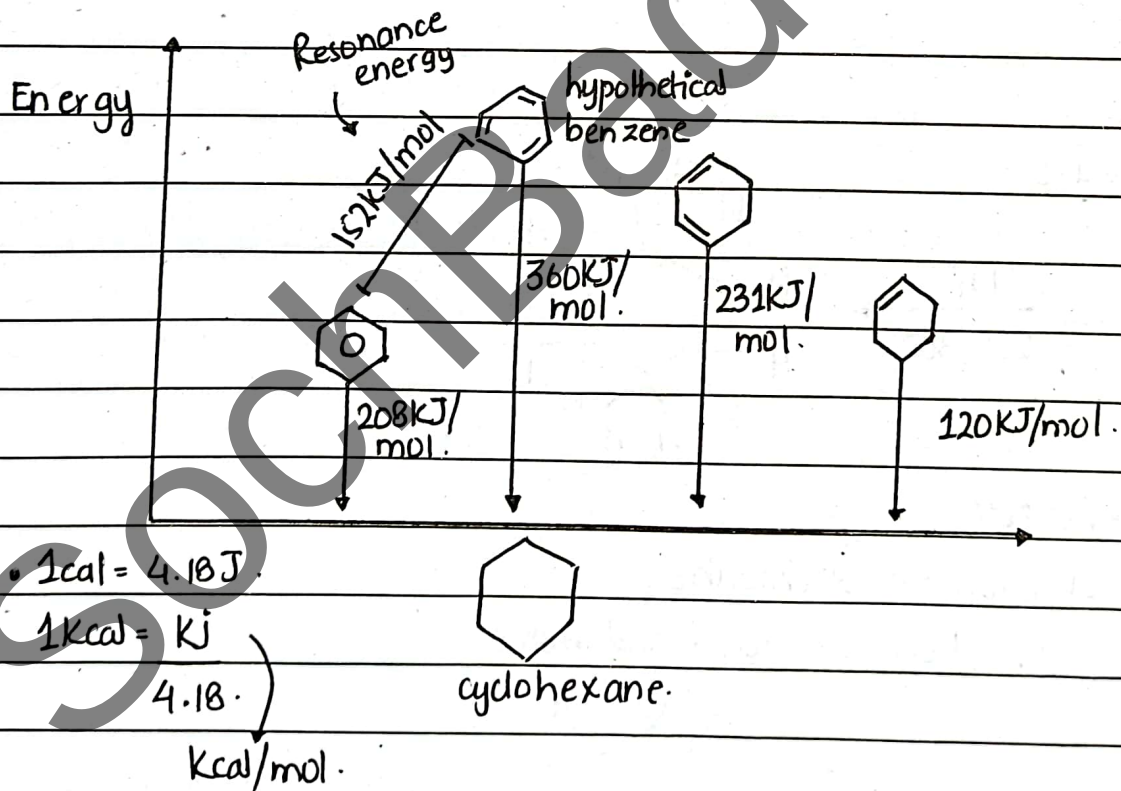
$$\text{Resonance Energy} = \Delta \text{Heat}_{(\text{Theoretical})} - \Delta \text{Heat}_{(\text{experimental})}$$

Resonance Energy $\propto$ Stability

reaction



Graph



- High Resonance energy of benzene as compared to all is high so it's more stable.

Benzene > 1,3-cyclohexadiene > cyclohexene

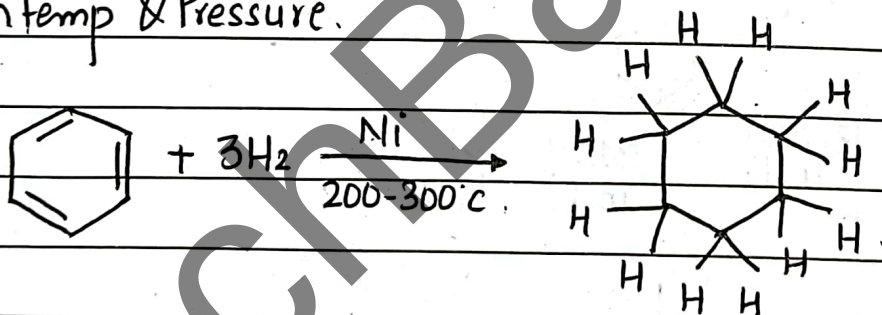
Reaction

more stable.

- π -delocalized e^- of benzene, and arenes make them nucleophiles.
- It's more likely to undergo substitution rxn than addition.
- This destroys aromatic system.
- Addition rxn requires more vigorous conditions.

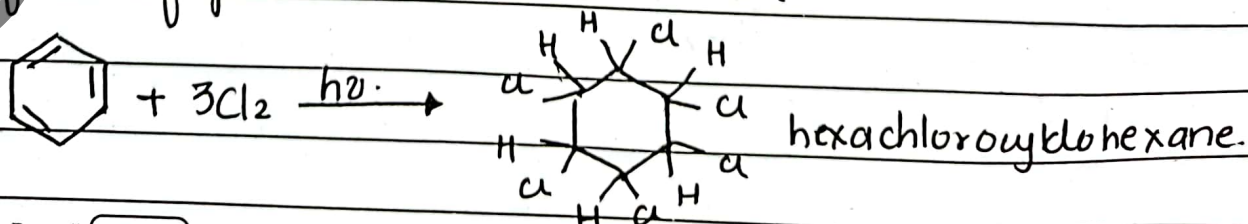
Catalytic hydrogenation

- $Ni \rightarrow 200-300^\circ C$.
- $Pt/Pd \rightarrow 25^\circ C$.
- Raney Nickel = $100^\circ C$.
- High temp & Pressure.

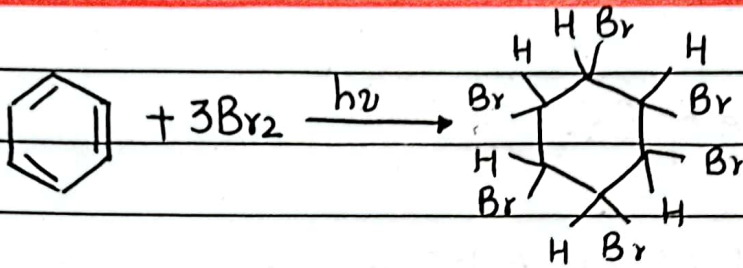


halogenation

- Add 3 molecule of Bromine & chlorine.
- Add influence of light, become saturated more.



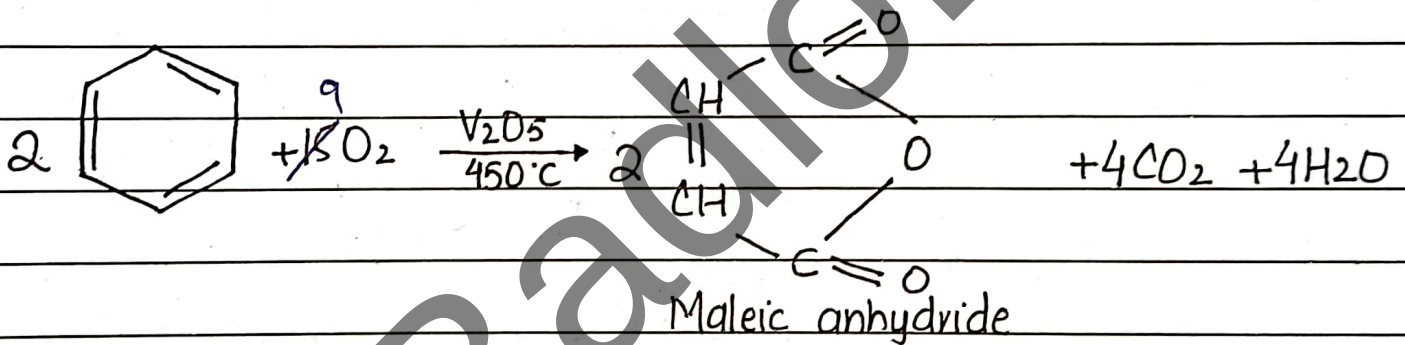
Date: _____



• hexabromocyclohexane.

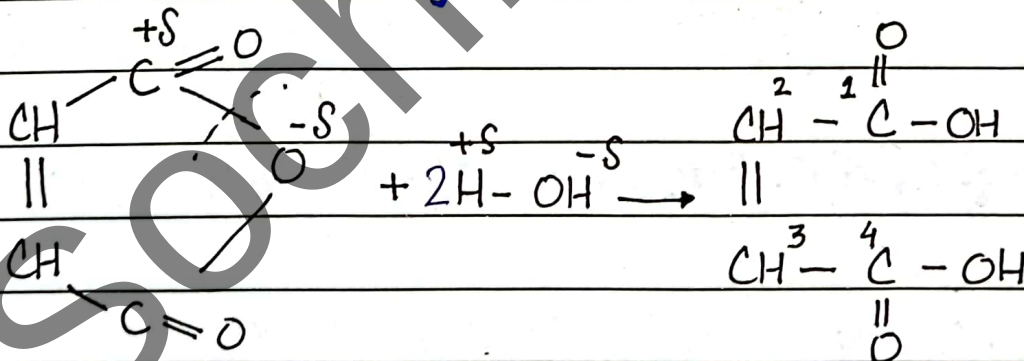
Oxidation Rxn

- Benzene can't be oxidized with KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ due to its very stable structure.
- For Oxidation, we need $450^\circ\text{C} + \text{O}_2 + \text{V}_2\text{O}_5$.



