DATE:

HYDROCARBONS

1. Differentiate b/w open & close chain hydrocarbons.

Open chain	Closed chain
→ Chain of hydrocarbons is non-cyclic.	→ Chain of hydrocarbons is in cycle or ring form.
→ All aliphatic hydrocarbons have open chain.	→ All aromatic hydrocarbons have closed chain.
→ Paraffins, alkynes	→ Benzene, cyclohexane.

2. Differentiate b/w saturated & unsaturated hydrocarbons.

Saturated	Unsaturated
→ Carbon atoms have single bonds	→ Carbon atoms have double or triple bonds
→ Chemically less reactive	→ Chemically more reactive
→ Only alkanes	→ Alkynes & alkenes
$CH_3 - CH_2 - CH_2 - CH_3$	$CH_2 = CH - CH_2 - CH_2 - CH_3$

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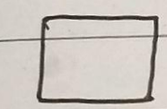
3. Compare alicyclic & aromatic hydrocarbons:

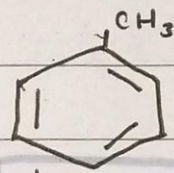
Alicyclic hydrocarbons	Aromatic hydrocarbons
→ Non-benzenoid cyclic hydrocarbons.	→ Hydrocarbons which contain atleast 1 benzene ring.
→ Can be saturated or unsaturated	→ Mostly saturated
→ Have no aroma	→ Have an aroma



~~cyclopentane~~ cyclobutane

cyclopentane

benzene



toluene

4. Give (3) physical properties of alkanes:

Physical properties:

→ Methane to butane is all colourless & odorless gases, pentane to heptadecane is colourless odorless liquids & the rest are solids

→ Alkanes only dissolve in non-polar solvents.

→ The MP & BP increase with increase in number of C-atoms but solubility decreases with increase in mass.

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5. Describe the reactivity of alkanes.

Reactivity of alkane:

Alkanes & paraffins are inert towards acids & reducing agents under normal conditions.

Explanation:

This reactivity can be explained by the help of inertness of σ bond & non-polar bonds.

1. **Inertness of σ bond:**

The electrons are held ~~by~~ tightly. Alot of energy is required to break these bonds. So alkanes are less reactive.

2. **Non-polar bonds:**

The electronegativity of carbon & hydrogen do not differ and the bonding e- b/w C-H & C-C are equally shared making them almost non-polar. Compounds like alkalis have no reaction with alkanes.

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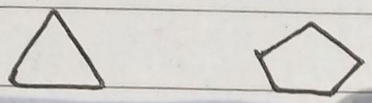
6. What are cycloalkanes ?

Cycloalkanes:

→ Contains only sp^3 hybridized C & H atoms connected by single bonds.
→ General formula is $C_n H_{2n}$

Example:



cyclo-pentane | cyclo-pentane.

7. Give the physical properties, reactivity & bond fission of cycloalkanes.

1. Physical properties:

→ Cycloalkanes have very weak london dispersion forces b/w them which can be easily broken.
→ Have low MP & BP.

2. Reactivity:

Cycloalkanes are not very reactive due to the bonds b/w C-H & C-C which are very weak.

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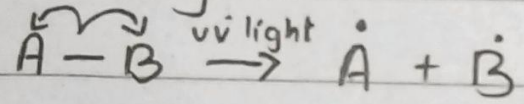
3. Bond - fission:

There are 2 ways to break covalent bonds.

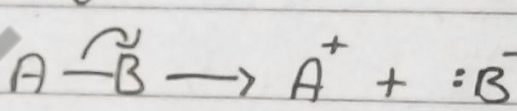
Homolytic fission:

When each of the two bonded atoms acquires one of the bonding e^-.

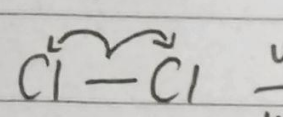


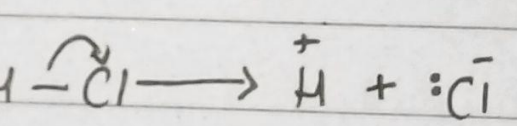
Heterolytic fission:

When one of the bonded atoms gets both of the bonded e^-.



Example:





8. What is halogenation reactions? Also explain it's mechanism.

Halogenation reaction:

→ Substitution of halogen to an alkane gives an alkyl halide.

$$R\text{-}H + X\text{-}X \xrightarrow{\text{sun light}} R\text{-}X + HX$$

$$CH_4 + Br_2 \longrightarrow CH_3Br + HBr$$

→ Only chlorination & Bromination are used.

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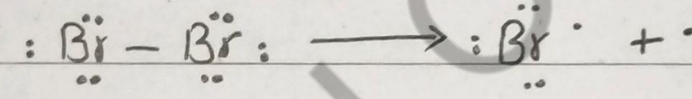
Mechanism of halogenation/photochemical reaction:

The mechanism consists of the following steps:

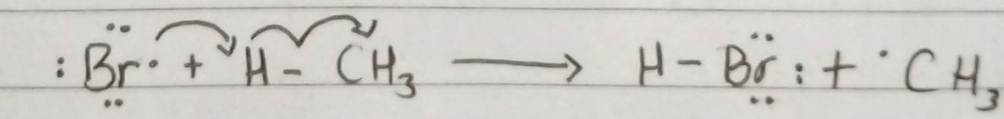
Step - 1 (initiation):

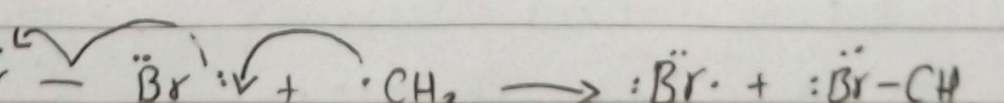
Sunlight causes the weak bonds to go under homolytic cleavage to generate 2 bromine free radicals.



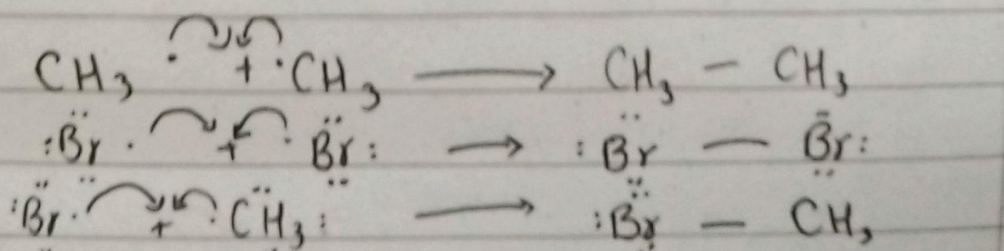
Step - 2 (propagation):

The Br free e⁻ attacks H atom of methane to form HBr and methyl free e⁻. Which then attacks another Br_2 molecule to form the methyl bromide product & a free radical.





Step - 3 (Termination):



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9. Explain isomerism & differentiate b/w it's two types.

Isomerism:

Compounds having same molecular formula but different chemical structures are called isomers. And this phenomenon is isomerism.

Stereoisomerism	Structural isomerism
→ Have same bonding patterns.	→ Have different bonding patterns.
→ Includes geometric isomerism.	→ Includes chain isomerism.
→ Occurs due to different spatial arrangements.	→ Occurs due to differences in bonding patterns.

10. What is chiral center & what are carbon based chiral center.

Chiral center:

It means that these objects don't have any symmetry, aka asymmetrical.

