

Chemical Bonding and Molecular Structure

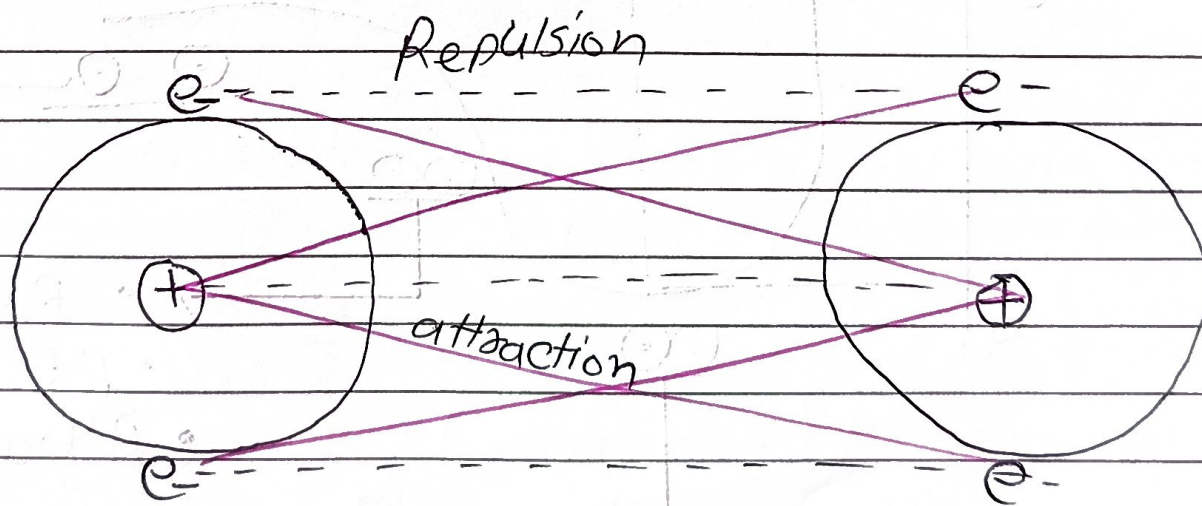
Chemical Bonding

→ When two Atom come closer to each other due to attraction or repulsion to formed chemical bonding

★ Each and every Atom contains positive and negative ions

★ Positive ions attract negative ions

★ Same type of ions repulsion to each other



Condition

When force of attraction = force of Repulsion

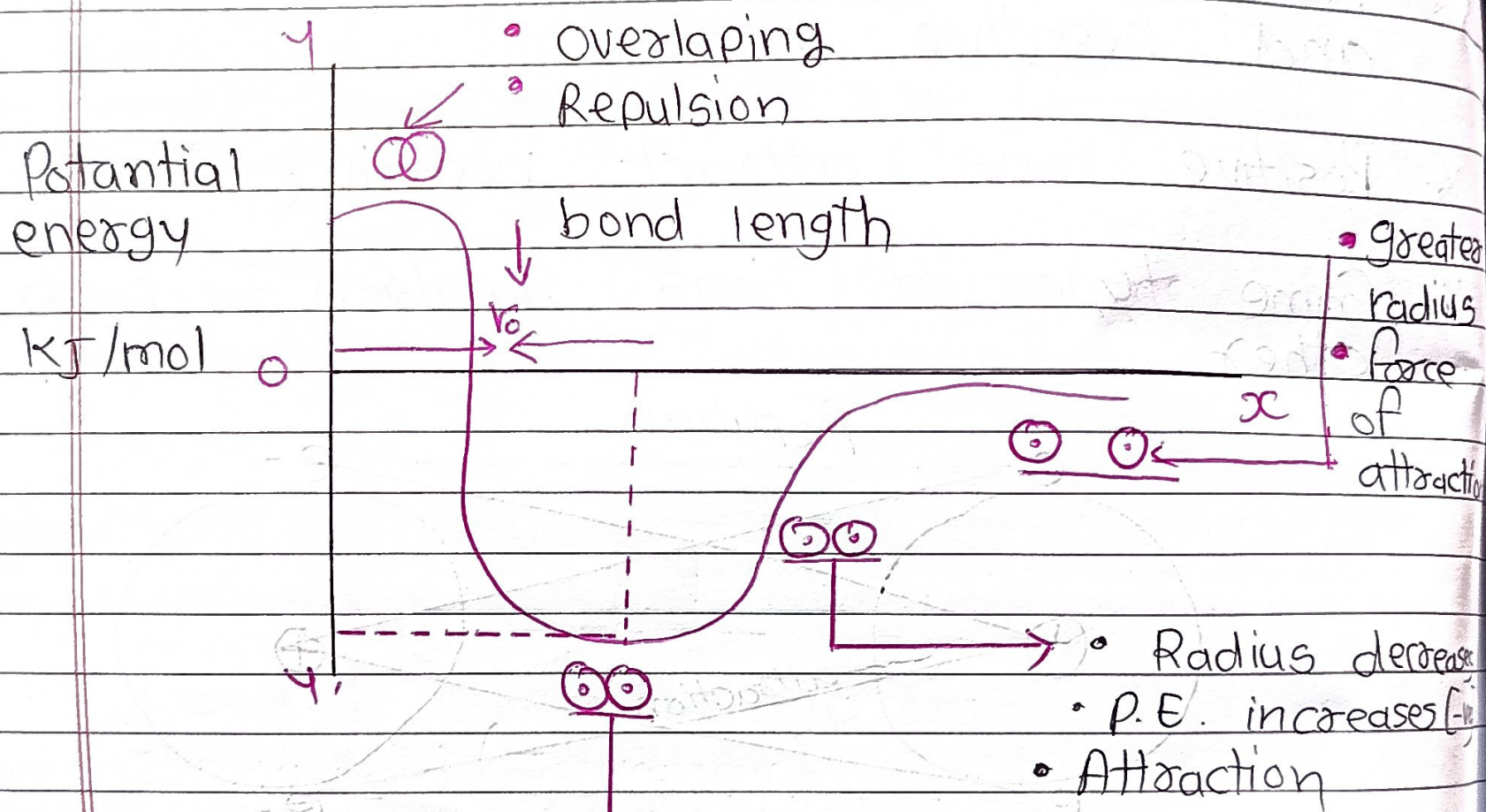
[Equilibrium]

*Q why atom formed bond?

→ 1) due to stability of gaining electron or octet form

2) lower the potential energy of the system

Q * How potential energy of system lower



Note: P.E $\uparrow$, $r \downarrow$
P.E $\downarrow$, $r \uparrow$

- Bond formation
- equilibrium
- Attraction
- decrease radius
- Increases P.E [-ve]

bond length

minimum distance between nucleus of two atom, It represent by r_0

Case I

1) $r = r_0$

Force of Attraction = Force of Repulsion

Case II

2) $r > r_0$

Attraction greater than repulsion

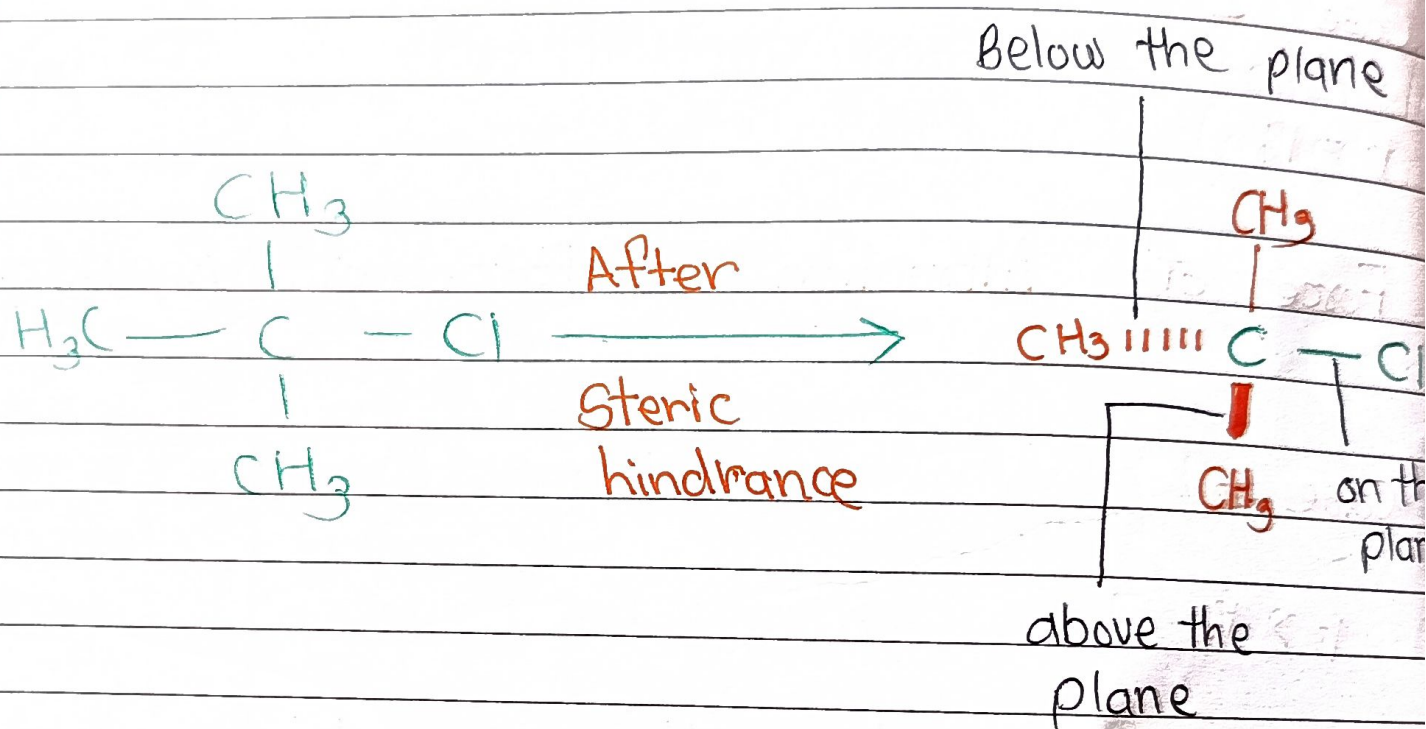
Case III

3) $r < r_0$

Repulsion greater than Attraction

★ Steric hindrance

When two atoms closer to each other in the same compound are out from the surface, it is called steric hindrance.