ALD:

Convert Maleic anhydride to Maleic acid



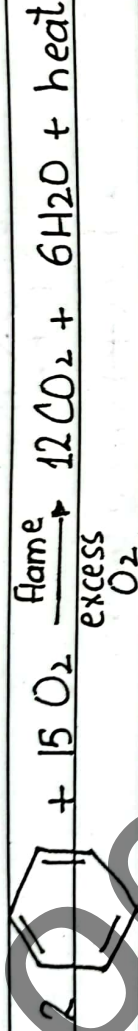
Maleic acid

2-butene-1,4-dioic acid

Date: _____

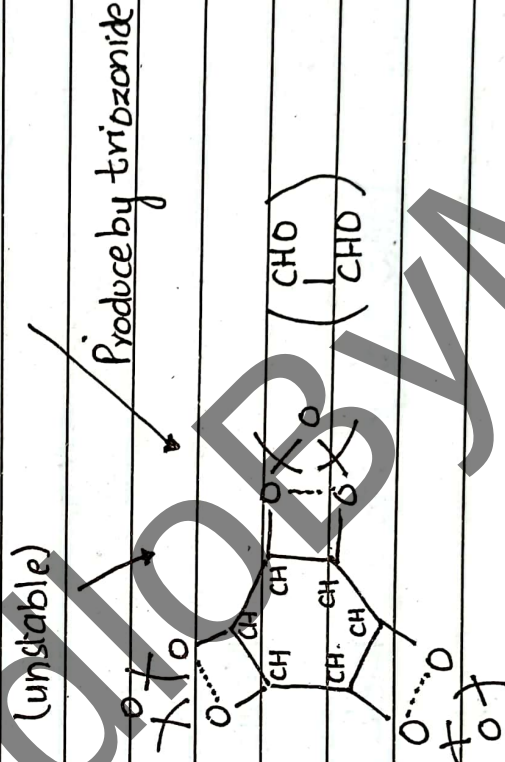
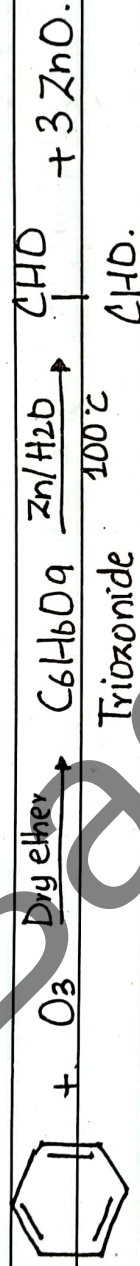
2- Combustion

- Burning of benzene in presence of O_2 .



3- Ozonolysis

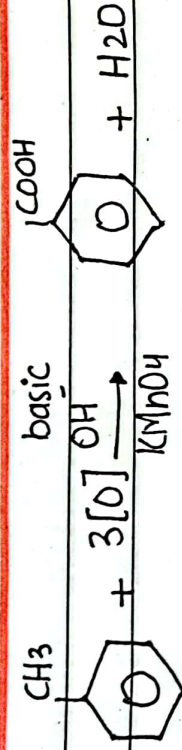
- produce glyoxal through trioxonide as intermediate.



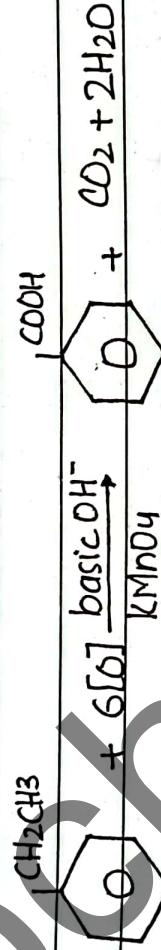
4- Oxidation of side rxn or identification test for alkyl benzene

- Benzene it self does not react with KMnO_4 or $\text{K}_2\text{Cr}_2\text{O}_7$.
- However, alkyl group present on benzene is oxidized to COOH .

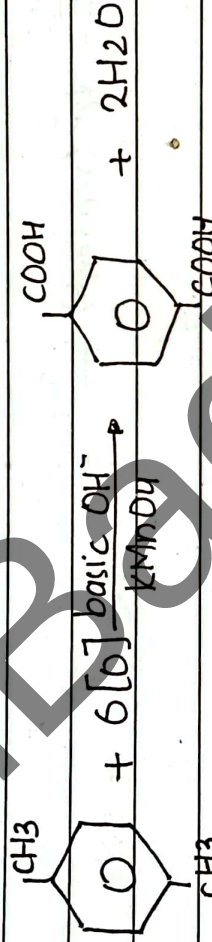
Date: _____



toluene



ethyl benzene



p-xylene

Terephthalic acid

benzene-1,4-dioic acid

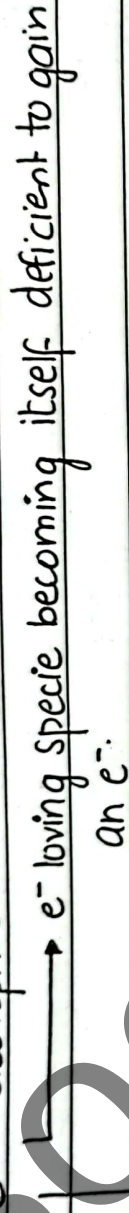
Substitution rxn

- for substitution rxn, we always need an electrophile.
- But the delocalized π e⁻ are so stable that they don't readily undergo rxn.
- Rather a weak electrophile won't work.
- We require a powerful electrophile for successful attack to penetrate the continuous sheath of e⁻ cloud.
- Substitution is preferred over substitution to preserve stable aromatic character.

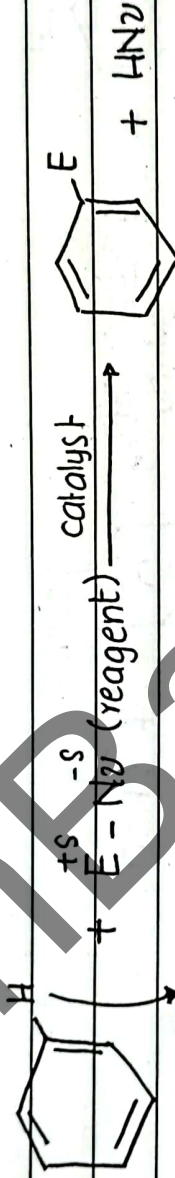
Date: _____

General rxn

E^+ = electrophile



Should be strong enough to act up resonance e^- .



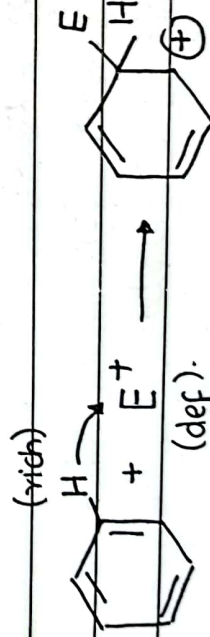
This gonna
replaced

Mechanism / Stereochemical evidence

Step 1: formation of electrophile

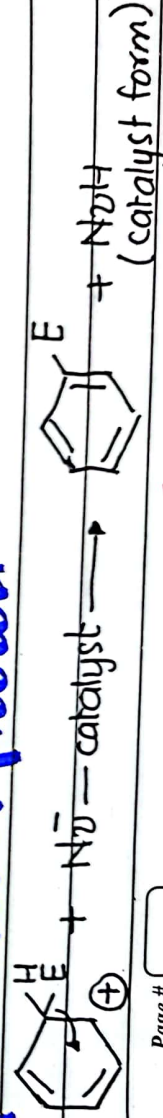


Step 2: attack of electrophile / phenonium ion



Phenonium / Arrhenium ion.

Step 3: loss of proton



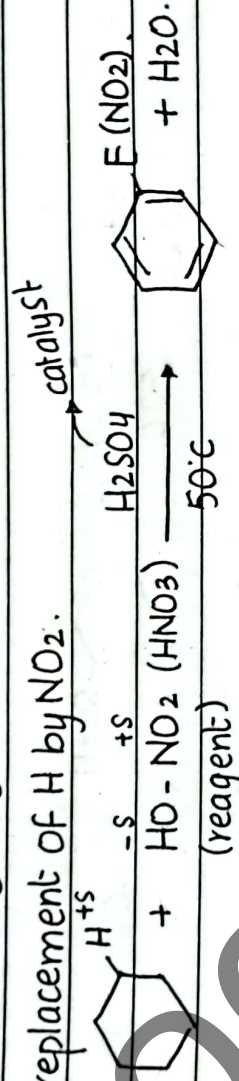
Page #

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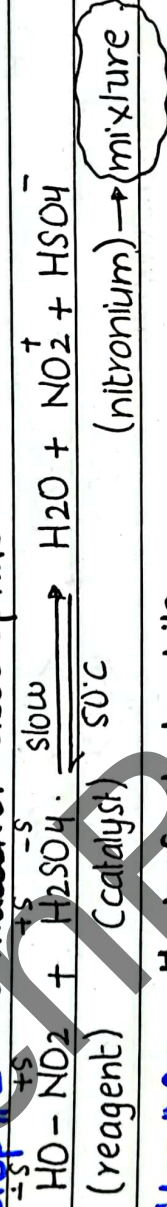
Date: _____

(1) Nitration

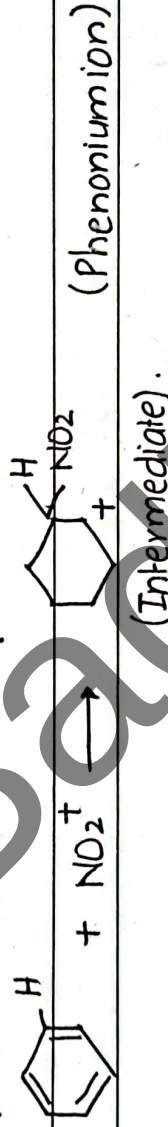
- replacement of H by NO_2 .