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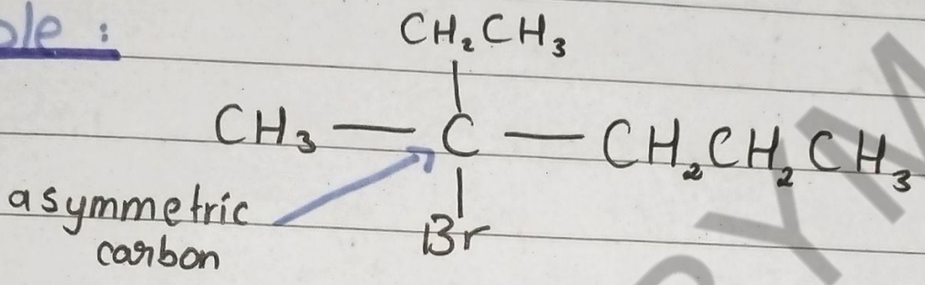
Carbon - based chiral centers:

A carbon atom which is bonded to 4 different atoms or group of atoms is called an asymmetric carbon or chiral carbon.

Example:



Molecules containing asymmetrical carbon is called asymmetric, or dissymmetric

11. What is optical isomerism?

Optical isomerism:

An optically active compound can exist in two isomeric forms which rotate the plane of polarized light in opposite directions. There are called optical isomers & the phenomenon is called optical isomerism.

→ Isomers that rotate clockwis are dextrorotatory or (+) isomers.

→ Isomers that rotate anticlockwise are levorotatory or (-) isomers.

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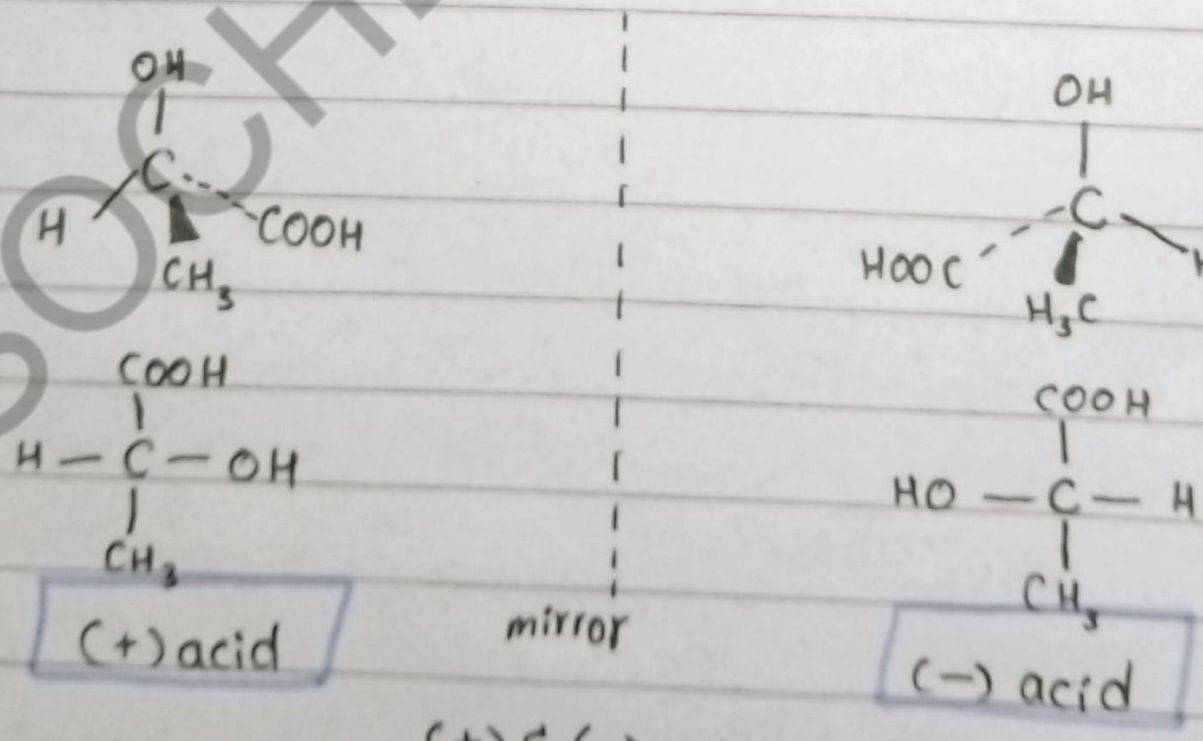
12. Explain optical isomerism of tartaric acid & lactic acid.

Optical isomerism of lactic acid:

→ Lactic acid is an example of optical isomerism compound.
→ It has 1 asymmetric carbon atom
→ 2 3D structures are observed & they aren't identical.
→ It's an enantiomer because the structures can't be superimposed.
→ 1(+), 1(-) & 1(+,-) forms are observed.



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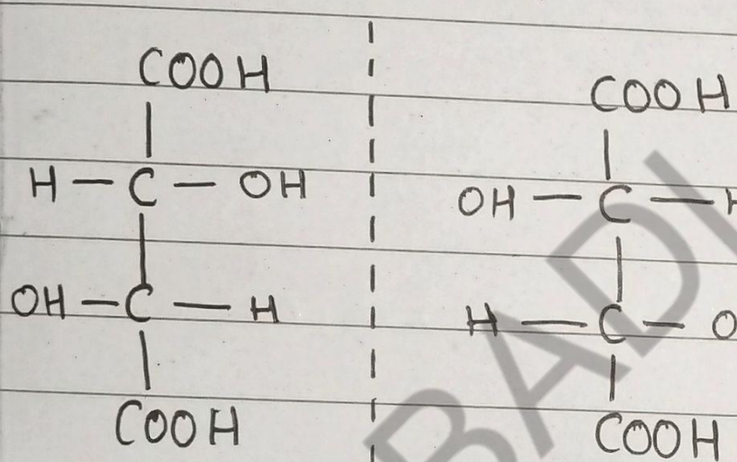
Optical isomerism of tartaric acid:

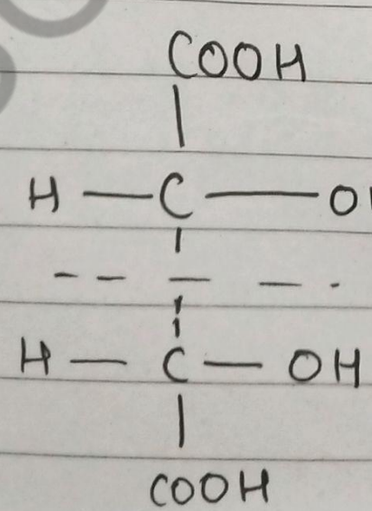
Tartaric acid contains 2 asymmetric C-atoms
Four isomeric forms of tartaric acid are known.

(+) Tartaric acid: It rotates clockwise
(−) Tartaric acid: It rotates anticlockwise
(±) Tartaric acid: It's optically inactive.
Meso-tartaric acid: Has symmetry but optically inactive.



(+) acid (−) acid

optically active



meso-acid

(±) acid
mix of (+) & (−)

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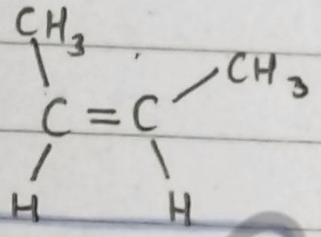
13. Define cis & trans isomer & explain their interconversion.

Cis-isomer:

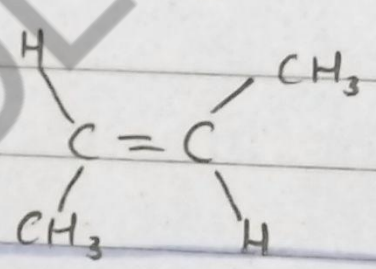
One in which two-similar groups are on same side of double bond.

Trans-isomer:

One in which two-similar groups are on different sides of double bond.



cis-2-butane



trans-2-butane

Interconversion of cis-trans isomers:

→ It's only possible when isomer is heated to high temp which breaks the pi bond.

trans isomer are more stable than cis isomer because the groups are equally balanced & are far apart.