Types of Chemical Bonding

Strong bond (Interatomic)
2 atom



- 1) Ionic bond
- 2) Covalent bond
- 3) Coordinate bond
- 4) Metallic bond

Weak bond (Intermolecular)
2 molecules



- 1) Van der Waals force
- 2) Hydrogen bonding

* Ionic bond

(gas) Cation $\rightarrow$ lose of $e^- \rightarrow +ve \rightarrow$ Endothermic reaction

(gas) Anion $\rightarrow$ gain of $e^- \rightarrow -ve \rightarrow$ exothermic reaction

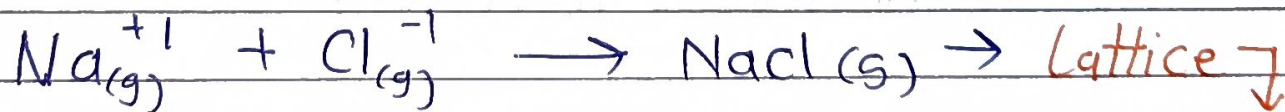
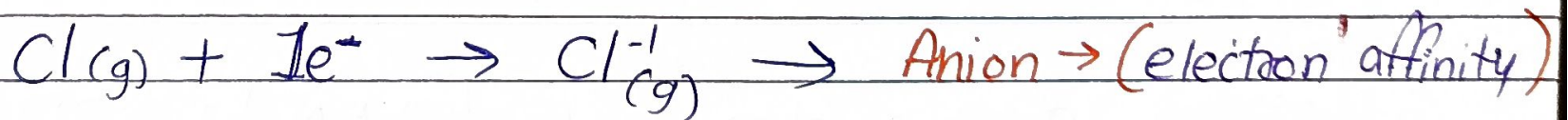
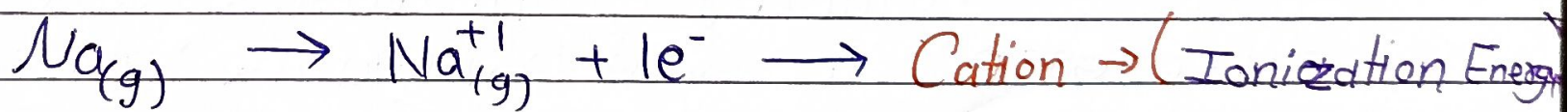
(solid) Lattice $\rightarrow$ cation + Anion $\rightarrow$ exothermic reaction

1) bond form by complete transfer of electron from one atom to another atom it is also called electrovalent bond

2) bond form by different ions is called ionic bond

3) bond form by Cation and anion is also called ionic bond

* formation of NaCl



Lattice Energy

$\Delta H \rightarrow$ Change in Enthalpy

$\Delta H > 0 \rightarrow$ Endothermic reaction $\rightarrow$ Ionization

$\Delta H = 0 \rightarrow$ Equilibrium

$\Delta H < 0 \rightarrow$ exothermic reaction $\rightarrow$ electron affinity
Lattice energy

How to find % of ionic character

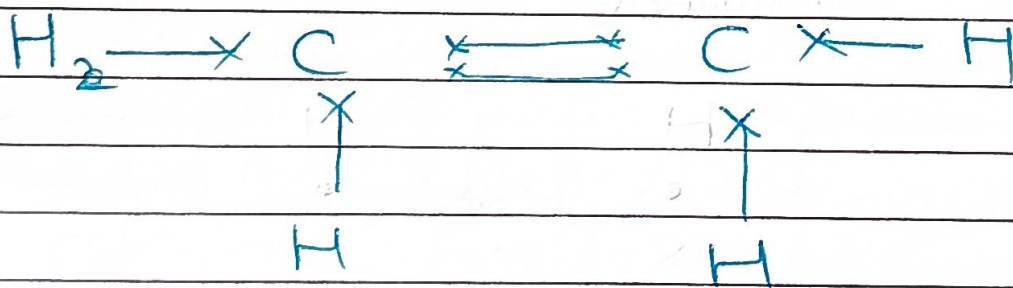
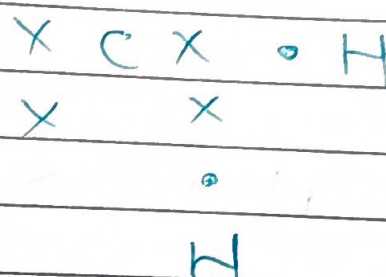
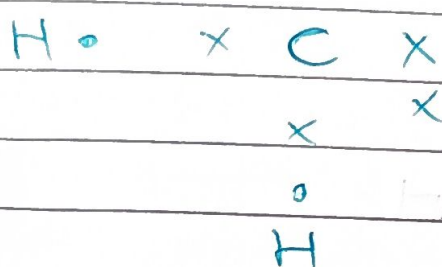
Ionic character $\propto \Delta EN$

$\downarrow$
Electric negativity

When difference in electronegativity maximum it gives high ionic character

Ionic character increases when difference in electronegativity increases

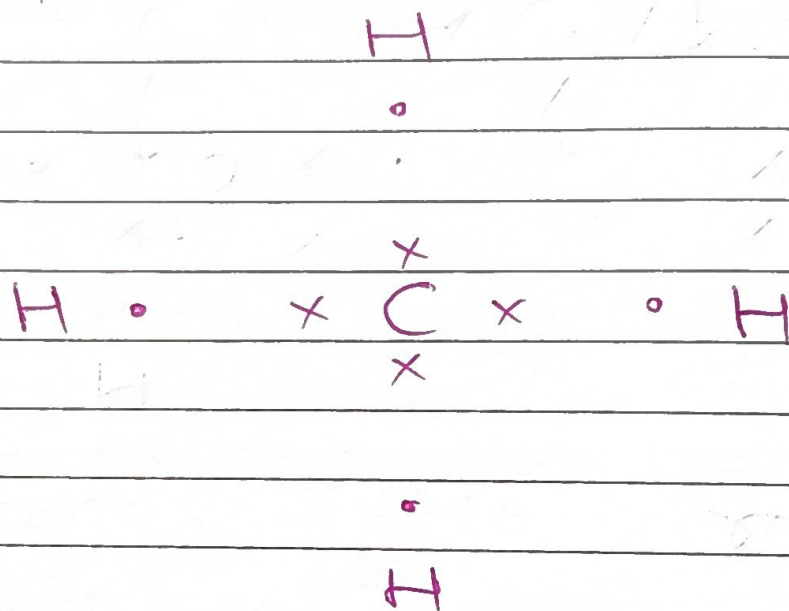
$$\% \text{ Ionic character} = 16 [\Delta EN] + 3.5 [\Delta EN]^2$$

$$C_2H_4$$


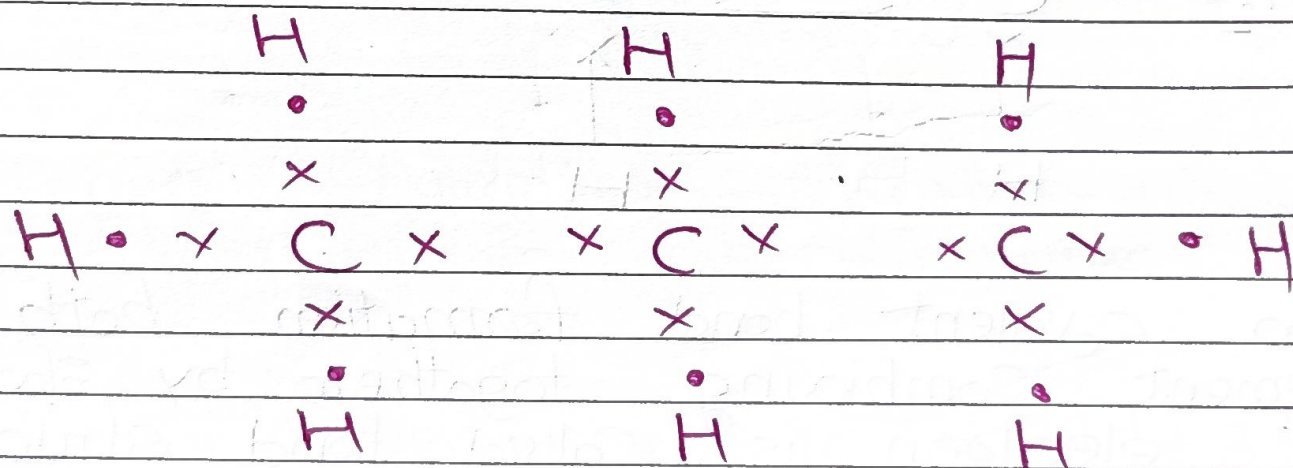
- ★ In covalent bond formation both element combining together by sharing of electron is called bond structure
- ★ Covalent bond compound less reactive than ionic compound