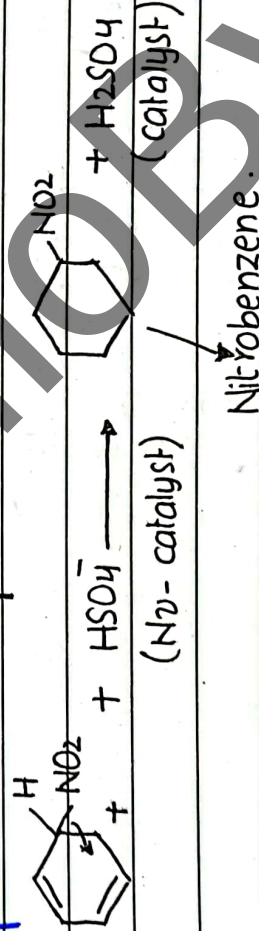
Step #1: formation of electrophile



Step #2: attack of electrophile



Step #3: Loss of proton

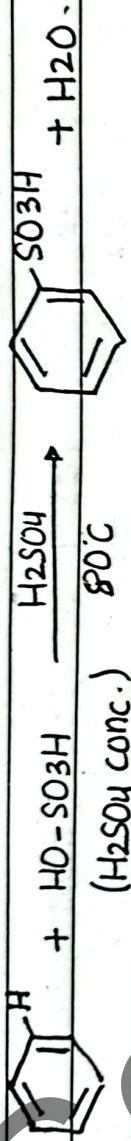


(2) Sulphenation

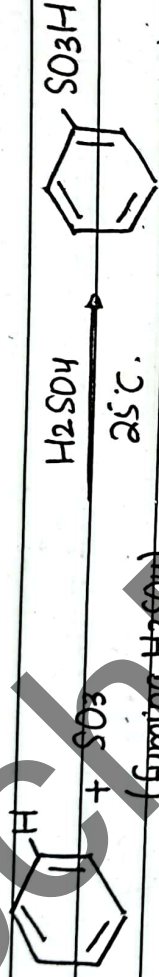
- Sulphonic acid group added
 - Benzene is heating with fume H_2SO_4 or conc. of H_2SO_4
- $\downarrow$
- gaseous H_2SO_4
- $\downarrow$
- highly reactive. $\rightarrow$ free sulphur trioxide

Date: _____

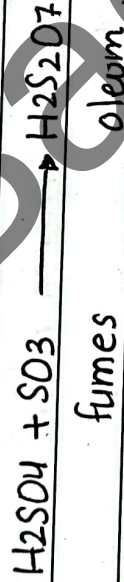
• HSO_3 (sulphonic acid).



Benzene Sulphonic acid

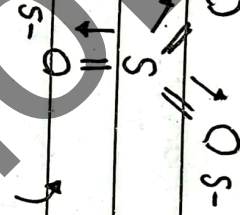
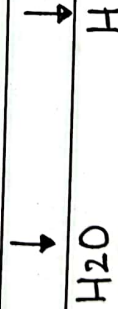


(fuming H_2SO_4)
more reactive

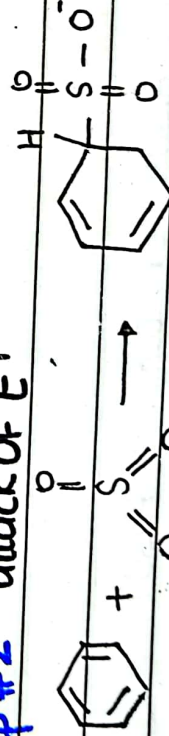


fumes

Step #1 Formation of SO_3 or E^+

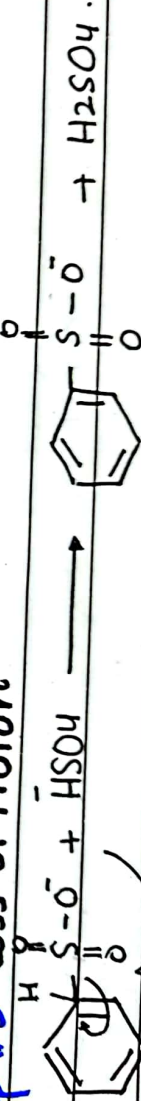


Step #2 attack of E^+



phenonium

Step #3 Loss of Proton



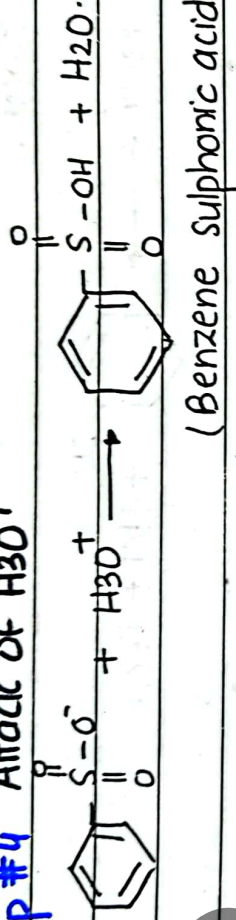
Page #



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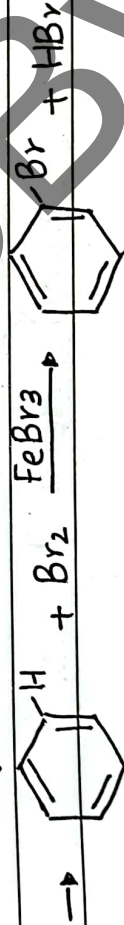
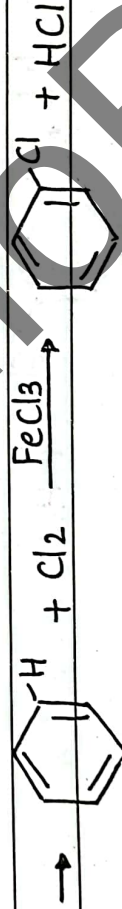
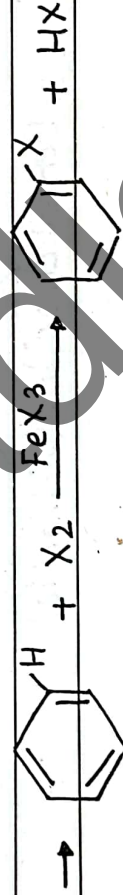
Date: _____

Step #4 Attack of H_3O^+

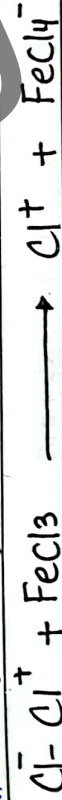


3 - halogenation

- The substitution of benzene to halide benzene in presence of Lewis acid catalyst.
- Substitution of halogen to benzene ring.
- Occurs in Presence of halogen (X_2).
- Cl_2 & Br_2 are frequently used than Fl_2 & I_2 due to their rxns.



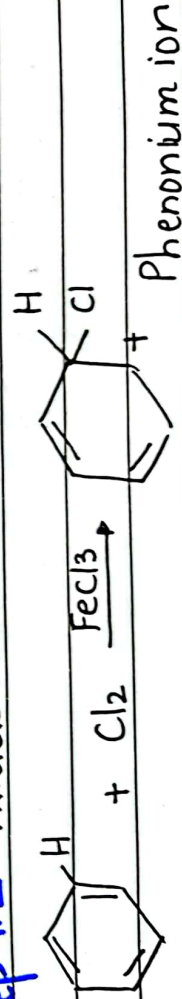
Step #1 formation of E^+



induced reagent catalyst
polar

NO - catalyst.

Step #2 Attack of E^+



Page #

Teacher's Signature: _____

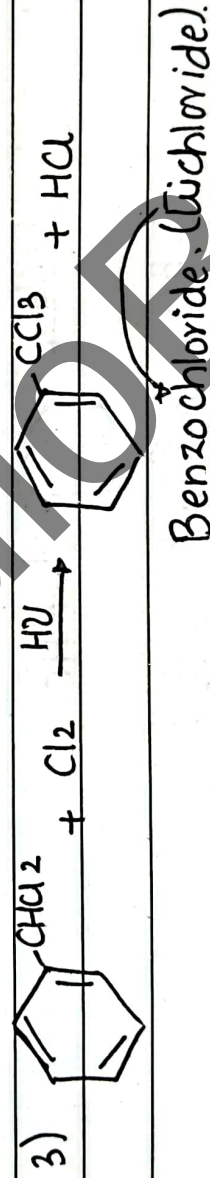
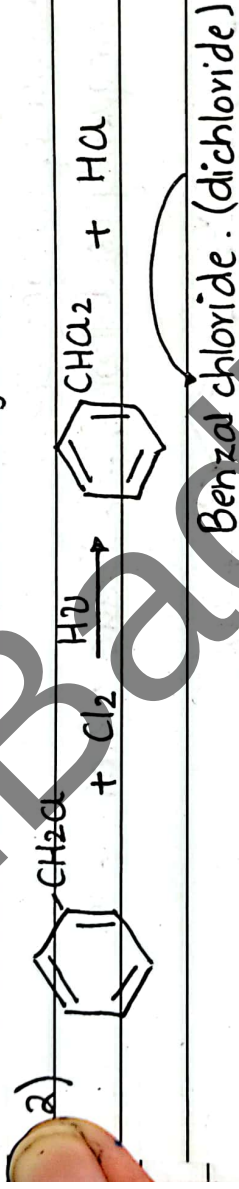
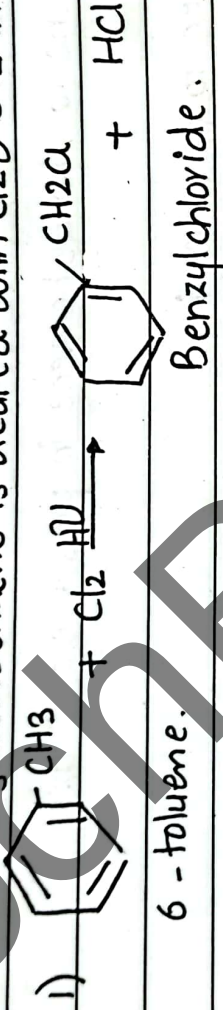
Date: _____

Step #43 Loss of Proton.



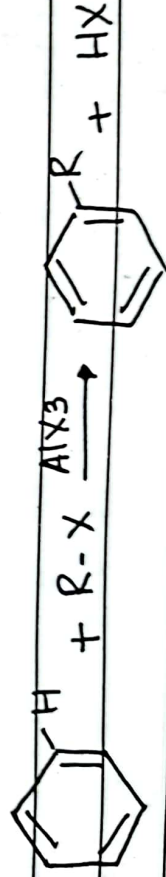
4- Halogenation of any side chain

When alkylated benzene is treated with Cl_2 & Br_2 in presence of H_2O .