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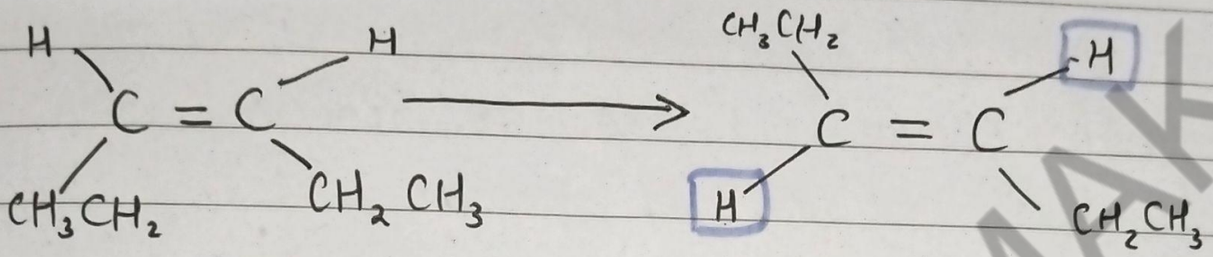
14. Explain if 3-hexene shows geometrical isomerism.



cis-3-hexene

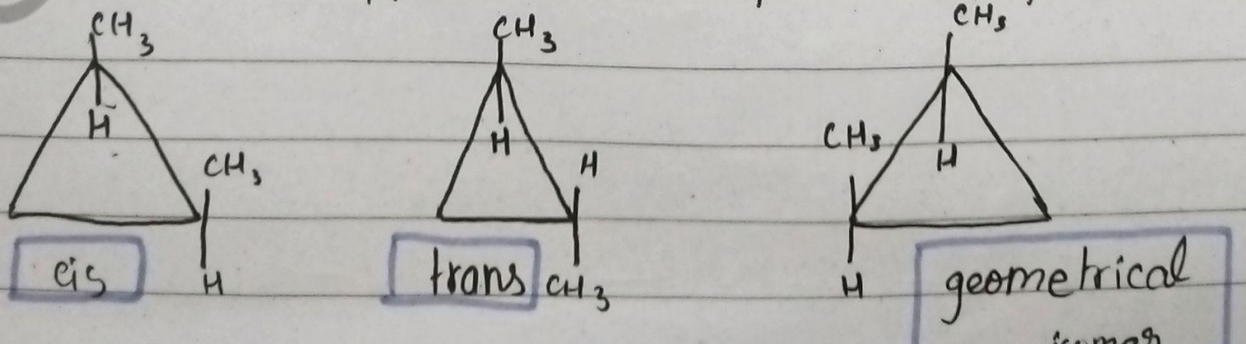
trans-3-hexene

Since carbon atom is on two different groups, 3-hexene has geometrical isomerism.

15. Is geometrical isomerism possible in cyclic compounds? Explain with example.

Geometrical isomerism occurs in cyclic compounds & it can be explained by using 1-2, dimethylcyclopropane.

In cis form 2 methyl groups are on same side & on opposite sides for trans form.



cis

trans

geometrical isomer

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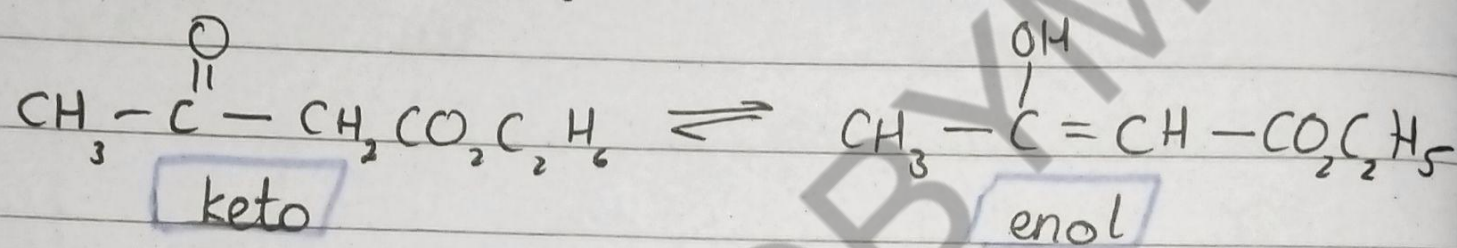
16. What is tautomerism?

Tautomerism:

→ A type of isomerism in which a compound simultaneously in 2 equilibrium forms.
→ It has shifting of proton
→ Example is Ethyl acetoacetate ester.



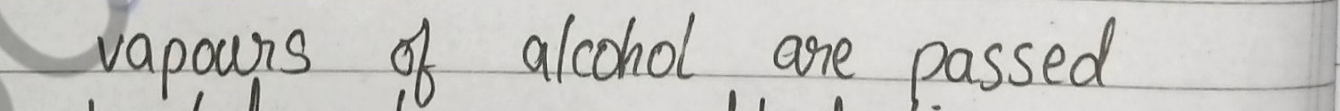
17. Explain the 2 ways of preparing alkenes.

A) Dehydration of alcohols:

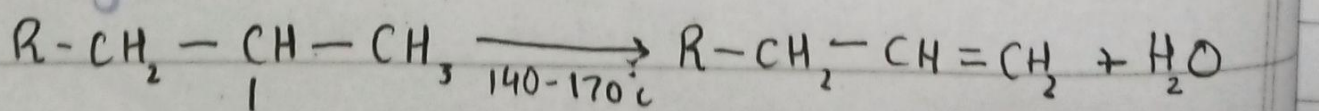
→ Removal of water

1) Primary alcohol:

When vapours of alcohol are passed over heated alumina, dehydration occurs.



2) Secondary alcohol:



secondary alc > Primary alc

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B) Dehydrohalogenation of alkyl halides.

→ Removal of hydrogen & halogen from alkyl halides is called dehydrohalogenation

→ Alkyl halides form alkenes.

$$R-\underset{H}{CH}-\underset{X}{CH_2} + KOH \xrightarrow{\text{alcohol}} R-CH=CH_2 + KX + H_2O$$

alkyl halide. — alkene

Example:

$$H_3C-\underset{H}{CH}-\underset{Br}{CH_2} + KOH \xrightarrow{\text{alcohol}} H_3C-CH=CH_2 + KBr + H_2O$$

1- bromo propane — propene

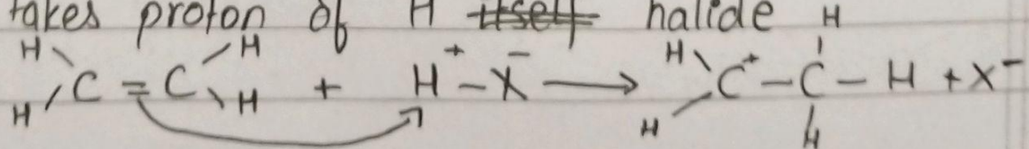
18. Write down the mechanism of hydrohalogeration of alkenes.

Hydrohalogenation:

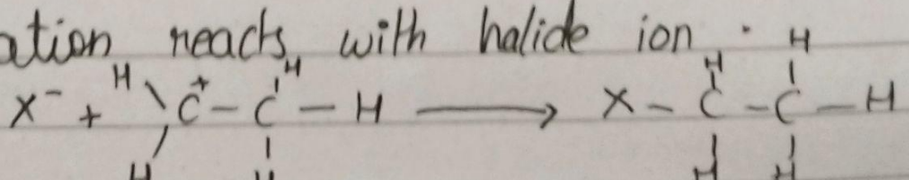
Addition of halogen to alkene is hydrohalogenation.

Mechanism:

Alkene takes proton of H ~~itself~~ halide



The carbocation reacts with halide ion.