* Covalent bond Compound maximum
Covalent character and minimum
Ionic Character

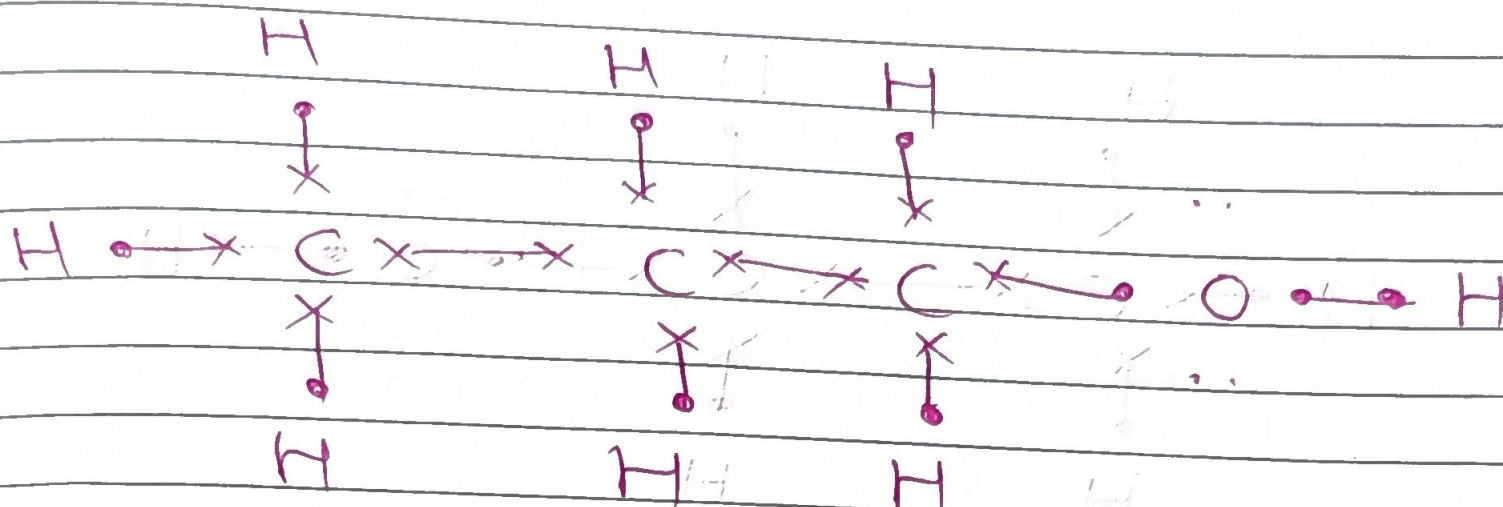
1) CH_4



2) C_3H_8 Propene



3) propanol

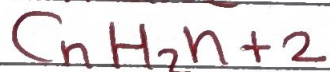


Note

functional group

- CHO
- COOH
- OH
- X (F, Cl, Br, I)
- CO
- NO₂
- NH₂ - amine

Alkane

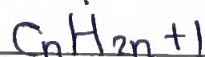


- bond



Saturated

Alkyl



Alkene



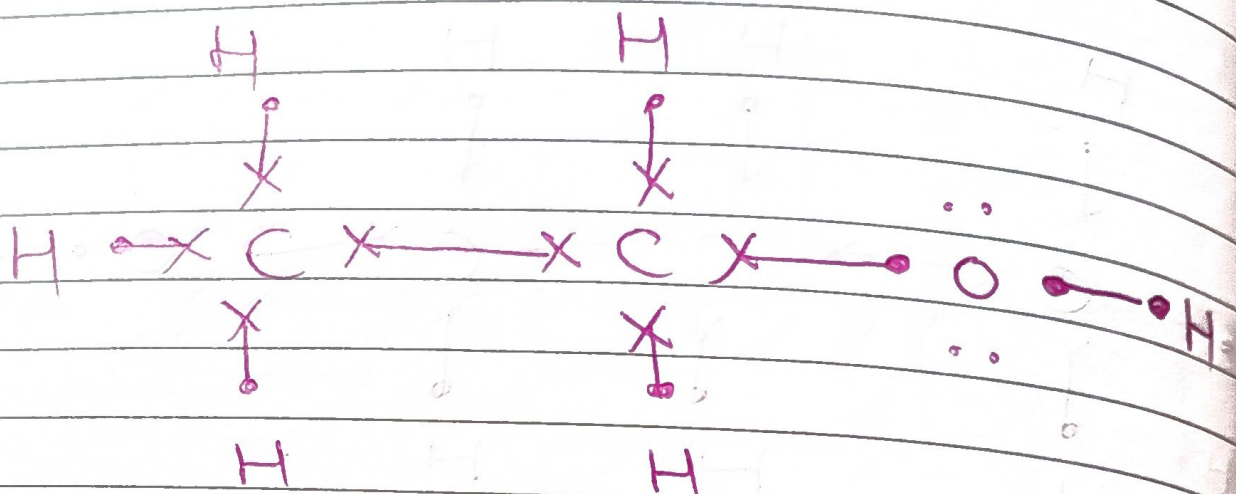
Alkyne



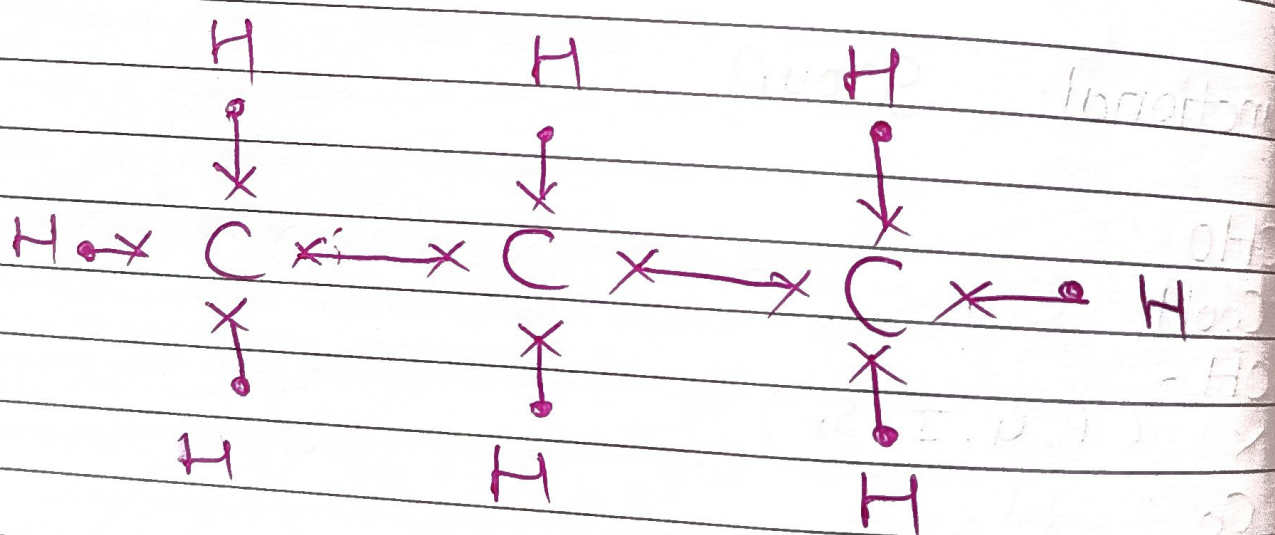
Unsaturated

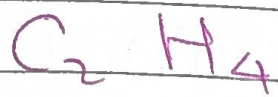
Covalent Bond $\rightarrow$ Lewis Structure & electron dot structure

i) C_2H_5OH ethanol



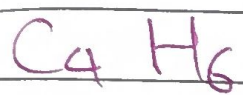
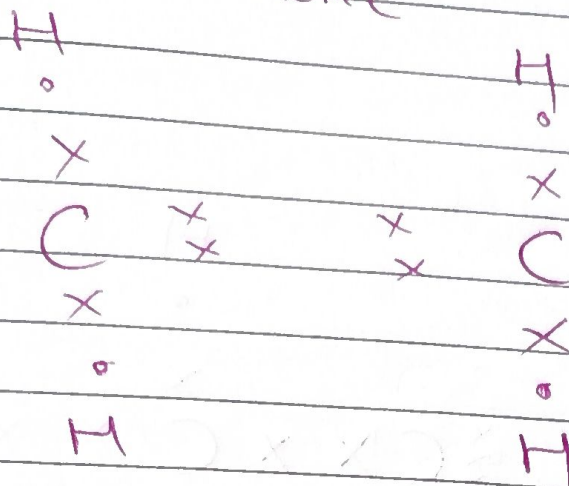
Propene C_3H_6



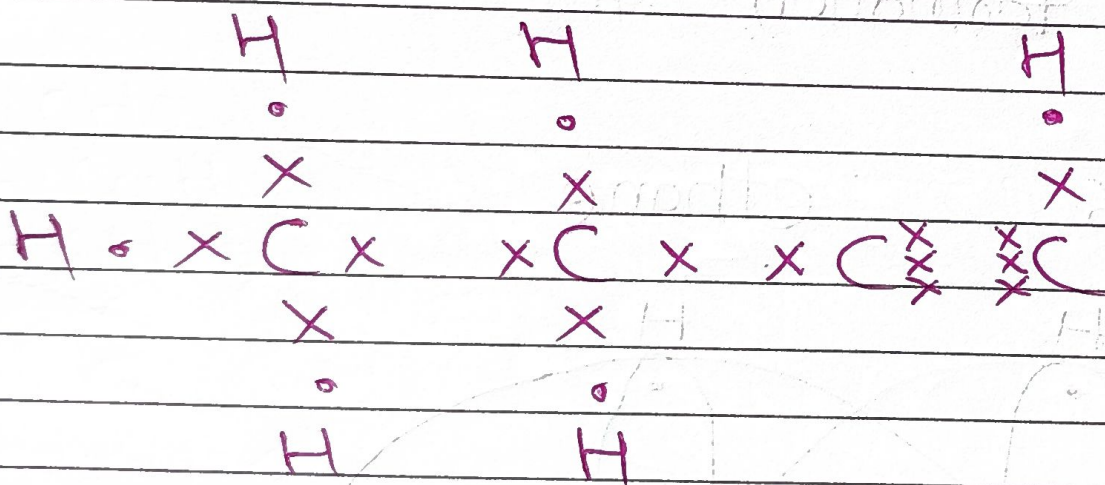


Ethene

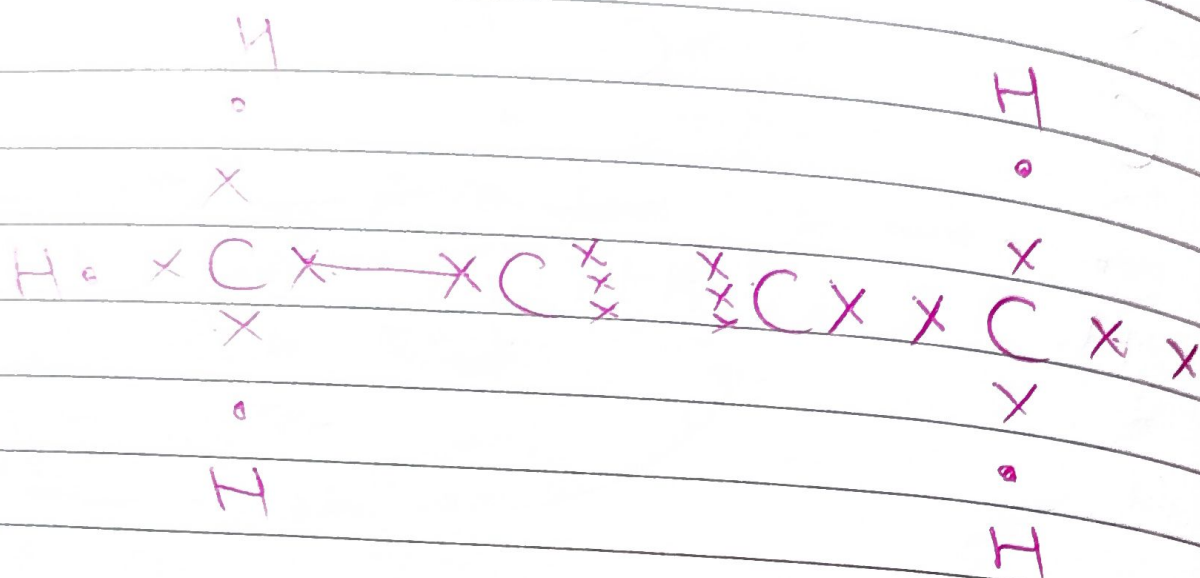
Formula (C_nH_{2n})