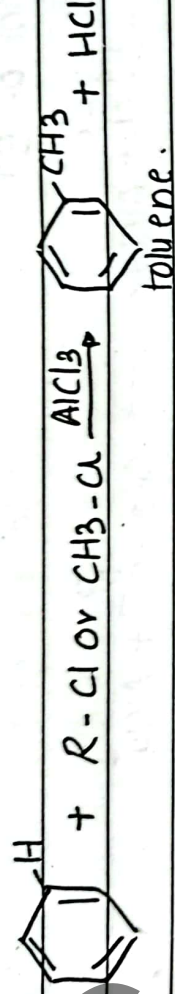


5) Friedel-Crafts alkylation

- Substitution of alkyl group in the benzene ring.
- In presence of AlCl_3 (Lewis acid catalyst).
- alkylated benzene form.



Date: _____



Step #1 Formation of E^+

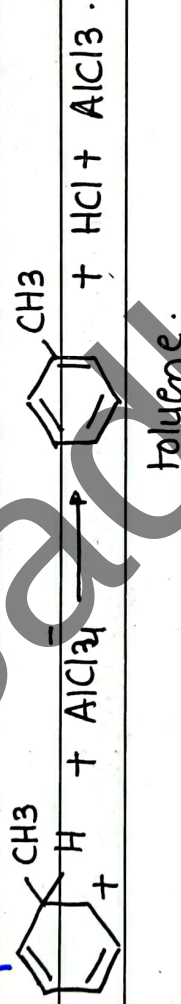


Step #2 attack of E^+



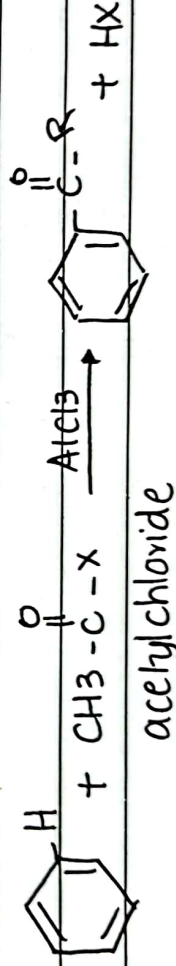
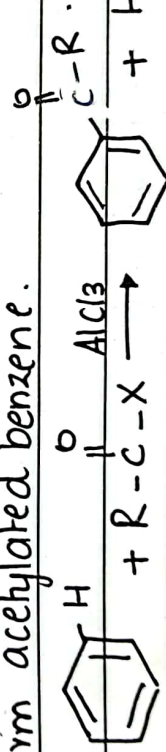
Phenonium ion

Step #3 Loss of H^+



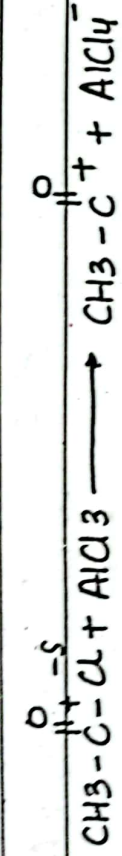
6- Friedel-Craft acylation

- The substitution of acyl group (RCO-) to benzene ring.
- In presence of Lewis acid catalyst AlCl_3 .
- form acetylated benzene.

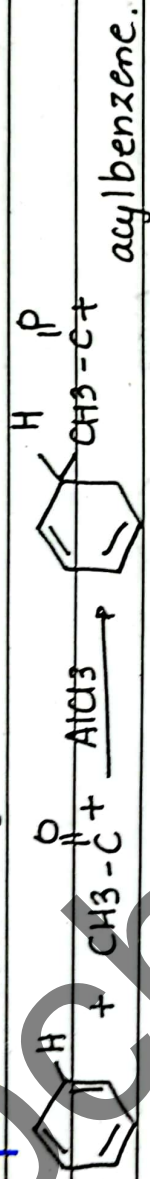


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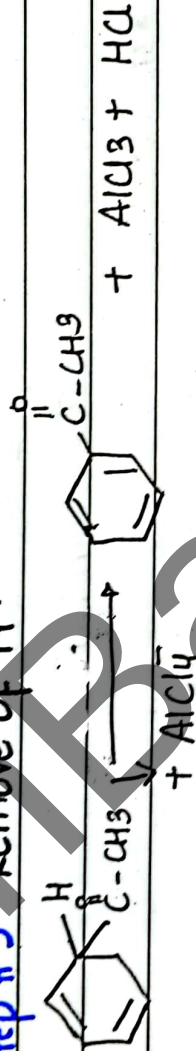
Step #1 Formation of E^+



Step #2 Attack of E^+



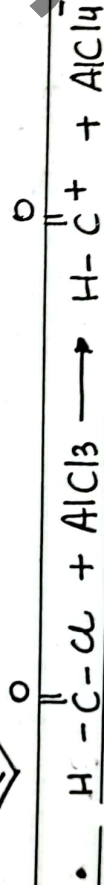
Step #3 Remove of H^+



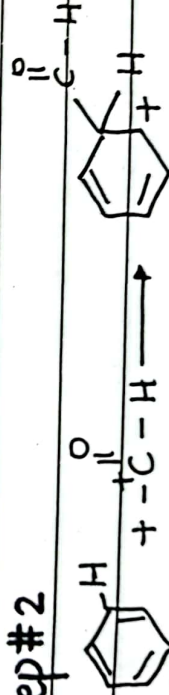
acylbenzene (methylphenyl ketone)

Convert formaldehyde to formaldehyde? or Benzene to formaldehyde?

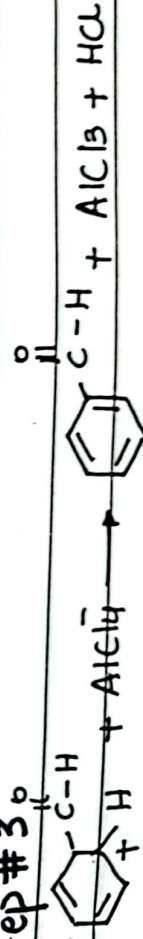
Step #1



Step #2



Step #3



Page #

Teacher's Signature: _____

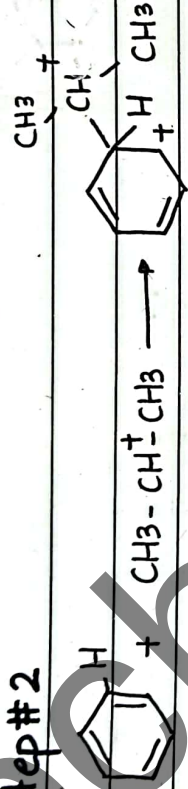
Date: _____

Convert benzene to Cumene?

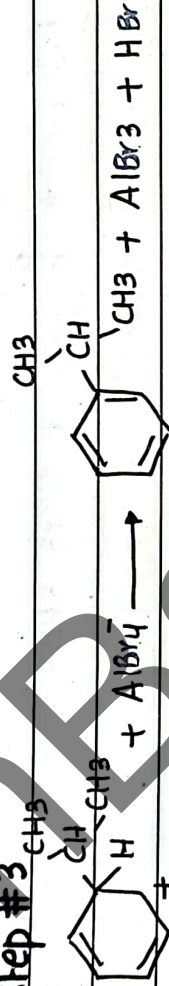
Step #1



Step #2



Step #3



Cumene

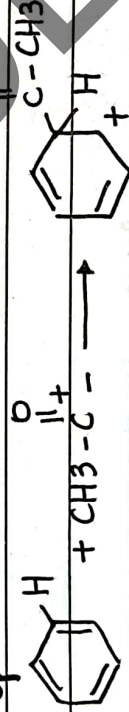
(isopropyl benzene).

Convert Benzene to acetophenone?

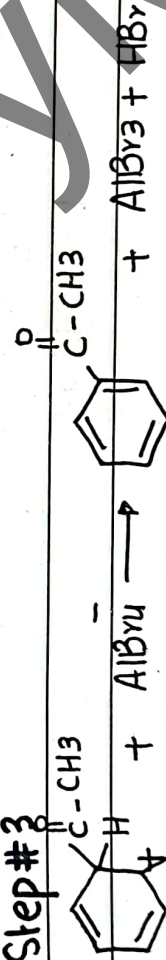
Step #1



Step #2



Step #3



acetophenone

(Methylphenyl ketone).

Page #

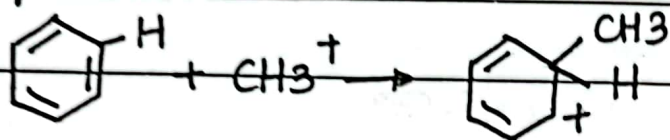
Teacher's Signature: _____

Convert benzene to toluene?

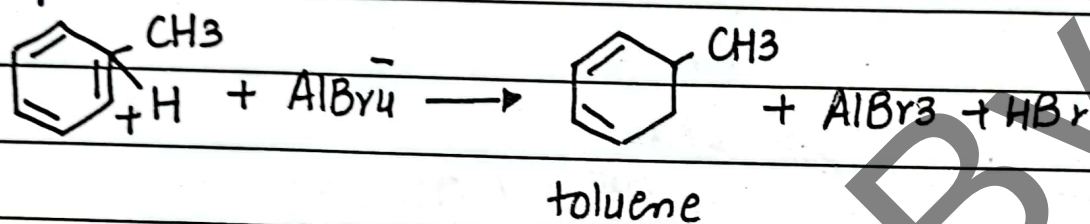
Step #1



Step #2

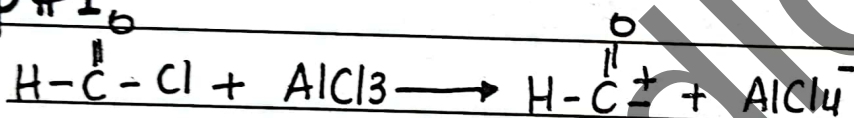


Step #3

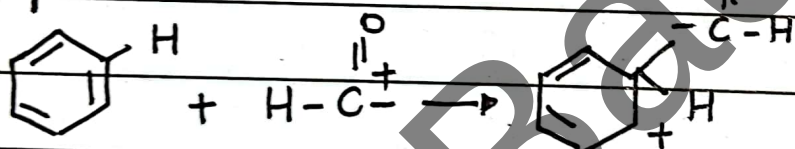


Convert benzene to benzaldehyde?