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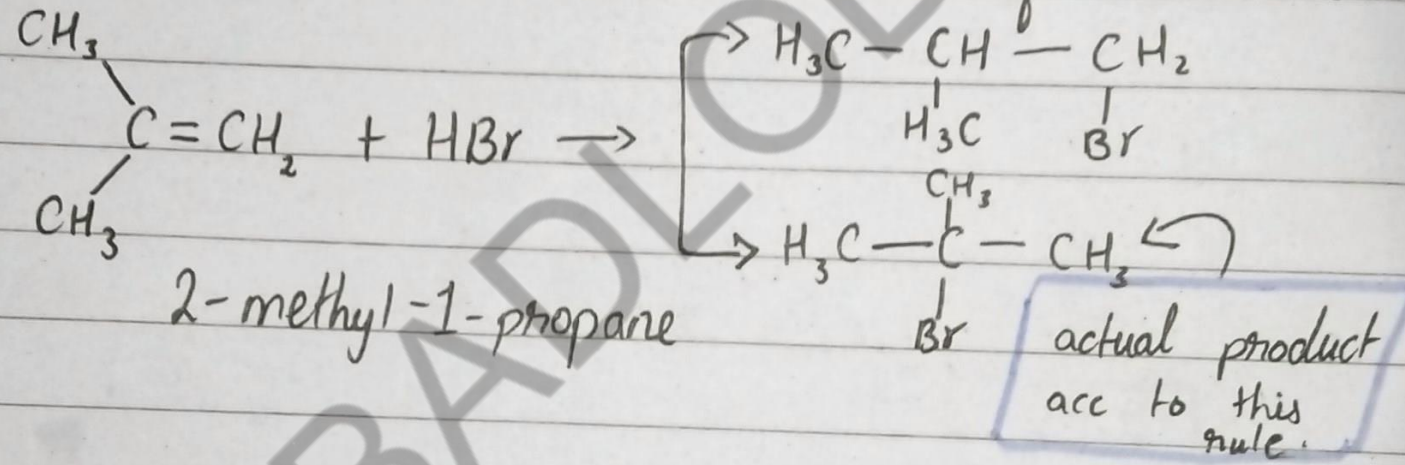
19: What is the markownikov's rule ?

Markownikov's rule:

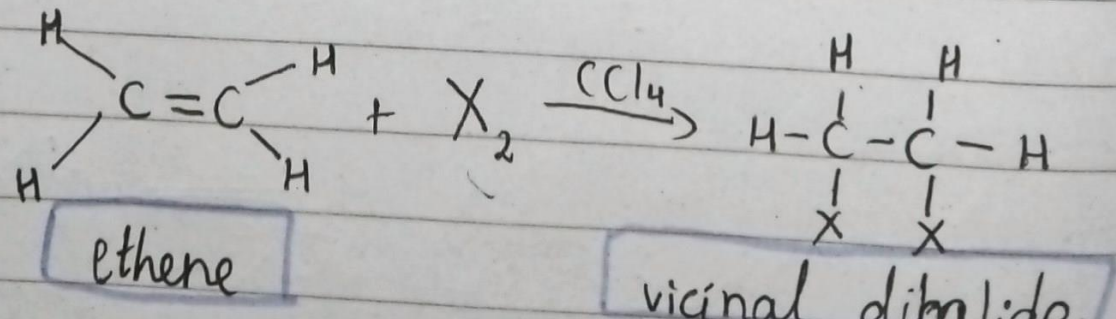
In addition of an unsymmetrical regent to an unsymmetrical alkene, the negative part of the adding regeant goes to that double bonded C-atom which has the least number of H-atoms.



20. Explain the mechanism of Halogeration.

Halogenation:

Alkenes react with halogen in an inert solvent like Carbon tetrachloride at room temp to give vicinal dihalides.



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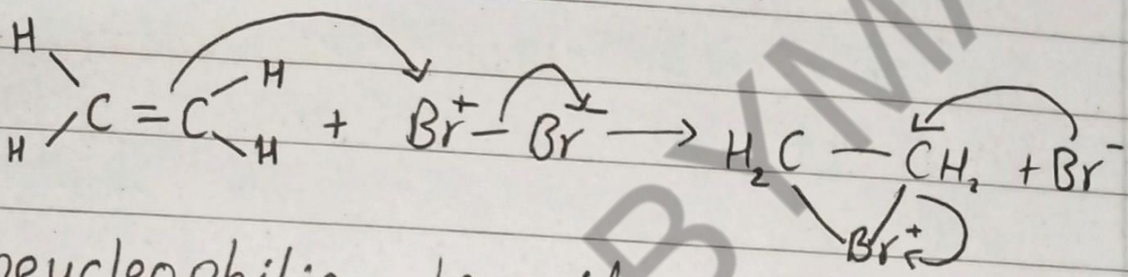
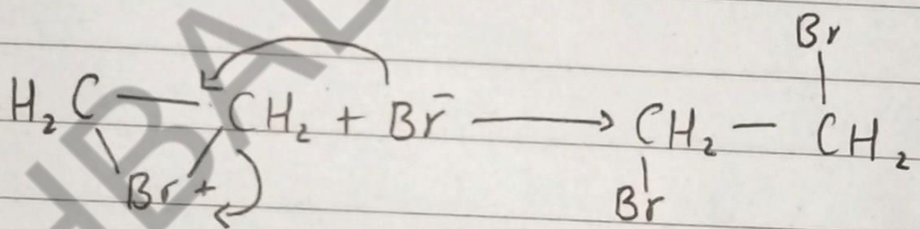
Mechanism:

a) A bromine molecule becomes polarized as it approaches the alkene. This polarized bromine molecule transfers a positive bromine atom to the alkene resulting in the formation of a cyclo bromonium ion.



b) The neucleophilic bromide ion then attacks on the carbon of cycle bromonium ions form vicinal dibromide & red-brown colour is released.

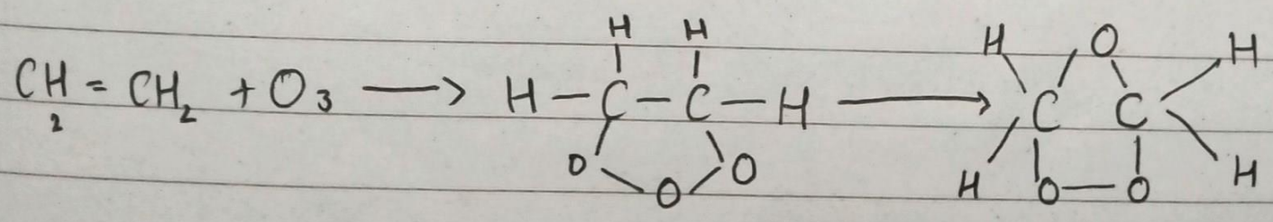


Trans - 1,2 - dibromo ethane

21. What is ozony ozonolysis ?

Ozonolysis:

Ozone reacts rapidly with alkenes to form unstable molonozide. And makes ozonide.



ethene molozonide ozonide

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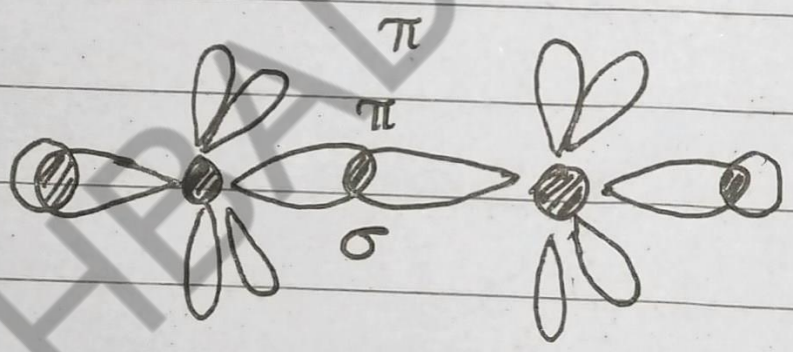
22. Describe the structure & physical properties of alkynes.