Butyne (Formula C_nH_{2n-2})



but 2 yne

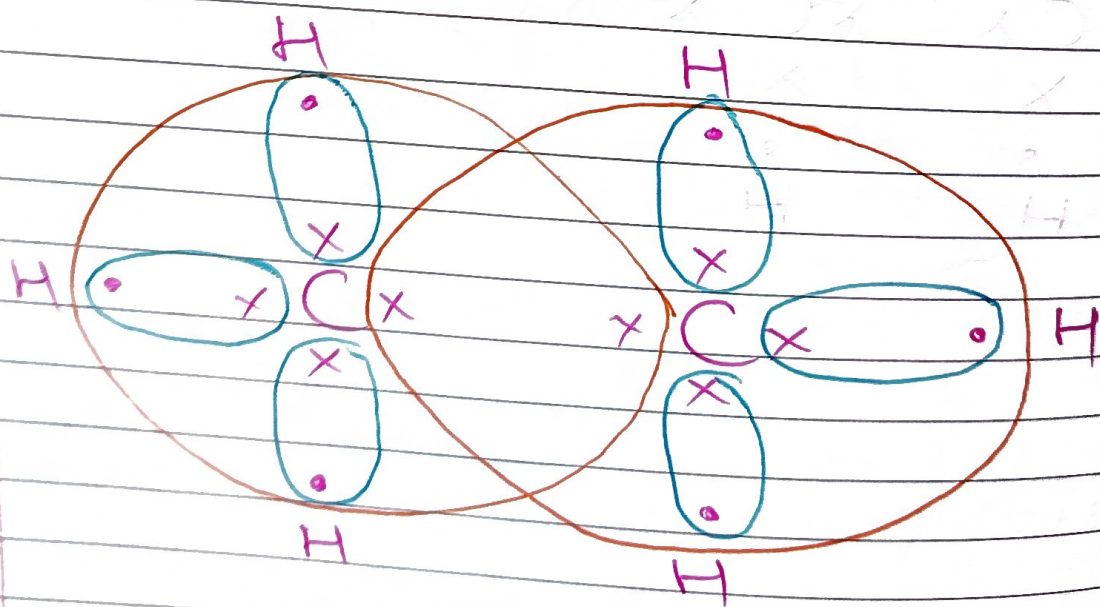


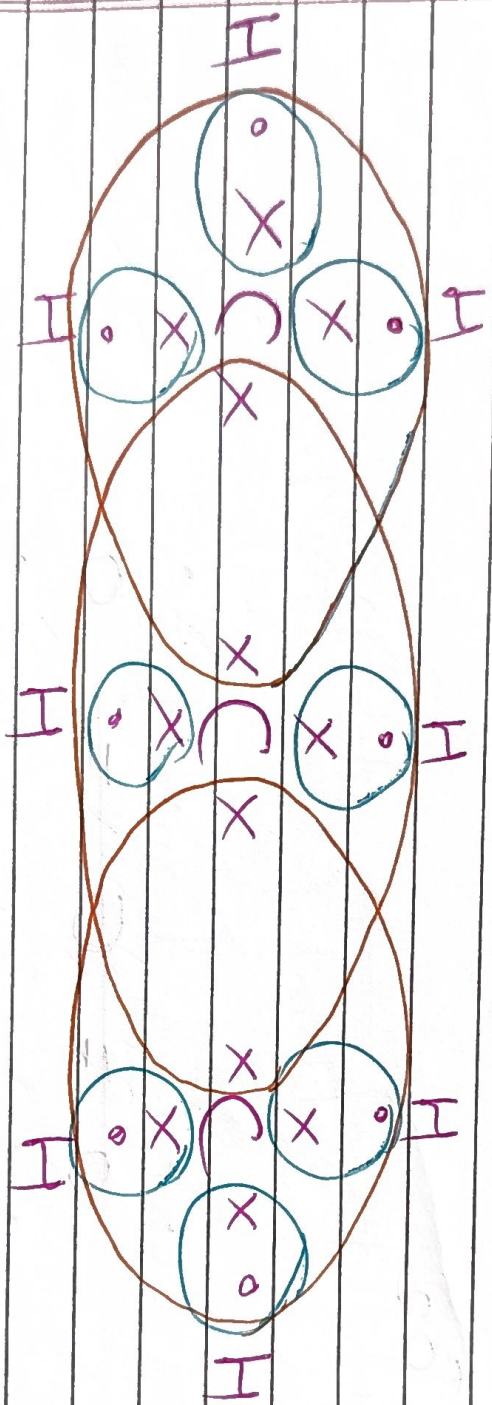
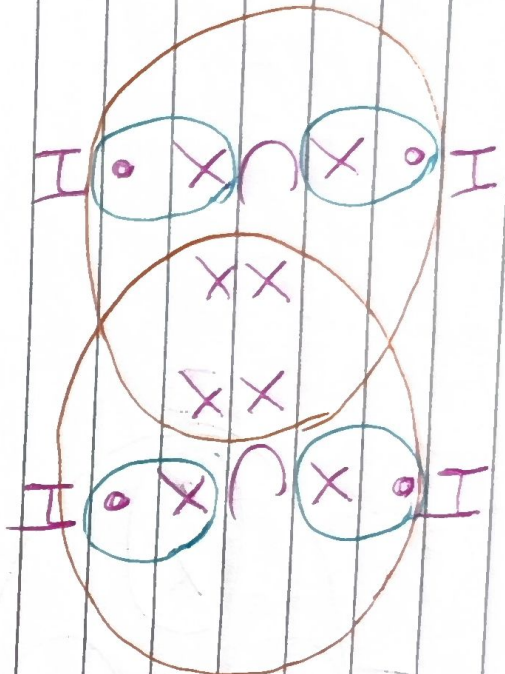
Octet formation

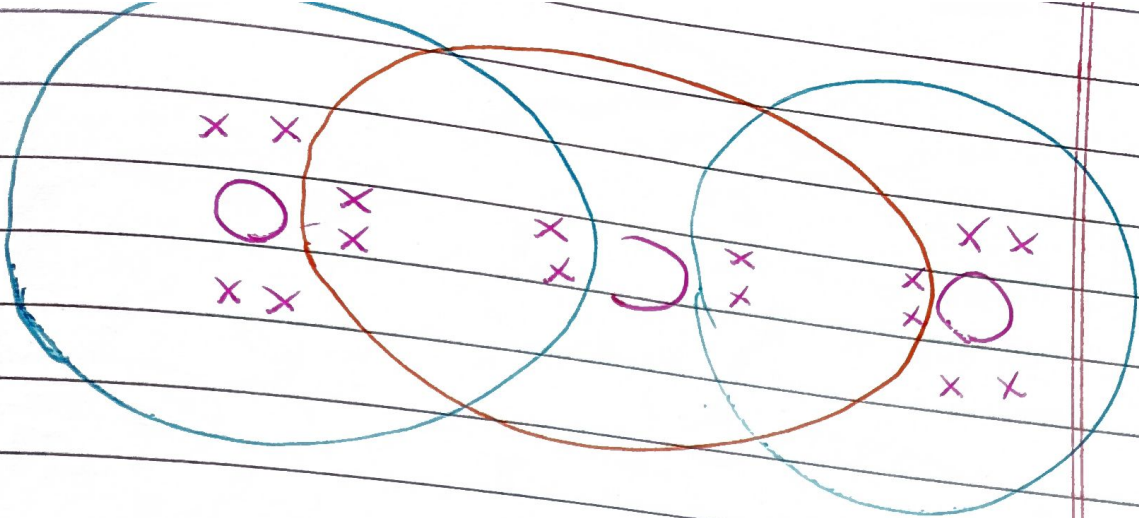
2)

C_2H_6

ethane

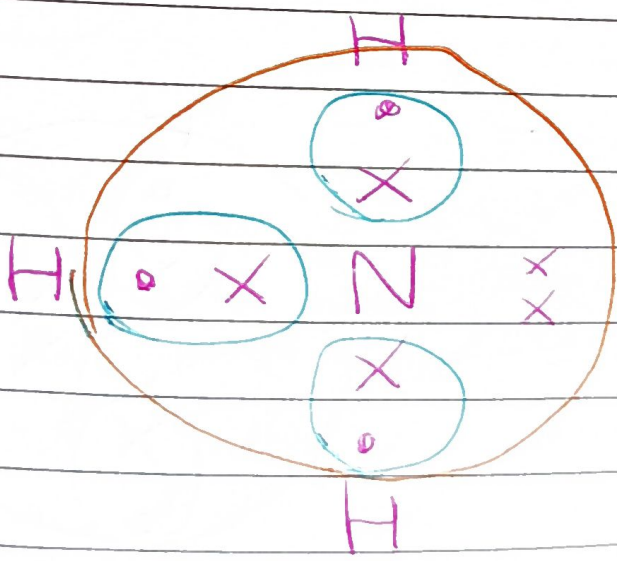






2)

3) CO_2

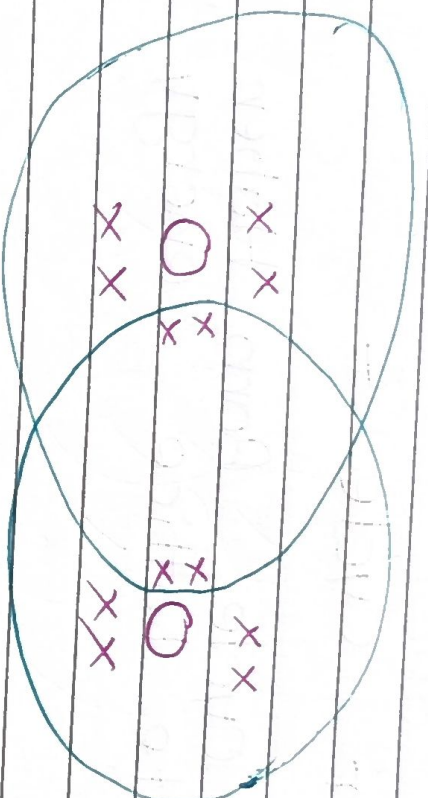


ammonia

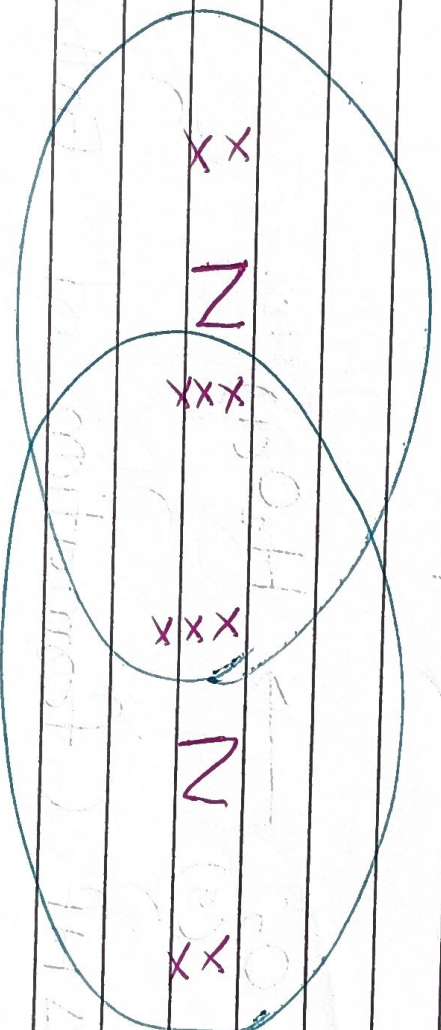
NH_3

4)

c) O_2

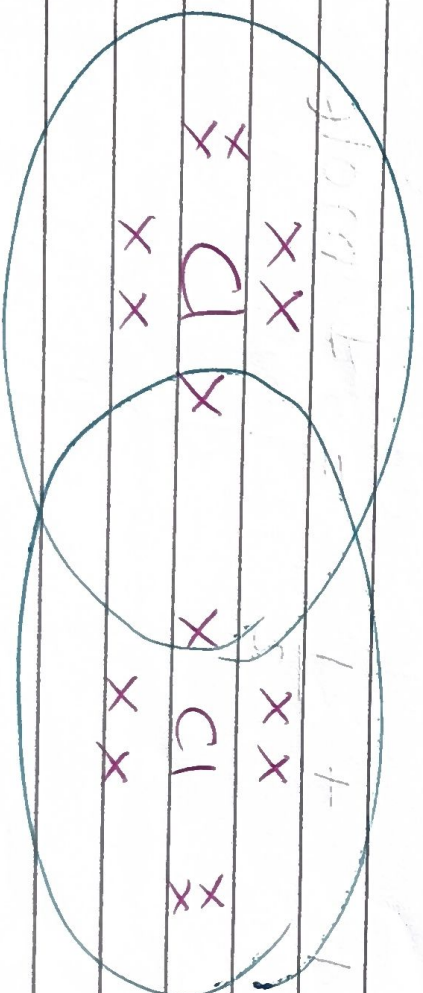


7) N_2



8)