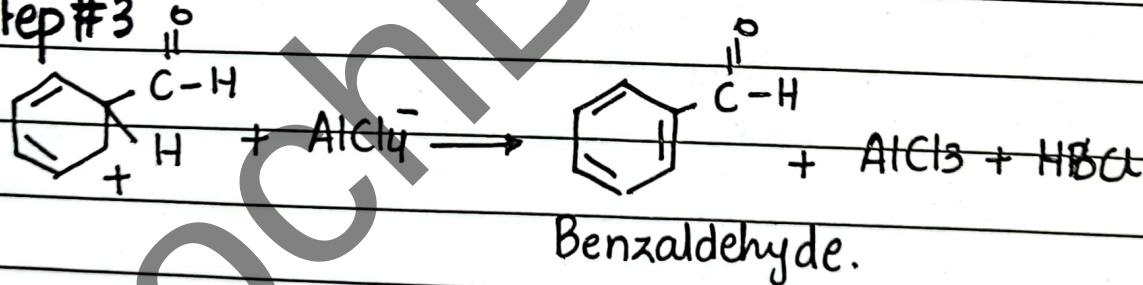
Step #1



Step #2

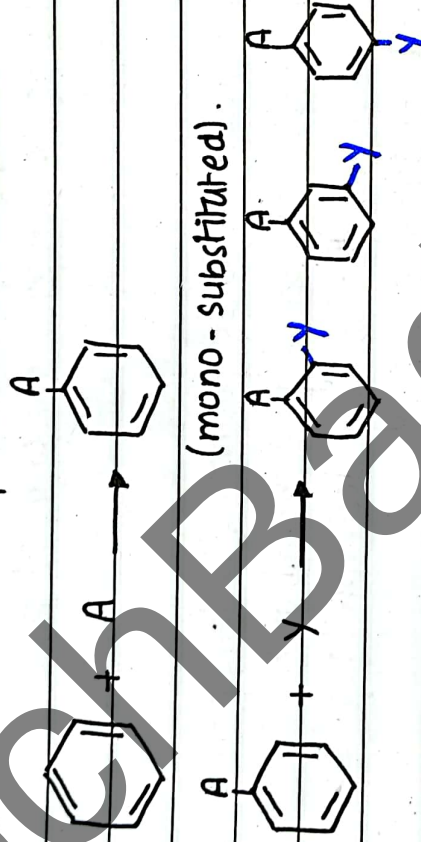


Step #3



Date: 29-08-24

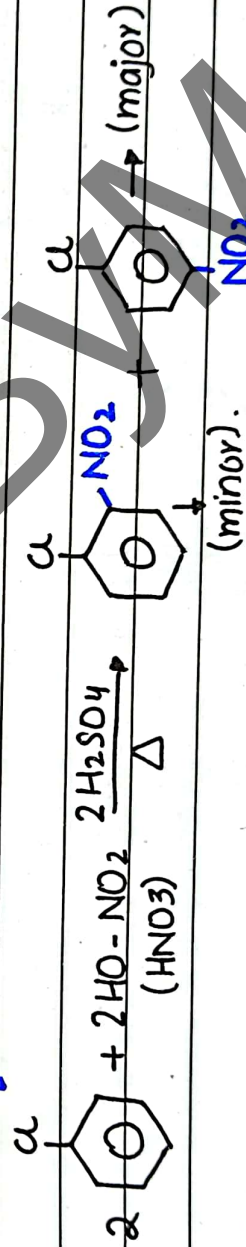
It is an effect that refers to how substituents on a benzene ring influence the position of an electrophilic substitution reaction.



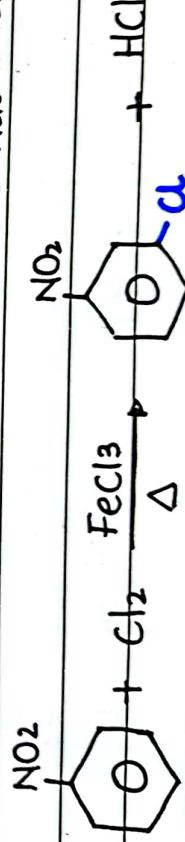
ortho 'o' meta 'm' para 'p'
(1,2) (1,3) (1,4).

→ On statistical basis, the proportion of disubstituted products would be:
 $O = 40\%$, $m = 20\%$, $p = 40\%$.

example



→ The nitration of chlorobenzene shows that it follows o-p distribution.



→ The chlorination of nitrobenzene shows it follows m-substitution.

Page #

Teacher's Signature: _____

→ These all example shows that mono-substituted grp will decide position of 2nd grp.

1- Ortho-Para directing group

The group which direct incoming groups to ortho-para position.

• These group are e^- donating to benzene making o&p position rich.

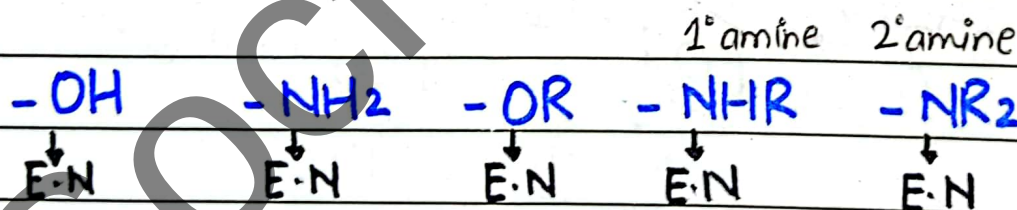
→ When any group got attached to 1st position, its lone pair will be transported to benzene and roaming all around ortho & para position due to delocalisation that's why electrophile gets attached to these e^- rich position.

rules

→ When group is made up of only 1 atom it will be always ortho & para directing group.

→ F, Cl, Br, I

→ When directly bonded atom has more E.N then 2nd group is also ortho & para.



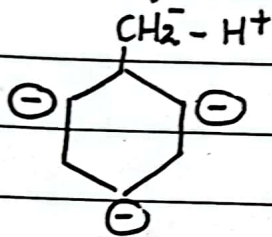
→ All groups are activators except halogen that is are partial activators due to their high electronegativity. that they do not want their all e^- to be lost or donated.

order

F, Cl, Br, I, -OH, -NH₂, -OR, -NHR, -NR₂, -R.

partial
activators

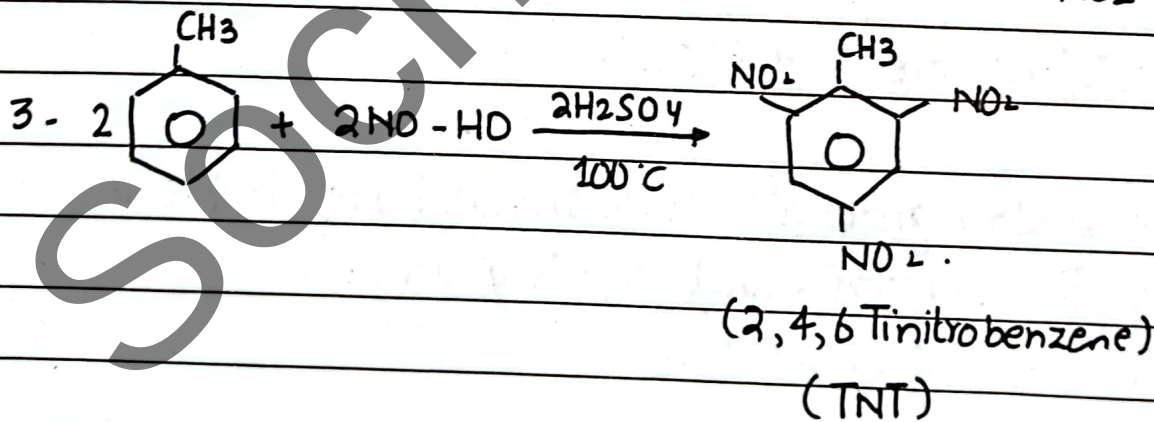
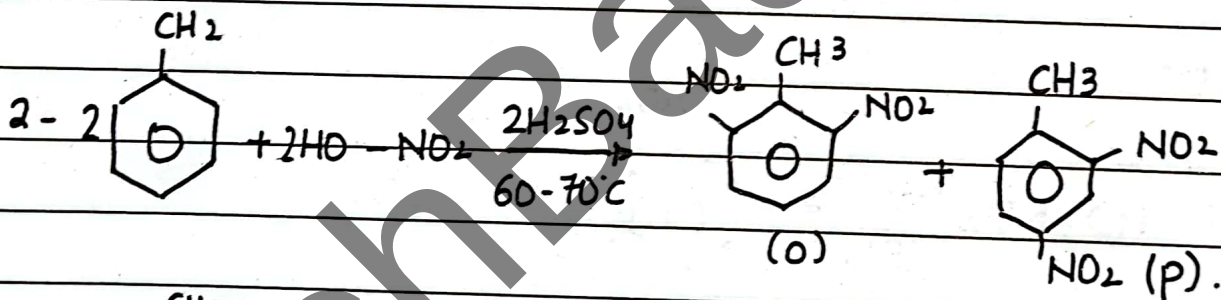
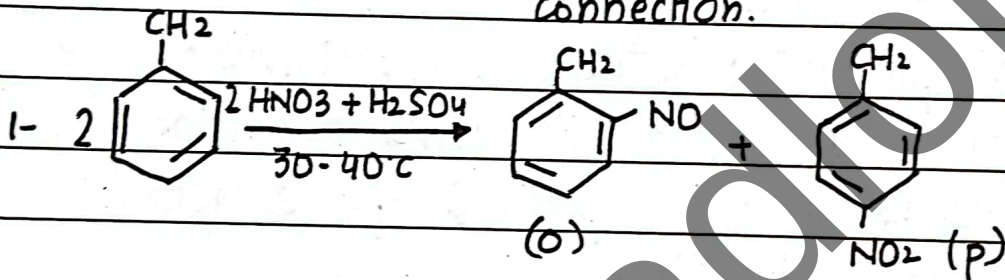
complete activators.