Structure of alkyne:

→ The two Carbons of a triple bond in acetylene are sp-hybridized.
→ They have sigma-bonds
→ The cloud of pi-electrons is present cylindrically symmetrical about the C-C
→ sigma-bond.



Physical properties:

→ alkynes are non-polar
→ soluble in non-polar organic solvents.
→ All are colourless
→ MP, BP & density increases gradually with increase molecular masses.

23. How are alkynes prepared ~~with~~ by dehydrohalogenation of vicinal dihalides?

Process:

A dihalide has 2 halogen atoms on adjacent carbon atoms is known as a vicinal dihalide. Removing the two molecules of Hydrogen halides from adjacent carbons with the help of alcoholic KOH or $NaNH_2$ in liquid ammonia gives an alkyne.

$$CH_2=CH_2 \xrightarrow{Br_2} \underset{\text{1,2-dibromo-ethane}}{CH_2(Br)-CH_2(Br)} \longrightarrow \underset{\text{vinyl bromide}}{CH(Br)=CH_2} \longrightarrow \underset{\text{ethyne}}{HC\equiv CH}$$

We use alcoholic KOH ~~sin~~ to avoid rearrangement of triple-bond.

$$\underset{\text{2,3-dibromobutane}}{CH_3-CH(Br)-CH(Br)-CH_3} \xrightarrow[\text{alc } 100\text{-}200^\circ c]{KOH} \underset{\text{2-butyne}}{H_3C-C\equiv C-CH_3}$$

$$\underset{\text{1,2-dibromopropane}}{H_3C-CH(Br)-CH_2(Br)} + 3NaNH_2 \longrightarrow CH_3C\equiv CNa + 2NaBr + 2NH_3$$

$$CH_3C\equiv CNa \xrightarrow{H_2O} \underset{\text{propyne}}{CH_3C\equiv CH} + NaOH$$

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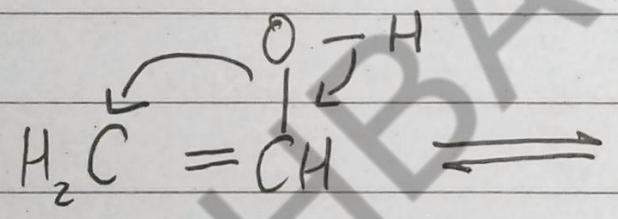
24. Explain hydration of alkynes.

Hydration:

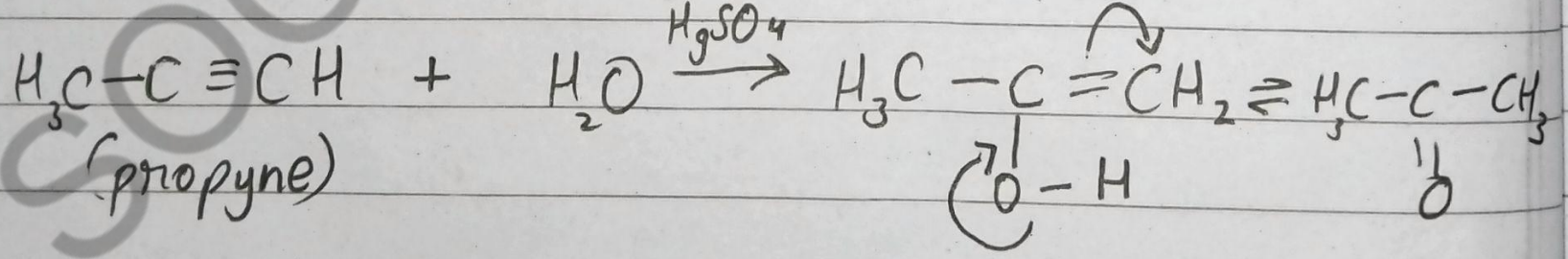
When water is added to alkynes in the presence of mercuric sulphate & sulphuric acid & 75°C carbonyl compounds are formed.
Vinyl alcohol is an unstable compound & changes into acetyldehyde.

$$HC \equiv CH + H\text{-}OH \xrightarrow[H_2SO_4]{HgSO_4} H_2C \equiv CHOH$$

(acetylene) (Vinyl alcohol)



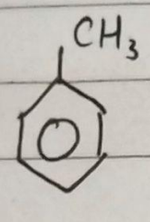
$H_2C=CH \rightleftharpoons H_3C-C-H$ (acetyldehyde)



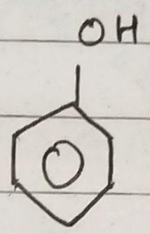
$H_3C-C\equiv CH + H_2O \xrightarrow{HgSO_4} H_3C-C(=O)-CH_3$ (propyne) (acetone)

It's industrially important for aldehyde production.

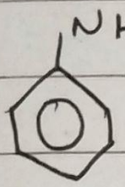
25. State the names of benzene rings with different functional groups.



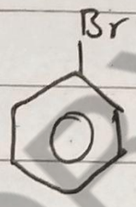
Toluene



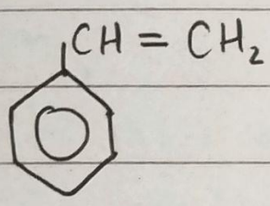
Phenol



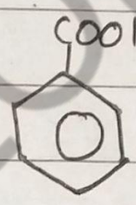
Aniline



Bromobenzene



Styrene



Benzoic acid

26. Explain the kekule structure & write it's drawbacks.

Kekule structure:

In benzene all the C-C bonds atoms are of the equal length & there is no C-C , C=C .

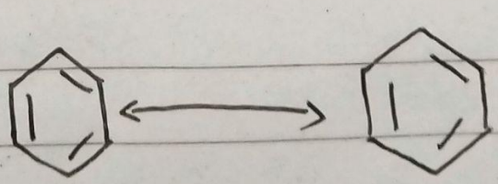
Kekule structures give precise idea of e^- position.

Drawbacks:

Less heat formation

Equal C-C bonds

Benzene is less reactive.