Cl_2



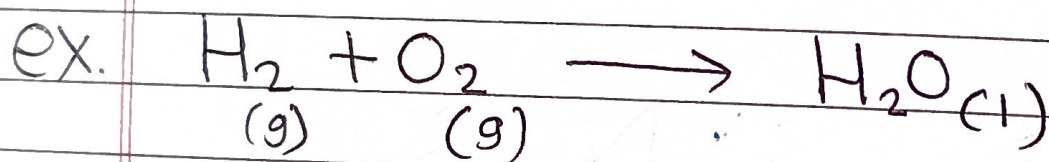
Calculation of Lattice energy

Born Haber Cycle :-

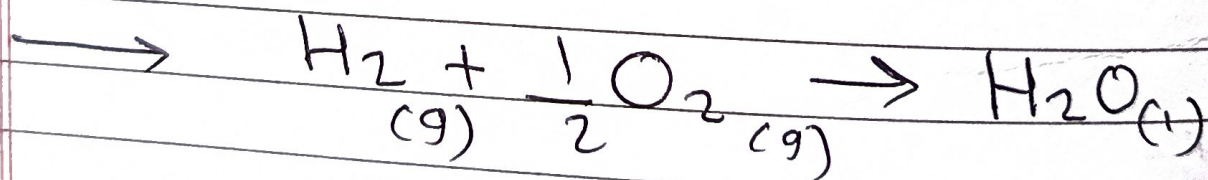
In this cycle Born Haber to calculate Lattice energy compound

Enthalpy of formation

Enthalpy of formation change
1 mole of product formed



2) $\Delta = \Delta H_f$ (formation of Enthalpy)



$$1 + \frac{1}{2} = 1 \text{ mole}$$

Calculation of Lattice energy (Imp)

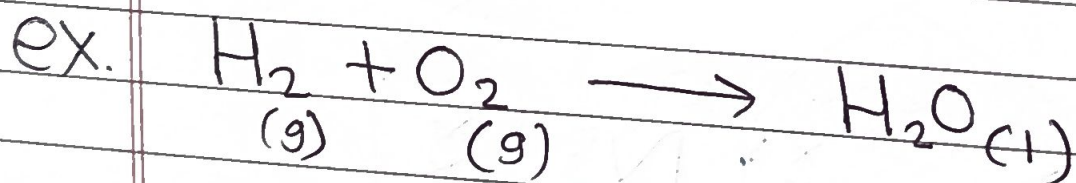
for J.E.

Born Haber cycle

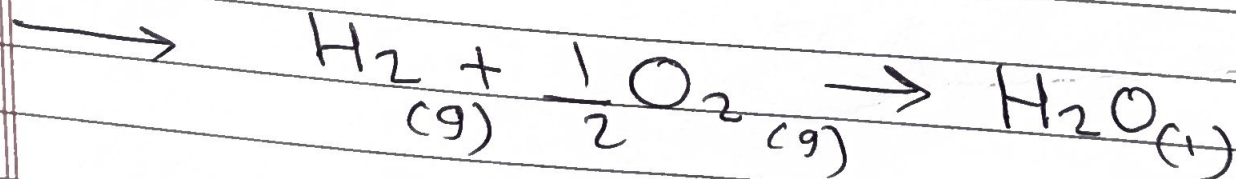
In this cycle Born Haber helps to calculate Lattice energy in Ionic Compound

Enthalpy of formation

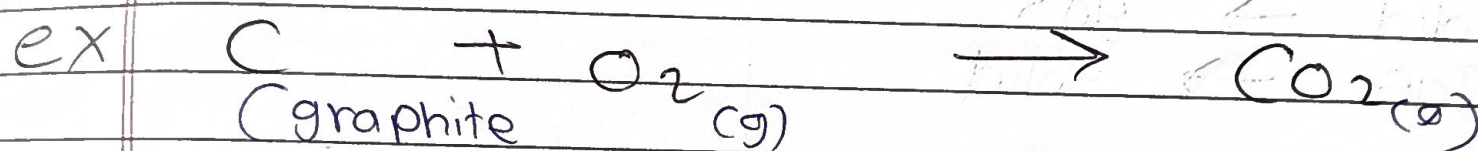
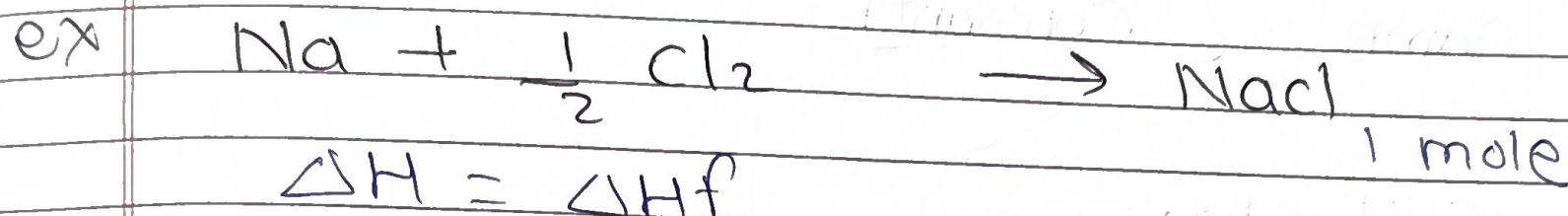
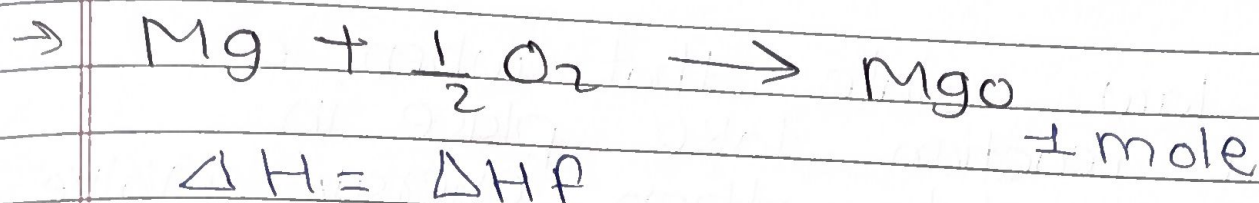
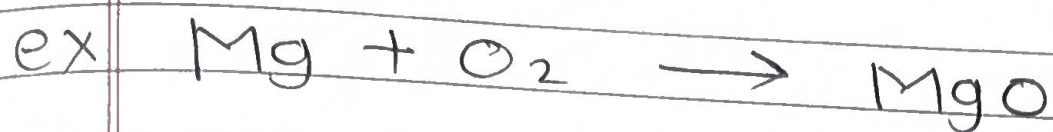
Enthalpy of formation change when 1 mole of product formed



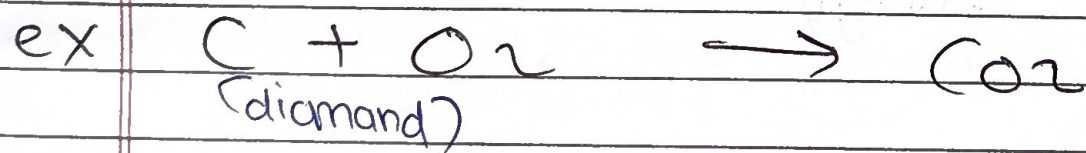
$\Delta = \Delta H_f$ (formation of Enthalpy)



$$1 + \frac{1}{2} = 1 \text{ mole}$$



- a) $\Delta H \neq \Delta H_f$
 b) $\Delta H = \Delta H_f$
 c) both a & b
 d) None
- C always find in graphite state

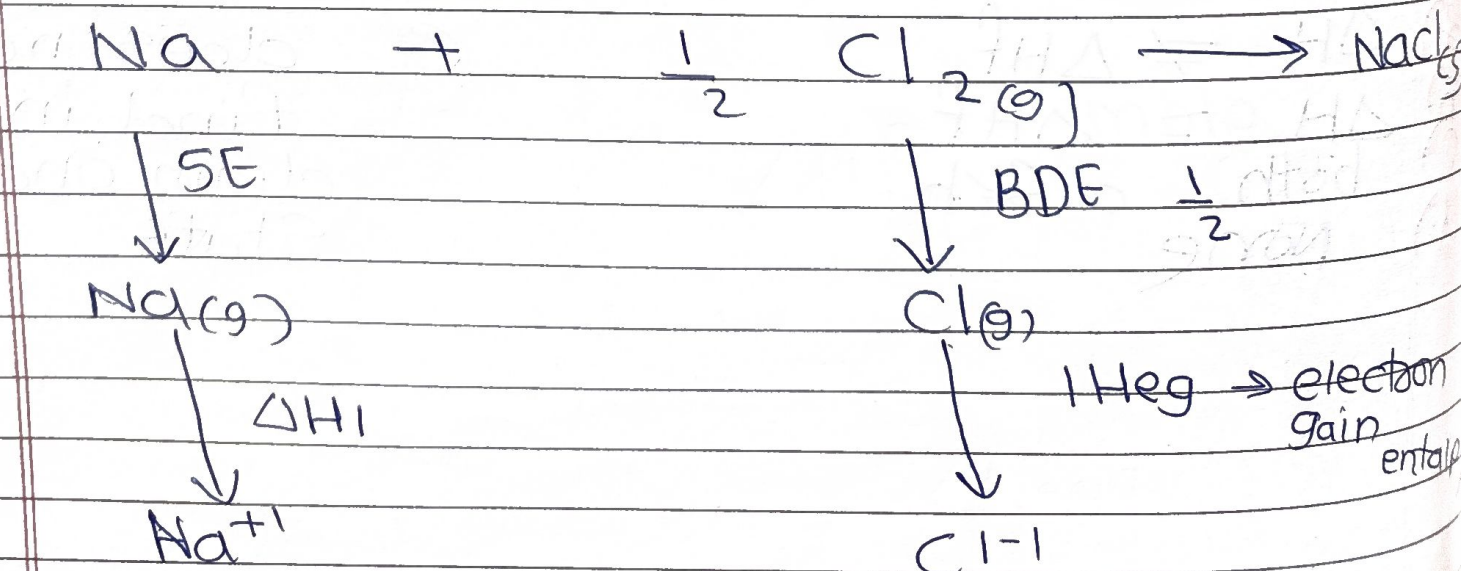
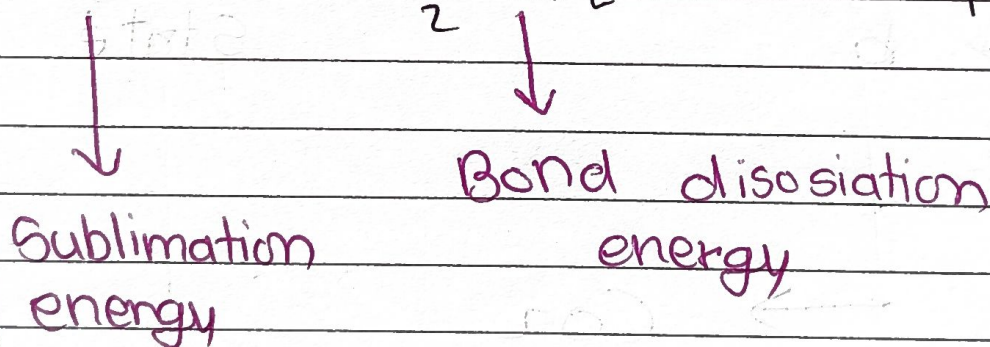
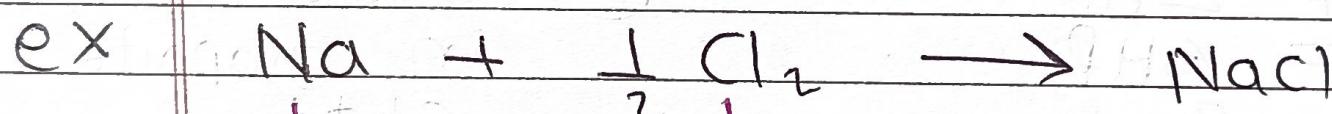
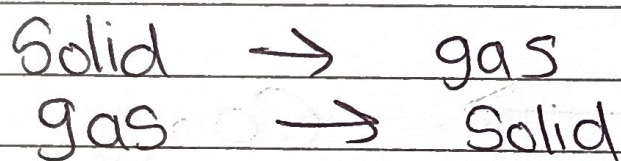