Example

hyperconjugation

S-orbital - p-orbital
e⁻ π bond

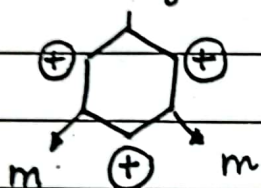
connection.



2. Meta-directing groups

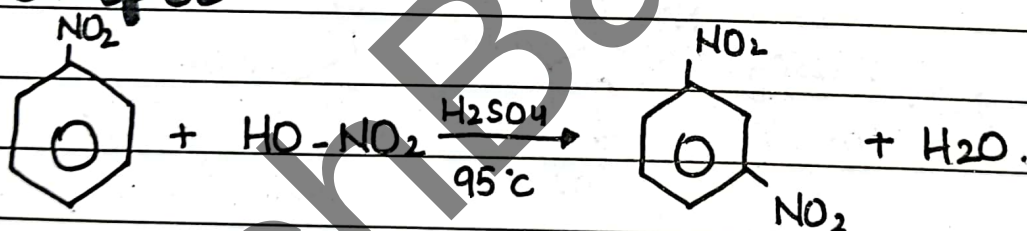
Groups which direct incoming groups to meta position is called meta-directing groups.

- These are electron withdrawing group, they attract e^- from benzene ring & benzene ring became e^- deficient.



- e^- deficiency occurs at ortho & para position, so only left place is meta, where electrophile attack.
- They either attract e^- , producing a temporary positive charge at ortho & para position, thus electrophile can't attract at these position due to repulsion. So, only place left is meta.
- They decrease the Benzene Activity.

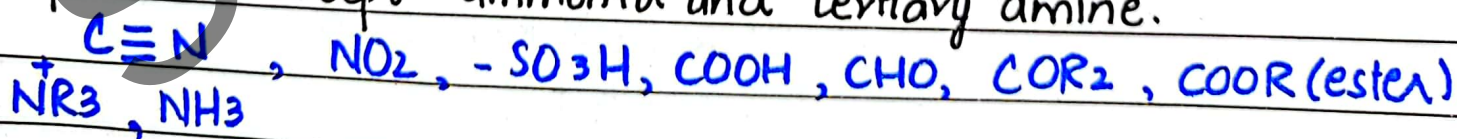
example



→ Ortho-para positions are e^- deficient.

rule

- 2 or more than 2 atom group atleast it should have double & triple bond except ammonia and tertiary amine.

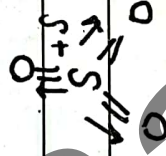


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- Directly bonded atom has less electronegativity than second and 3rd atom bonded to it.

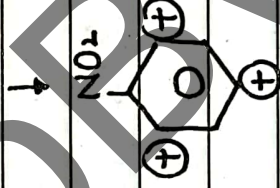
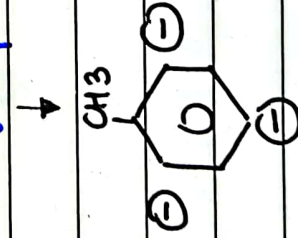


- If central atom is electron deficient, it will also act as meta directing group.



- all meta directing groups are complete deactivators.

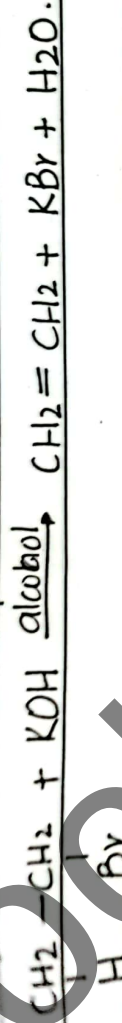
ortho-Para directing > Benzene > meta-directing group



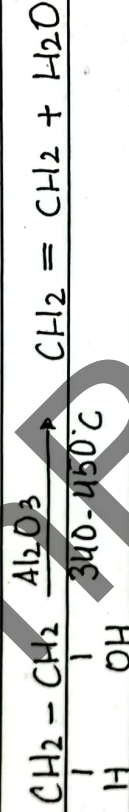
Date: 4.9.24.

alkyl halide:

Heating of bromoethane from alcoholic KOH.



alcohols:



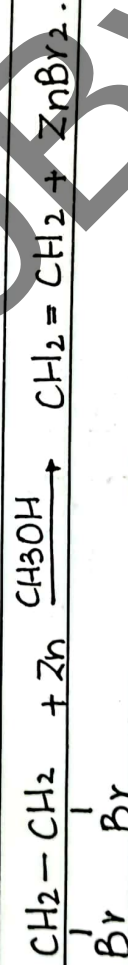
electrolysis of salt:

When aqueous sol of potassium salt of succinic acid is electrolyzed.

Reaction is called Kolbe's electrolysis.

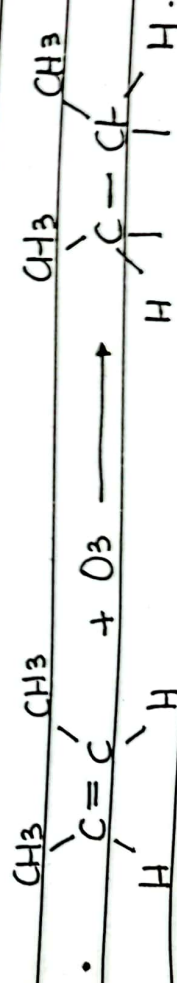
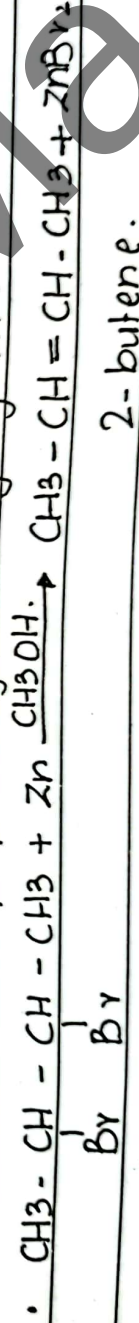


Vicinal-dihalides:



1,2-Bromoethane

3- First we need to prepare any alkene by any rxn.

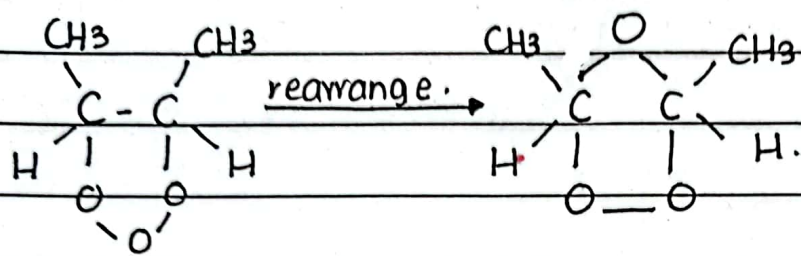


Cis-2-butene

monoxide.

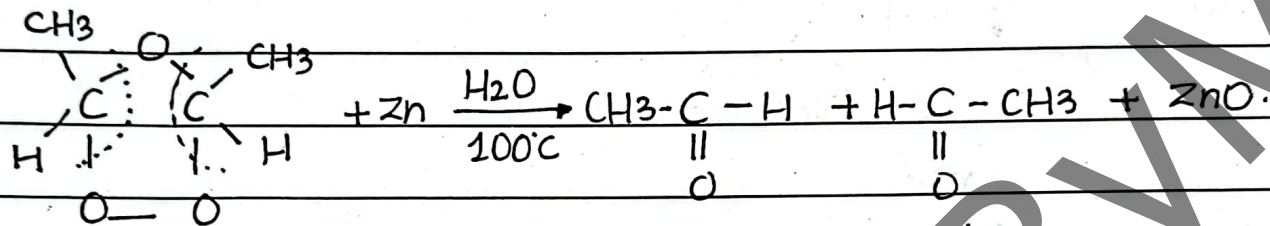
Page #

Date: _____



molozonide

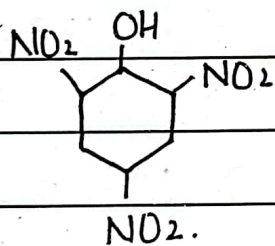
ozonide.



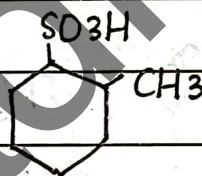
acetaldehyde.