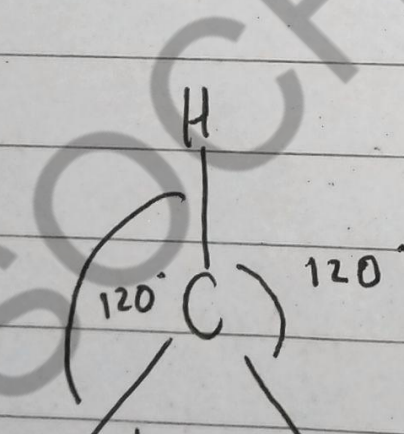


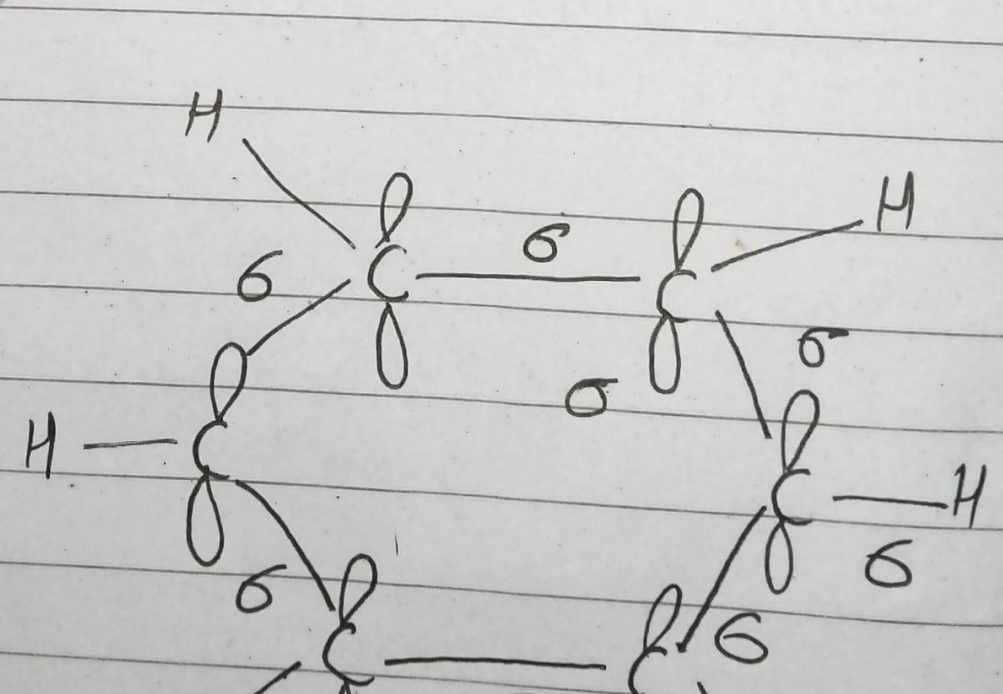
DATE: DAY:

27. Explain the mordern concept of structure of benzene.

Modern concept:

Each C-atom is sp^2 hybridized in benzene since each C-atom is attatched to 3 other atoms. Two sp^2 hybridized orbitals overlap with 2 sp^2 hybridized orbitals to make two sigma bonds. Similarly one sp^2 hybridized orbital of each carbon overlaps with 1s atomic orbital of H to make a sigma bond.





DATE: DAY:

28. Explain resonance & resonance energy.

Resonance:

The possibility of different pairing schemes of valance electrons of an atom within the molecule is resonance.

Explanation:

The resonance is represented by a double headed arrow.
The p-electrons of C-atoms get different pairing schemes in benzene.
The stability of benzene molecule increases with increase in resonating structures.

Resonance energy:

The regonance energy of a compound is a measure of the extra stability of the conjugated system compared to the corresponding number of isolated double bonds.

$$\text{Resonance energy} = \Delta H_{cal\ (theoretical)} - \Delta H_{obs\ (experimental)}$$

$$\text{Resonance energy} \propto \text{Stability}$$

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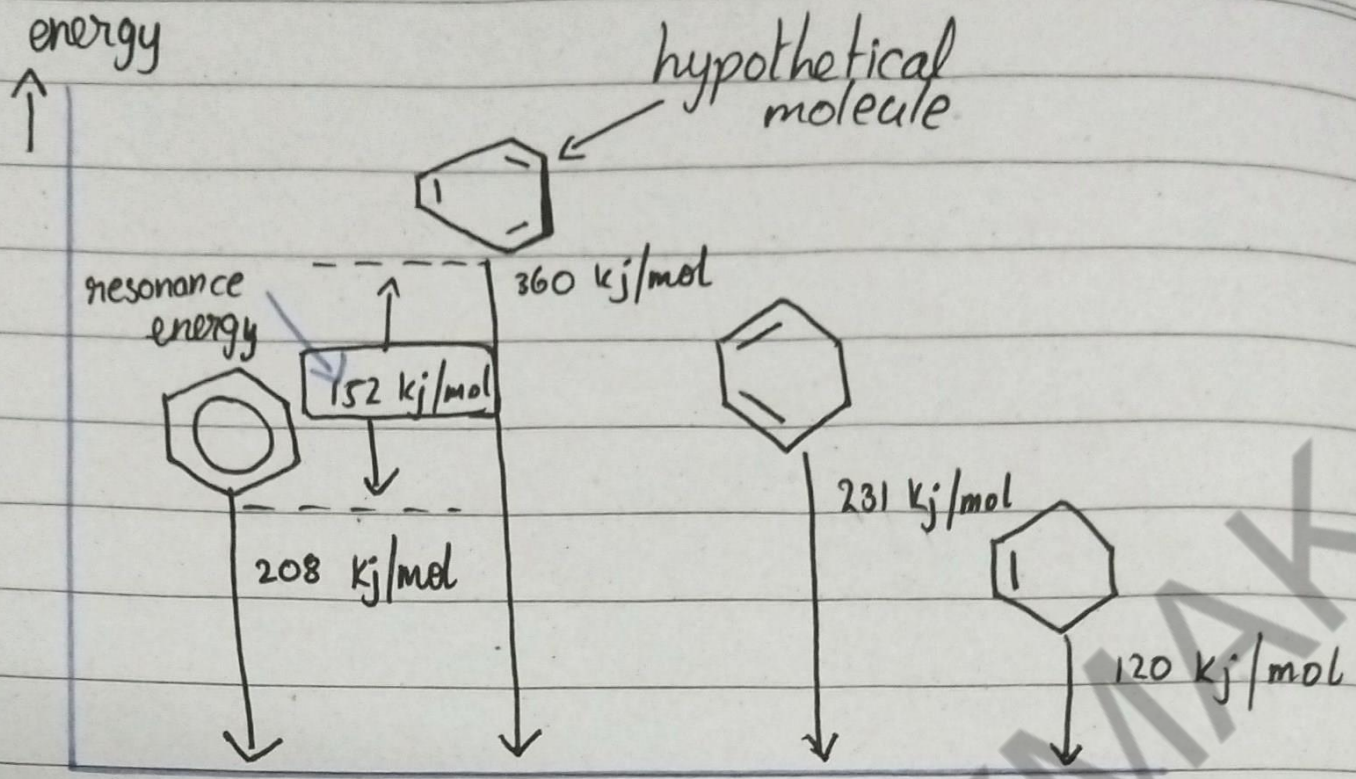


1,3 cyclohexadiene = 240 - 231 = 9 kj/mol

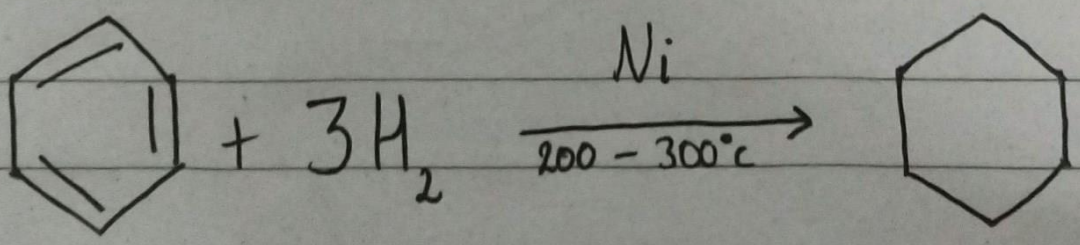
Benzene = 360 - 208 = 152 kj/mol

152 kj/mol is high resonance energy so that is why benzene ring is very stable.

29. Explain addition reaction of catalytic hydrogenation & halogenation.

1. Catalytic hydrogenation:

Addition of hydrogen with catalysts like raney nikle at high temp.