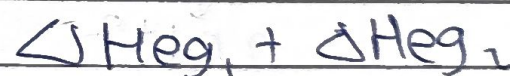
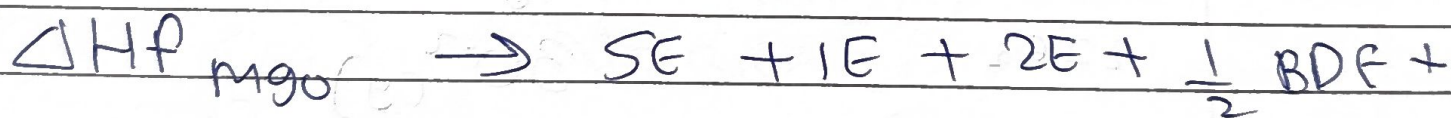
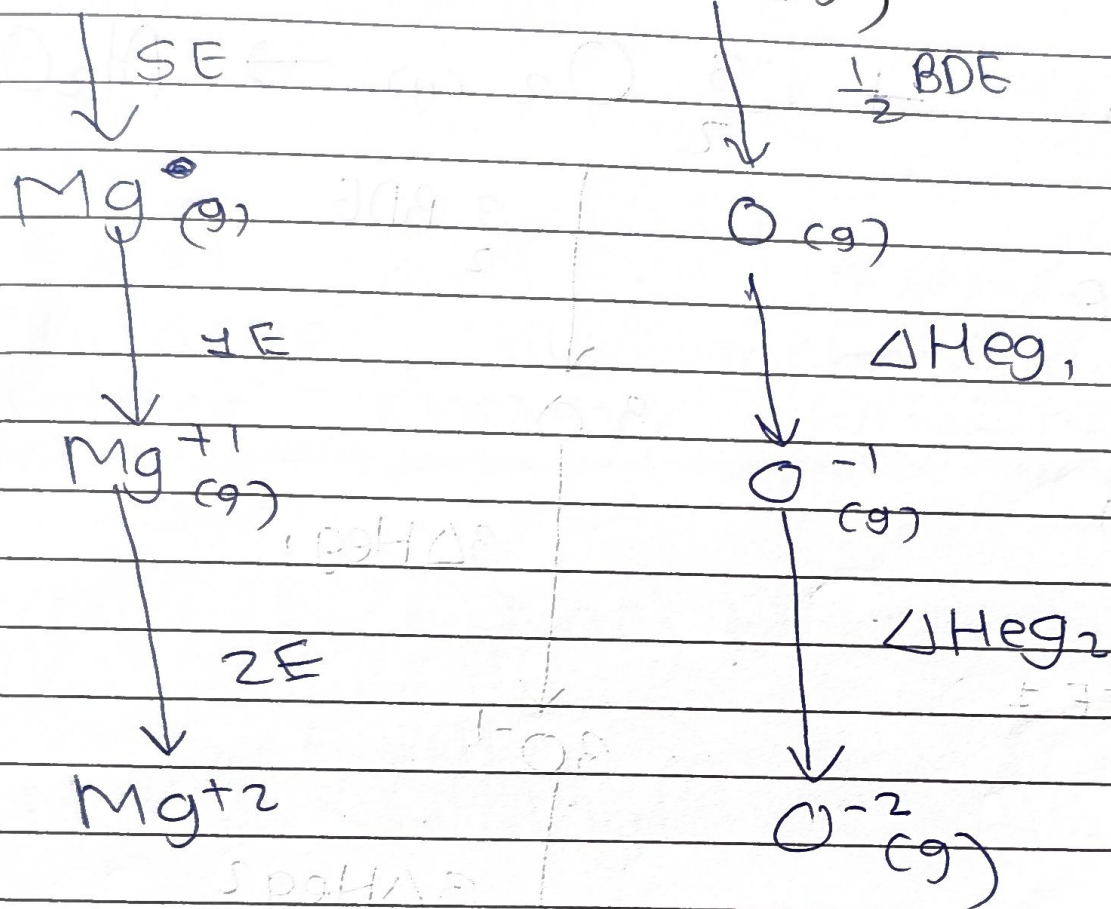
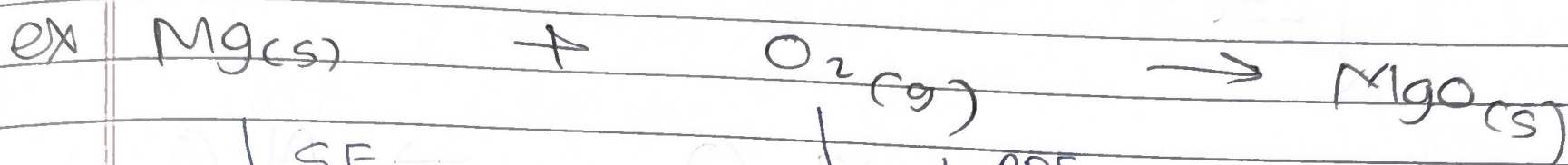
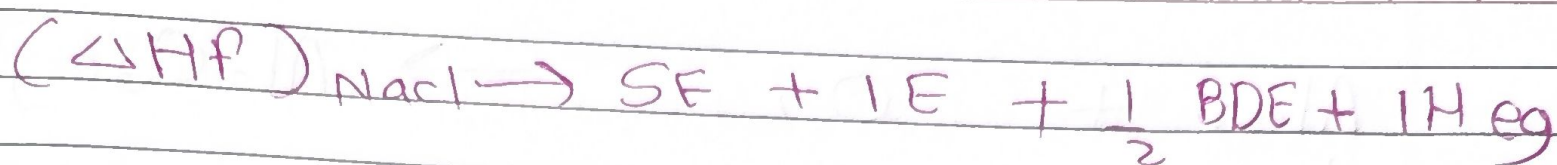
- a) $\Delta H \neq \Delta H_f$
 b) $\Delta H = \Delta H_f$
 c) both a & b
 d) None
- C does not find in diamond state

Hess's law

This law state that when a chemical reaction take place in multiples state then energy in all the process well be same [Constant]

ex Sublimation





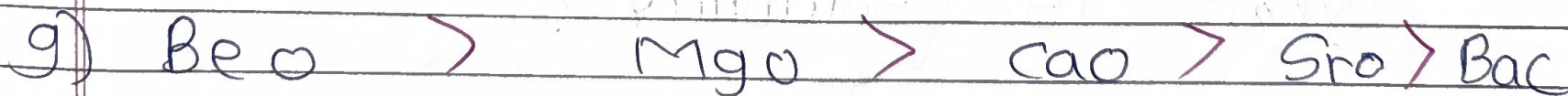
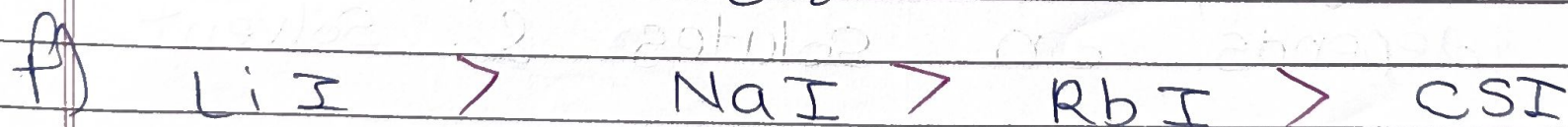
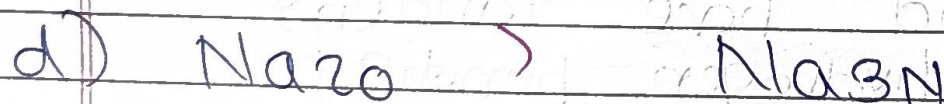
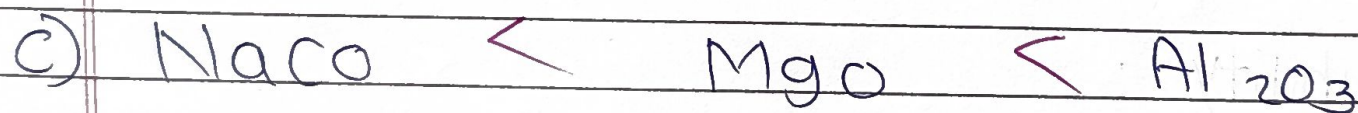
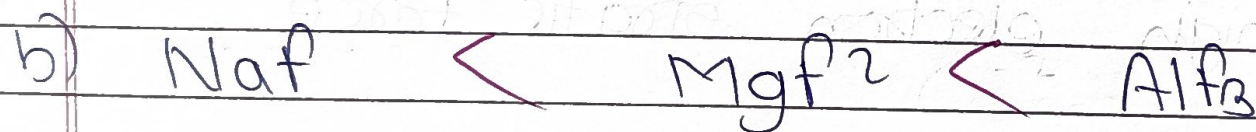
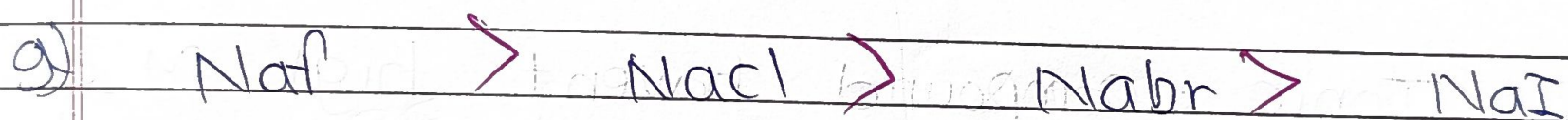
Factor affecting Lattice energy

Lattice energy $\propto$ anion and cation

Lattice energy $\propto \frac{1}{\text{Size of atom}}$

★

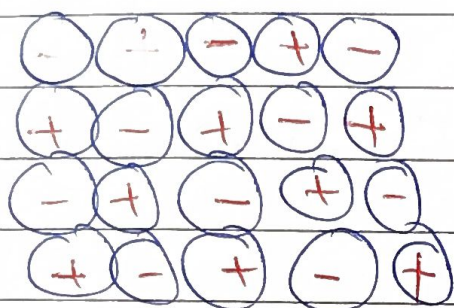
Q1 Arrange in increasing order of Lattice energy



Properties of Ionic Compound

a) physical state
all ionic compound Solid State

M.P & B.P



Ionic compound haven't high M
Boiling point because ionic compound
contain high electron static force

* Solubility :

Ionic compound have tendency
formation of hydrogen bonding

Solubility of ionic compound
depends on solutes & solvent

What is solubility?