Question 7

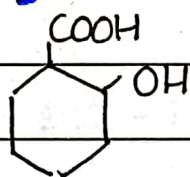
2,4,6-Trinitrophenol



2-methylbenzenesulphonic acid



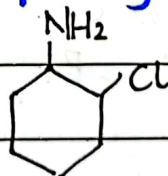
2-hydroxybenzoic acid



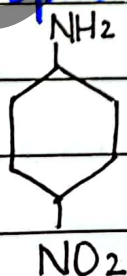
1,4-dichlorobenzene



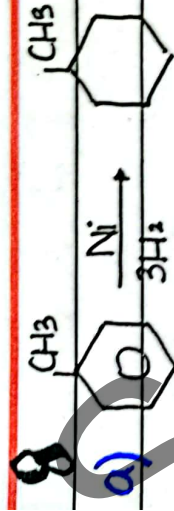
2-chlorophenylamine



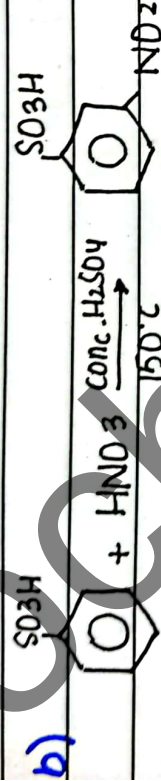
4-nitrophenylamine



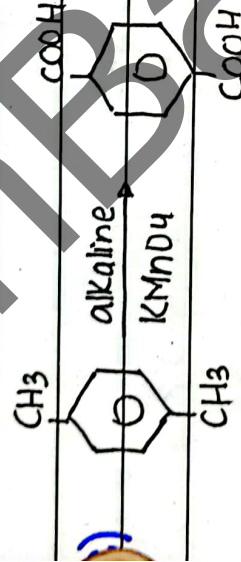
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toluene 1-Methylcyclohexane

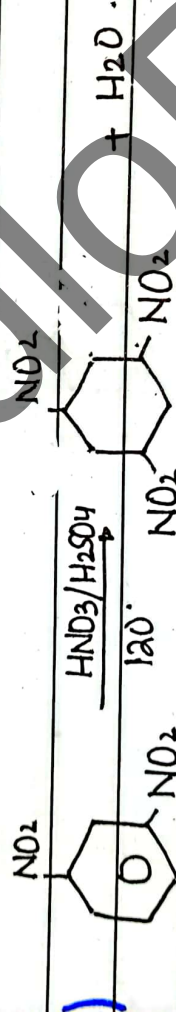


3-Nitrobenzenesulphonic acid

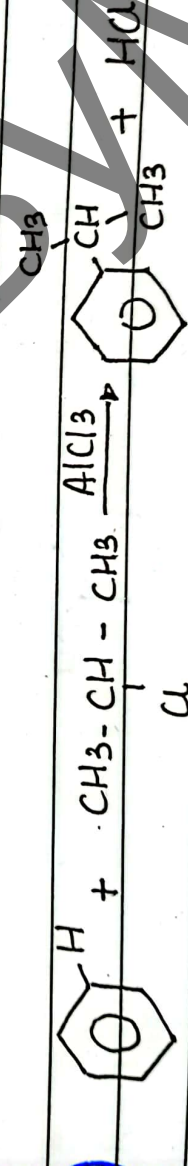


p-xylene

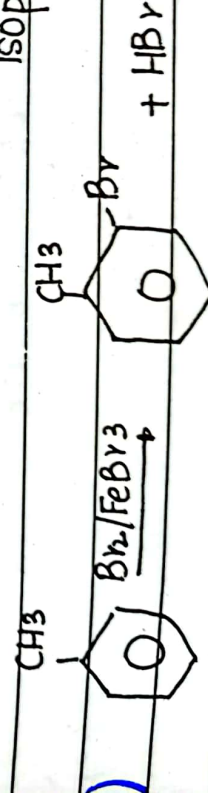
ter-Phthalic acid



1,3,5-Trinitrobenzene



isopropylbenzene / Cumene



toluene

o-bromotoluene

9-

- a) 1, 3- Dibromobenzene
- b) 2- Ethyl toluene , ~~1, 3~~-Dimethylbenzene.
- c) 1, 2, 3- Trimethylbenzene.
- d) 5- Bromo - 3- Chloronitrobenzene.
- e) 5-nitrobenzoic acid
- f) 3- chlorophenol.

1- Why organic compound are diverse in nature?

Organic compounds are diverse in nature because of the ability of carbon atom to make stable bonds, Long chains, rings and complex structures due to their catenation property with single, double & triple bonds.

2- How many carbon can combine (max?)

There's no limit. Their catenation property makes them possible to form longest possible chain.

3- Is saturated comp more stable than unsaturated?

Single bond is present in saturated compounds which contains single electrons that's are very strong to be broken down whereas unsaturated comp contains σ & π e^- leading to less stability.

Why benzene is aromatic?

Huckle Rule:-

$$4 + 2 = 6e^-$$

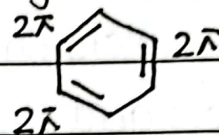
If $n =$ whole digit, then comp is aromatic & obeys rule.

$$4 + 2 = 6e^-$$

$$4n = 6 - 2$$

$$4n = 4$$

$$n = 1.$$



thus, it's an aromatic comp.

Why straight chains have higher boiling point?

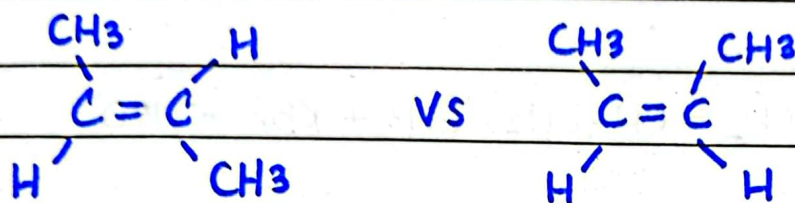
Straight chains have higher boiling points as they can pack closely together leading to strong inter-molecular forces compared to branched chains. This requires more energy to break interaction & transition among substances.

Why chlorine can't be reacted in presence of diffused light but bromine can do so in direct and diffused light?

Chlorine requires less energy due to dissociate into reactive chlorine radicals compared to bromine which means it can readily under broader range of light conditions. On the other hand, bromine requires more energy to initiate the rxn.

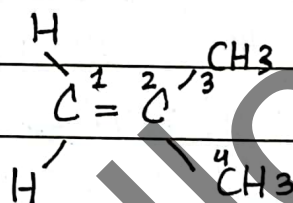
Why trans are more stable than cis?

It's because 2 bulky groups lie on an opposite side of double bond so steric repulsion is less (in trans) & dipole moment is zero than cis.



Why 1-butene does not form cis and trans isomerism?

1-butene :-

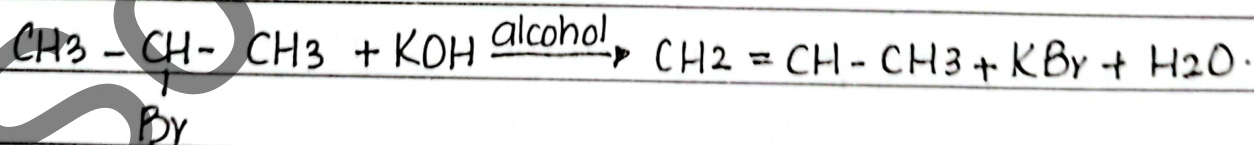


It does not form cis and trans because double bond is present between first and second carbon, each carbon atom involved must have 2 different groups attached whereas 1-butene 1st carbon is to 2 same H-groups.

How will you prepare alkene from dehydrohalogenation?

We know remove the halogen group from an alkyl halide :-

example:-



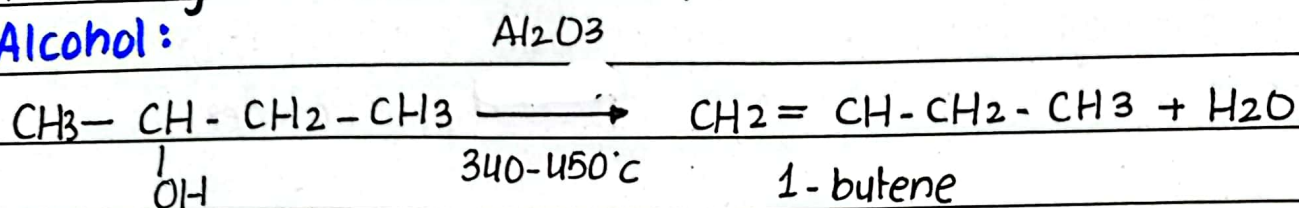
Write 2 methods for prep of alkene.

We can prepare alkenes by :-

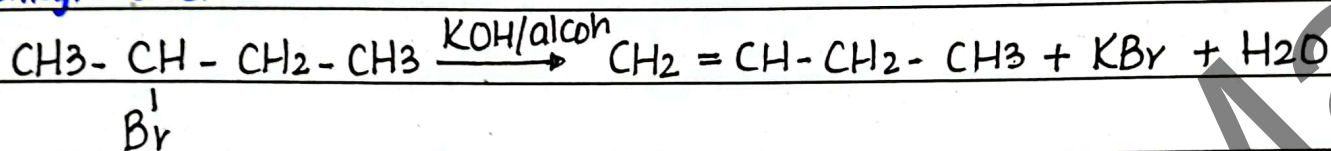
- dehydrohalogenation of alkyl halides
- Dehydration of alcohol.

How will you obtain 1-butene from - alcohol & - alkyl halide?

Alcohol:



alkyl halide:

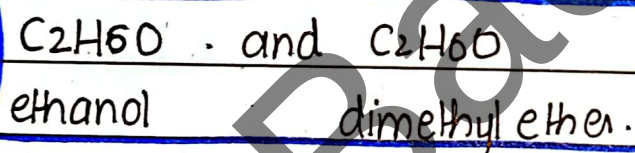


Difference b/w Position and functional group isomerism?

In position isomerism, there's the same functional group present by their position or arrangement is diff.



Whereas in functional group isomerism, there's no concerned with position but there's change in isomerism.



How is halogenation a test for Saturation?

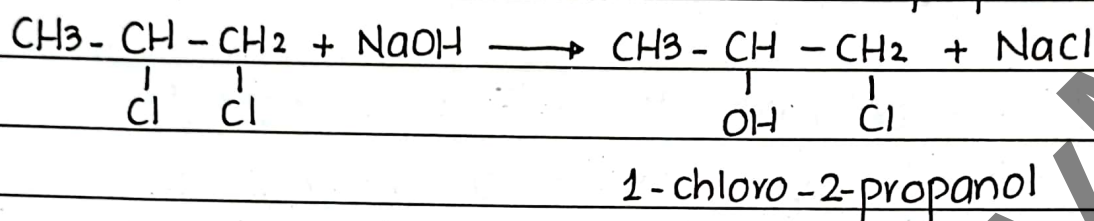
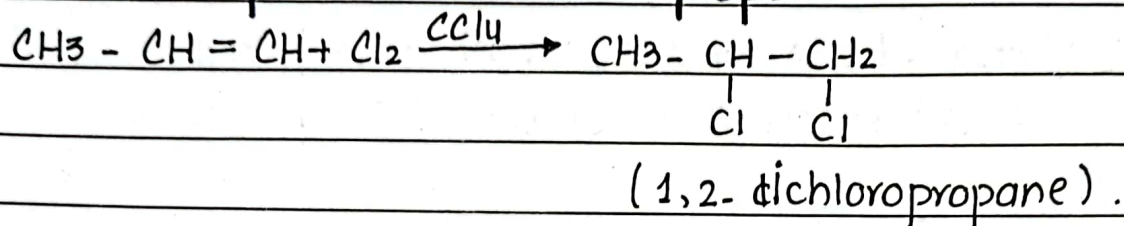
Yes, it's test for saturation.