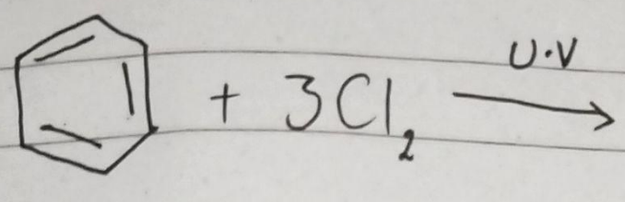


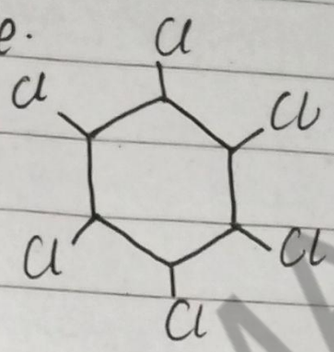
cyclohexane

DATE: DAY:

2. Halogenation:

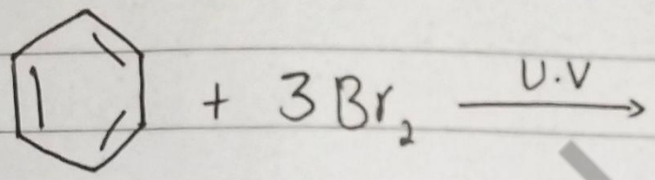
Addition of X_2 in molecule.

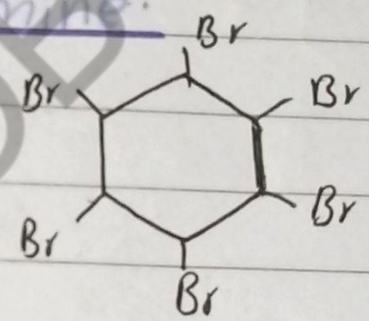




hexachloro cyclo-hexane.

Extra: Reaction with bromine:

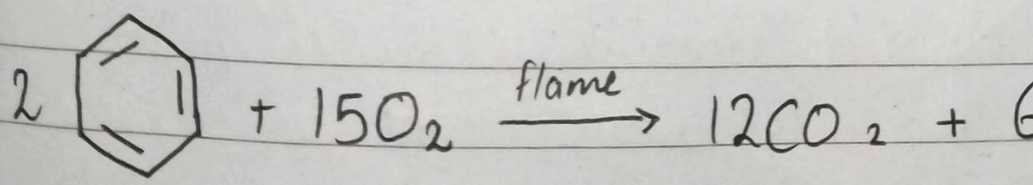




hexa bromo cyclo hexane.

30. State the combustion reaction of benzene.

Burning of carbon in presence of oxygen.



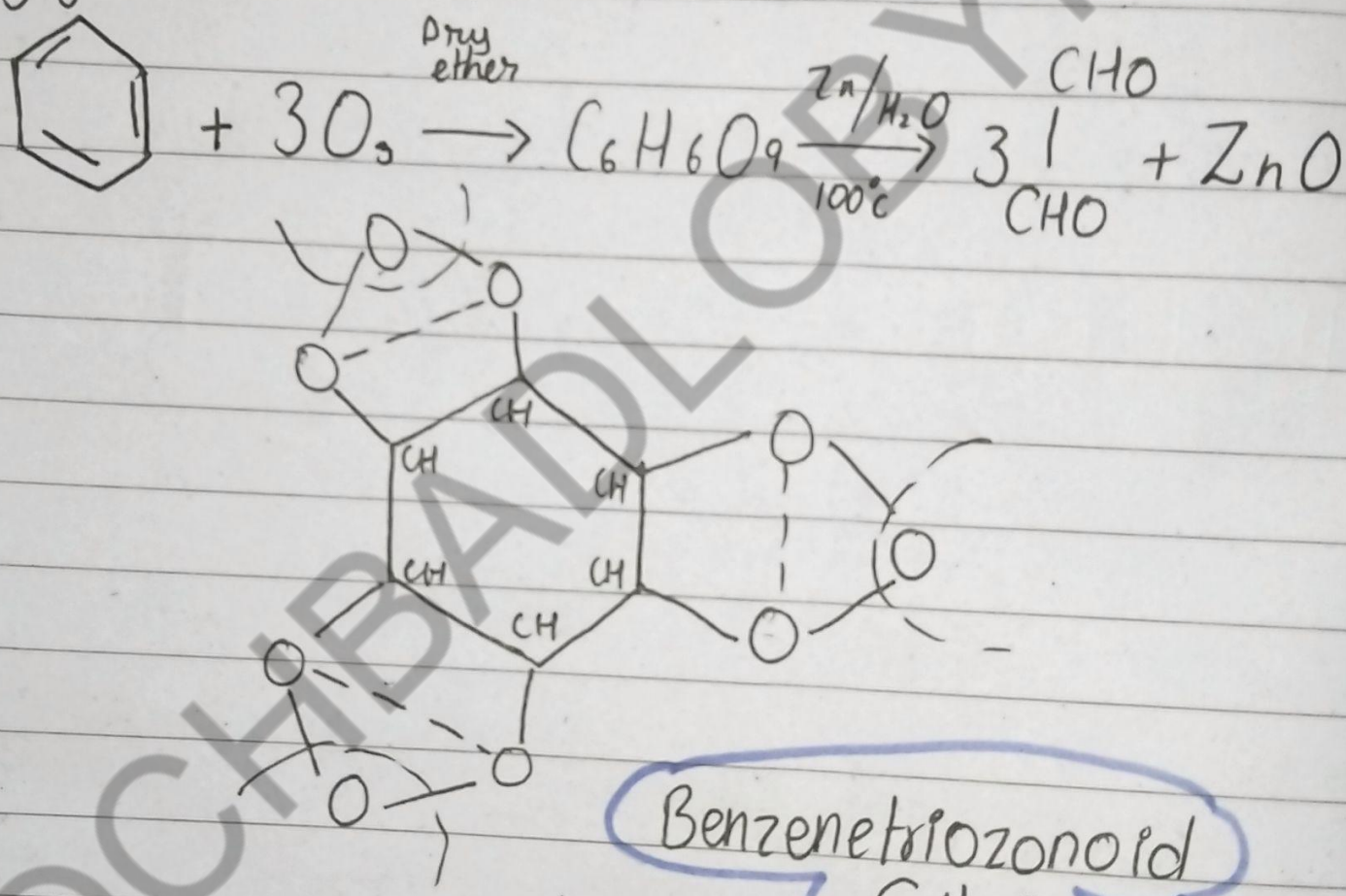
DATE: DAY:

31. Define ozonolysis & draw the structure of benzene triozonoid.

~~Ozonide~~

Ozonolysis:

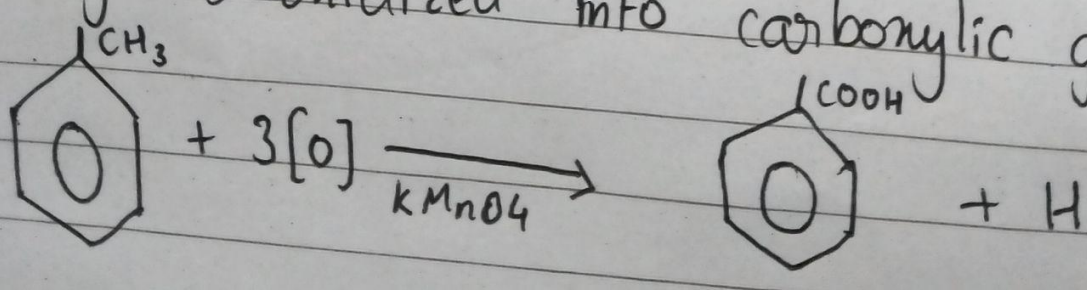
Benzene reacts with ozone to give glyoxal.



Benzenetriozonoid
$C_6H_6O_9$

32. Identification test for alkyl benzene.

Benzene does not react with $K_2Cr_2O_7$ however the alkyl group present on benzene ring is oxidized into carboxylic group.