Solubility is define as that inter
mixing solute & solvent, solute
surrounded by solvents

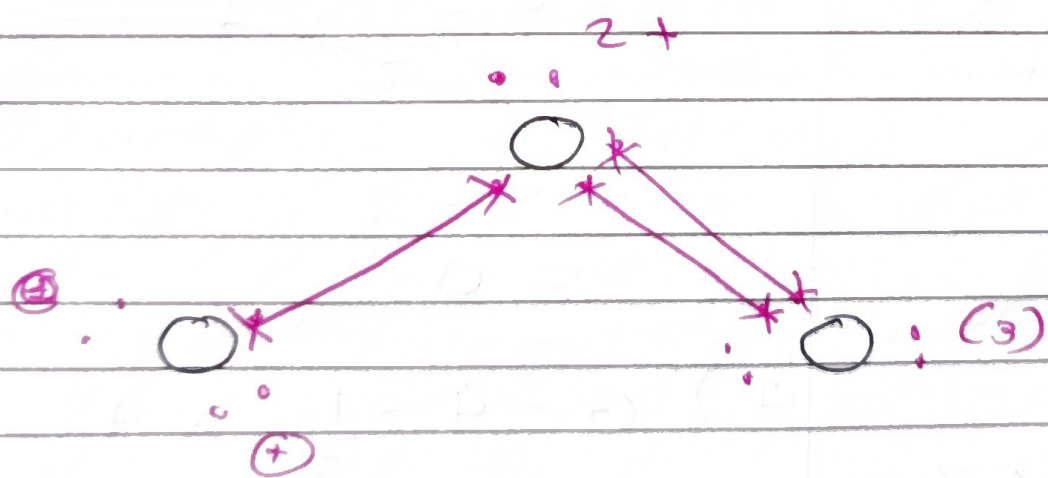
Formal Charge

Formal charge state that difference between sharing pair - unpair e^- and valence

Formal Charge

- 1) Total number of valence e^- in atomic in free state
- 2) total number of bonding e^-
- 3) $\frac{1}{2}$ [total number of bonding electron]

ex $[O_3 \text{ (ozone)}]$



$$1) 6 - 4 - \frac{1}{2} \times 2$$

$$\begin{array}{r} 6 - 4 - 1 \\ 2 - 1 \\ + 1 \end{array}$$

$$2) 6 - 2 - \frac{1}{2} \times 6$$

$$\begin{array}{r} 4 - 3 \\ + 1 \end{array}$$

$$3) 6 - 4 - \frac{1}{2} \times 4$$

$$\begin{array}{r} 2 - 0 \\ = 0 \end{array}$$

★ Limitation of the octet rule :

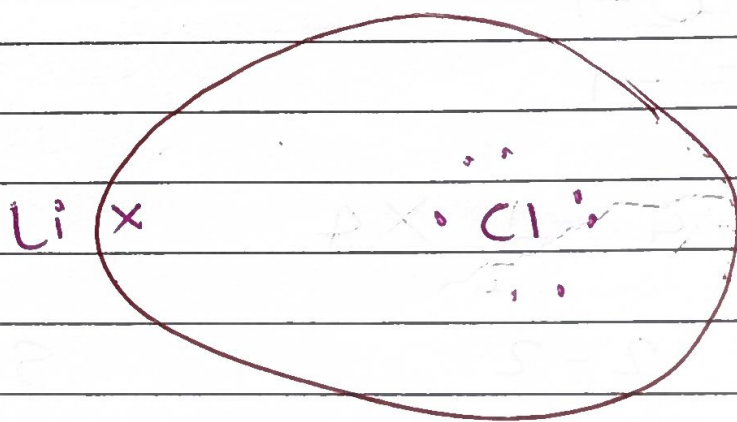
★ Octet rule states that any element completes their valence, forming 8 electrons in their outermost shell.

Note: Hydrogen completes their shell by 2 electrons, which is called a doublet of hydrogen.

There are three types of drawbacks of the octet rule.

a) Incomplete octet of central atom

i) LiCl

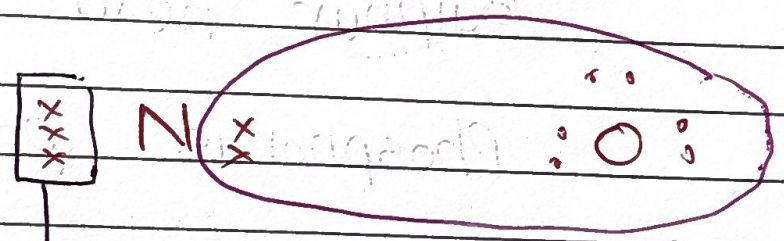


b) odd electron molecule

Such chemical compound that central atom contains odd number of electron is called odd electron molecule

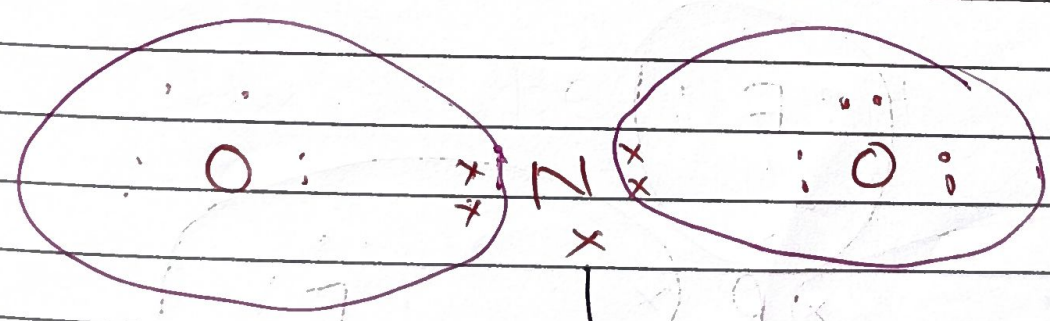
ex NO Nitrogen monoxide
NO₂⁺ Nitrogen dioxide

i)



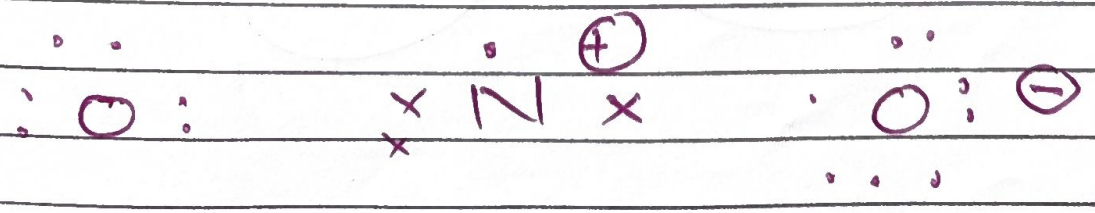
odd number of unshared electron

ii) NO₂⁻



odd number of unshared electron

or



C) The Expanded octet

When central atom of molecule has more than 8 electrons. That formation of octet is called expanded octet.

ex. H_2SO_4

Sulphuric acid/
Hydrogen sulphate

-(king of acid)

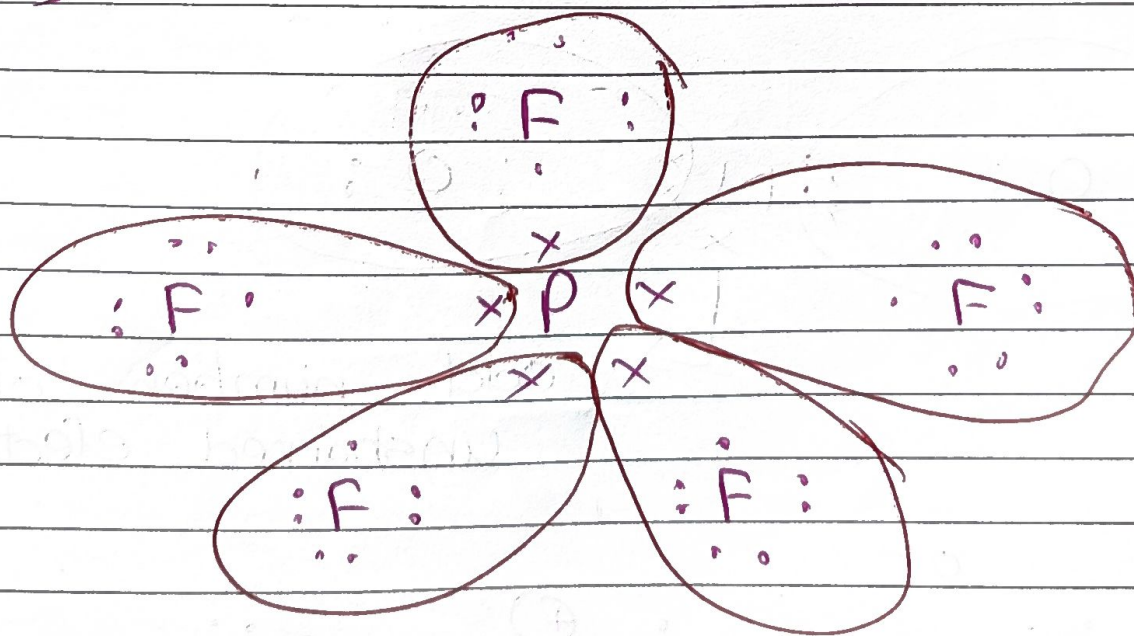
SF_6

Sulphur hexa fluoride

PF_5

Phosphorus penta fluoride

PF_5



Find the dipolemoment / charge / Bond length

$$M = Q \times \text{Bond length (r)} \quad \text{Cm}$$

$$\mu = 3.33564 \times 10^{-30} \text{ Cm}$$

$$Q = \text{Magnitude of charge}$$

Dipole moment of an substance are 1.85 D and bond length 6.17 cm Find the charge of That substance