→ **Positive:** The color of halogen solution (orange, red) disappears in reaction with unsaturated comp.

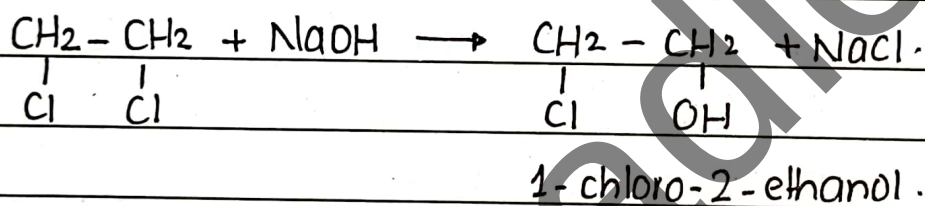
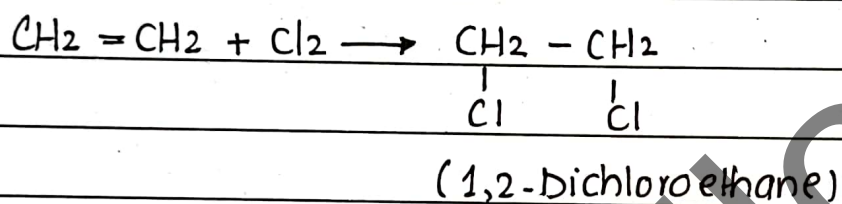
→ **Negative:** In reaction, with saturated comp it does not change color because there's no reaction.

Date: _____

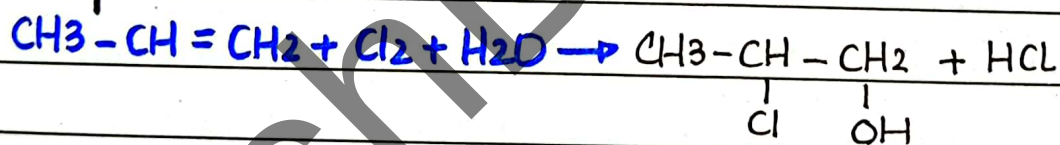
Convert Propene to 1-chloro-2-propanol.



Convert 2 Ethene to 2 chloroethanol.



Complete the rxn:



Trick for Ozonolysis mcq

- Alkene in which = bond carbon has branch, will surely form branch.
- Alkene in which = double bonded carbon has no branch will surely form aldehyde.

1-butyne is more acidic than 2-butyne?

The position of triple bond - triple bond is present at terminal position in 1-butyne thus it's terminal alkyne while 2-butyne is an internal alkyne.

How we can distinguish between ethene and ethyne sol.

Ethene does not react with cuprous chloride and no precipitate is formed. On the other hand, ethyne reacts with cuprous chloride to form red precipitate.

How we can distinguish between 1-pentyne and 2-pentyne.

1-pentyne has a terminal alkyne group which reacts with ammoniacal cuprous chloride & forms red precipitate. 2-pentyne does not react with cuprous chloride, they're no precipitate forms.

Why alkanes are less reactive?

Alkanes are less reactive because they have strong carbon to carbon and carbon & hydrogen. Single bonds are relatively stable and non-polar.

Why alkanes are called Paraffins?

They are called Paraffins because the name **Parum affins** - Latin word meaning **little affinity**. This term reflects their low reactivity.

Why alkenes are called olefins?

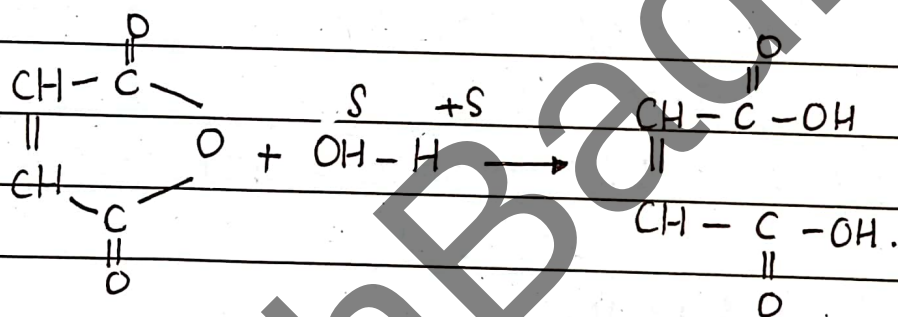
The alkenes are called so because lower members of series react with chlorine to form oily product. The term **olefins** was derived from **Original French 'Gaz oléfiant'** which means **oil forming gas**.

Why Benzene is stable?

Benzene is a stable compound due to :-

- Delocalization of π bonds
- 5 Resonance Structure.
- high resonance energy (152 kJ/mol)

Write formula of Maleic acid.



Why there's a need of strong electrophile.

A strong electrophile is needed because benzene is highly stable due to its aromaticity to disrupt this stability and allow alkyl group to attach the alkyl halide must be converted into a stronger electrophile (a carbocation). This strong electrophile then reacts with benzene ring allowing substitution.

Difference b/w ortho-para & meta groups.

ortho-para groups

meta groups

definition

The groups which direct the incoming electrophile towards ortho & para positions.

The groups which direct the incoming electrophile towards meta positions.

activity

Makes activity greater.

Makes activity reduced.

specie

electron-rich specie.

electron-deficient specie.

atoms

The electrophile have 1 atom.

The electrophile have 2 or more atoms.

E.N.

Directly bonded atom have more E.N.

Directly bonded atom have less E.N.

Reactions

Activators rxn.

Deactivators rxn.

example

OH, NH₂, OR, NHR, NR₂

CN, NO₂, NR₃, NH₃, SO₃H etc.



Exercise

1: Select the right answer from the choices given with each question

- i. The molecule of ethane possesses which hybridization;
✓ a. sp^3 b. sp^2 c. sp d. sp^2d
- ii. The sp^2 hybrid orbitals are oriented in space at one angle;
a. 109.5° b. 180° c. 100° d. 120° ✓
- iii. The geometry of acetylene is,
a. angular b. bent c. trigonal d. linear ✓
- iv. Which reaction is used as test for the presence of alkene;
✓ a. reaction of cold diluted alkaline $KMnO_4$ b. Combustion
c. Polymerization d. Catalytic hydrogenation
- v. The general formula of alkane is;
✓ a. C_nH_{2n+2} b. C_nH_n c. C_nH_{2n} d. C_nH_{2n-2}
- vi. Sodalime is;
a. NaOH b. KOH c. Mixture of Na and Ca hydroxide d. CaO and NaOH ✓
- vii. The marsh gas is
a. Ethane ✓ b. Methane c. Propane d. Butane



- viii. Acidic hydrogen is present in
 a. Acetylene ✓ b. Ethane c. Benzene d. Ethene
- ix. The electrophile in aromatic sulphonation is;
 a. H_2SO_4 b. HSO_4^- c. SO_3 ✓ d. SO_4
- x. Catalyst used for Friedal Craft's reaction is;
 a. HNO_3 b. MgCl_2 c. BeCl_2 ✓ d. FeCl_3
- xi. Benzene can not undergo
 a. Elimination ✓ b. Substitution c. Oxidation d. Addition
- xii. Shape of benzene molecule is
 a. Pyramidal b. Liner planar c. Trigonal ✓ d. Hexagonal
- xiii. The isomers of a substance must have
 (a) same chemical properties (b) same molecular weight ✓
 (c) same structural formula (d) same functional groups
- xiv. Ethanol and dimethyl ether are best considered:
 (a) structural isomers ✓ (b) stereoisomers (c) enantiomers (d) diastereomers
- xv. Alkenes show geometrical isomers due to
 (a) asymmetry (b) rotation around a single bond
 (c) resonance (d) restricted rotation around a double bond ✓
- xvi. Geometrical isomerism is shown by
 (a) lactic acid (b) maleic acid ✓ (c) 1-butene (d) 1,1-dichloroethylene
 $\text{C} \equiv \text{C}$
- xvii. A molecule is said to be chiral
 (a) if it contains plane of symmetry (b) it contains center of symmetry
 (c) if it cannot be superimposed on its mirror image ✓
 (d) if it can be superimposed on its mirror image
- xviii. Which of the statements is false regarding chiral compounds
 (a) rotate the plane of polarized light (b) have cis and trans isomers ✓
 (c) exist as enantiomers (d) can be detected with a polarimeter
- xix. An optically active compound
 (a) must contain at least four carbons
 (b) when in solution rotate the plane of polarized light
 (c) must always contain an asymmetric carbon atom ✓
 (d) in solution always give a negative reading in polarimeter
- xx. Plane polarized light is affected by
 (a) identical molecules (b) all polymers
 (c) chiral molecules ✓ (d) all biomolecules
- xxi. It is possible to distinguish between optical isomers
 (a) by using chemical tests (b) by mass spectrometry
 (c) by IR spectroscopy ✓ (d) by polarimetry ✓

2. Answer the following questions briefly.

1. What is cis-trans isomerism?
2. Why alkanes are relatively chemically inert? ✓
3. Alkenes usually undergo addition reactions while alkanes do not why? ✓

rotate
plane
polarize
light