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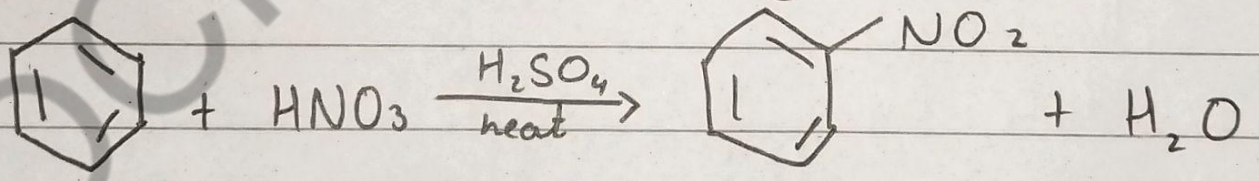
33. Why is there a need to make a strong electrophile instead of a weak electrophile? [SLO]

Answer: Making a strong electrophile is important because it increases the reactivity of the molecule in a reaction. A strong electrophile has a higher tendency to accept electrons, making the reaction more efficient & allowing for faster & more specific chemical transformations.

34. Explain nitration & it's mechanism.

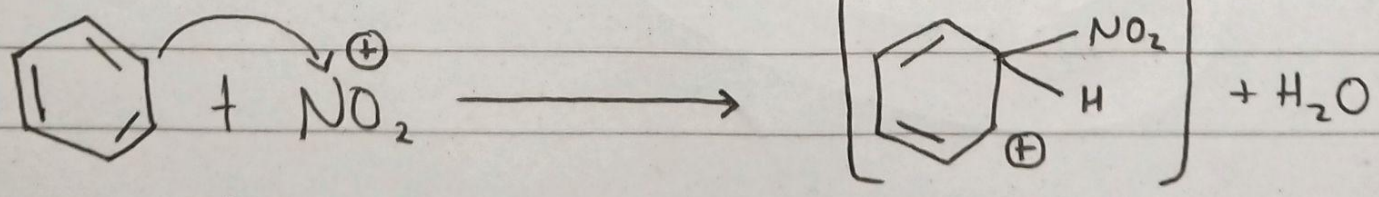
Nitration:

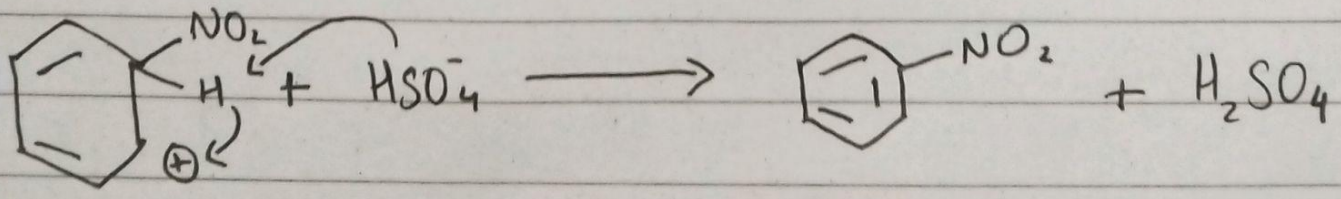
Replacement of H-atom by NO_2.



Mechanism:

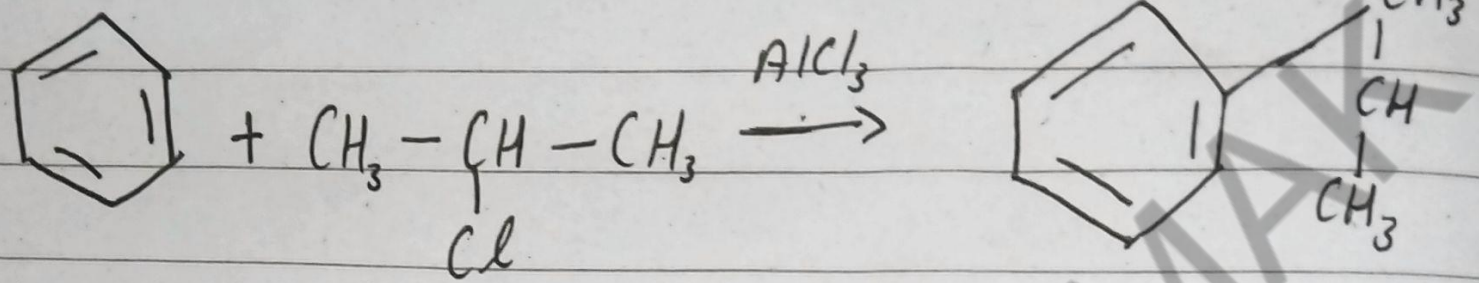
① $HONO_2 + H_2SO_4 \overset{50^\circ C}{\rightleftharpoons} NO_2^+ + HSO_4^- + H_2O$





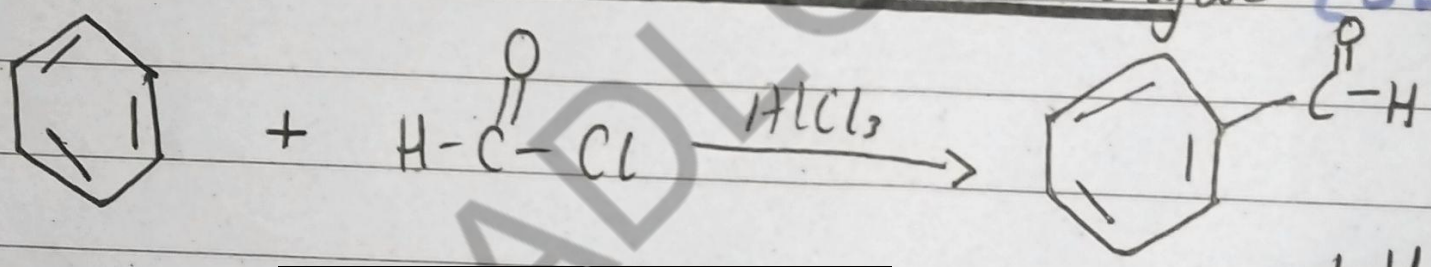
DATE: DAY:

35. Convert benzene into cumene. [SLO]



benzene isochloropropane cumene. + HCl

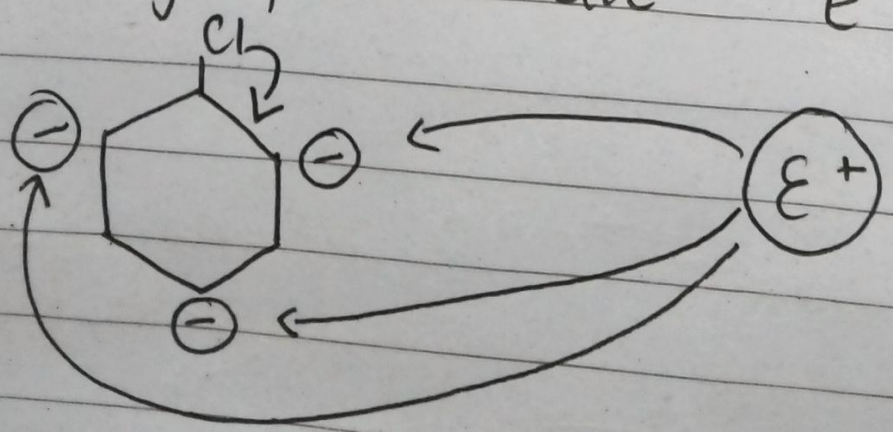
36. Convert benzene to benzaldehyde. [SLO]



Benzene Benzaldehyde. + HCl

37. Ortho-para directing groups.

Groups which direct incoming group to ortho-para position is called o-p directing group.
These groups donate e^- to benzene.



DATE: _____ DAY: _____

38. Why reaction of toluene takes place at 40°C & not 50°C like benzene. [SLO]

The reaction of toluene takes place 40°C instead of 50°C because the presence of the methyl group in toluene makes it more reactive than benzene. This increased reactivity allows the reaction to occur at a lower temperature (40°C).