$$\rightarrow 1.85 \times 3.33564 \times 10^{-30} \text{ Cm}$$

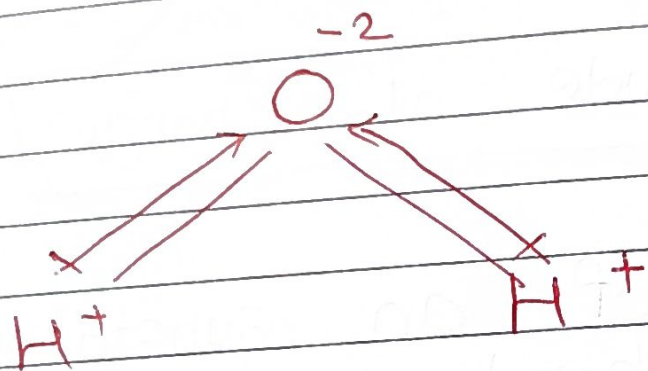
$$6.17 \times 10^{-30} \text{ m}$$

$$Q = \frac{1.1}{6.1} = \frac{6.17 \times 10^{-30} \text{ Cm}}{6.17 \text{ m}}$$

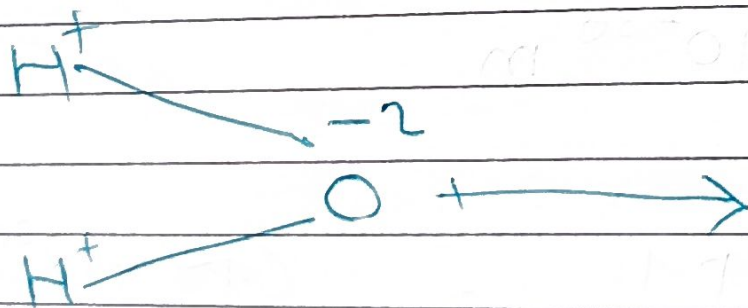
$$= 10^{-30} \text{ C}$$

Dipole moment by $\vec{\mu}$ (ve) vector Quantity it represents
 tail head

Dipole moment of H_2O



Resultant dipole moment



Dipole moment

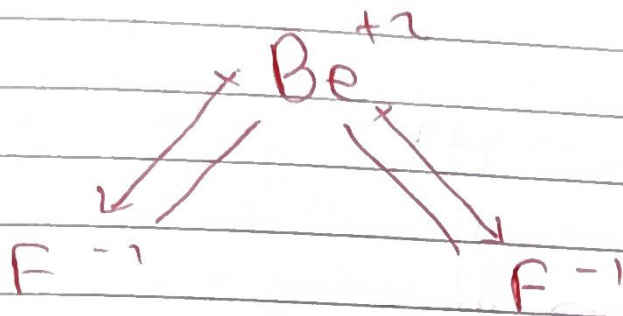
Resultant

Dipole moment

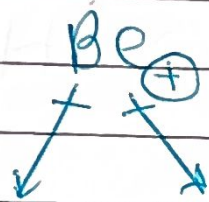


Resultant

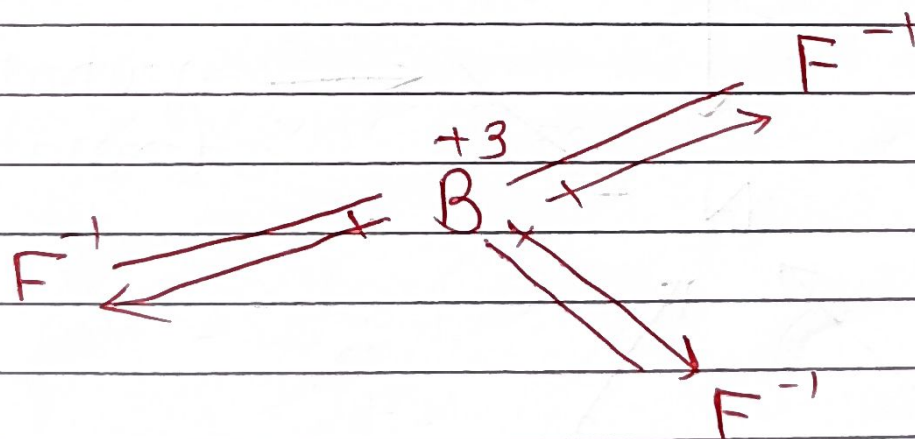
Dipole moment of BeF_2



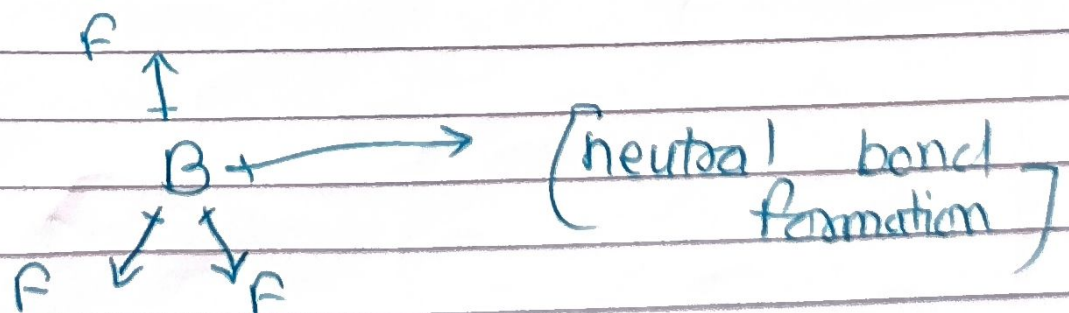
Resultant dipole moment



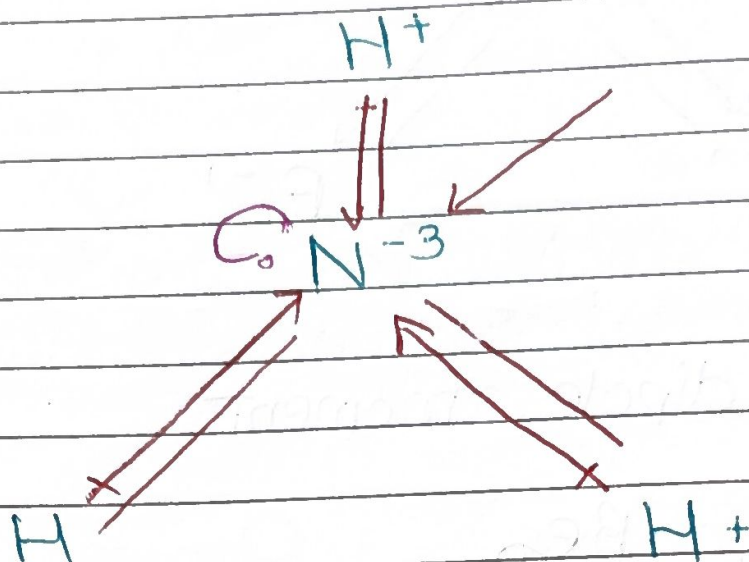
Dipole moment of BF_3



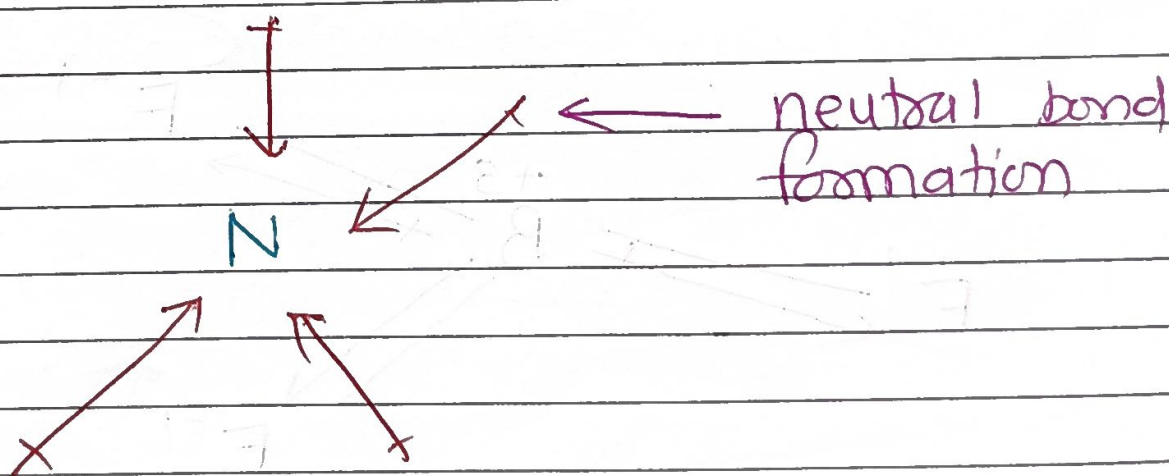
Resultant dipole moment



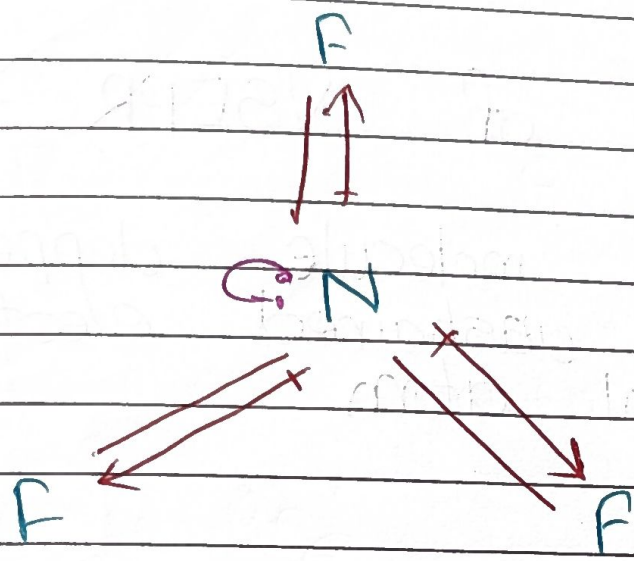
Draw the bond dipole moment and resultant dipole moment of NH_3 & NF_3



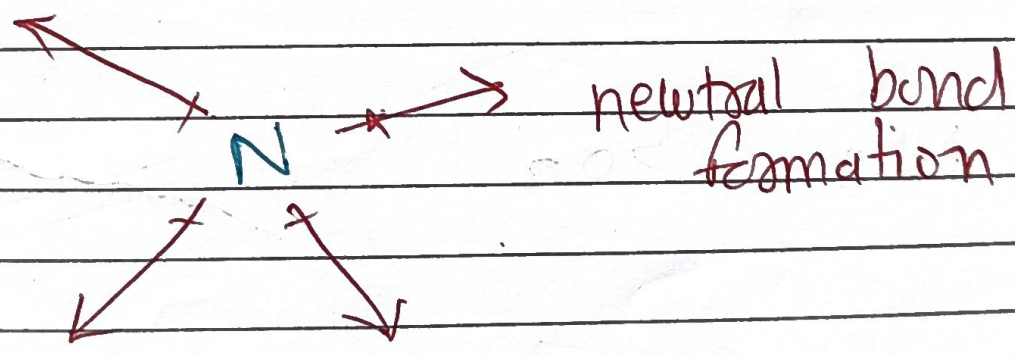
Resultant dipole moment



NF_3 Nitrogen trifluoride



Resultant dipole moment

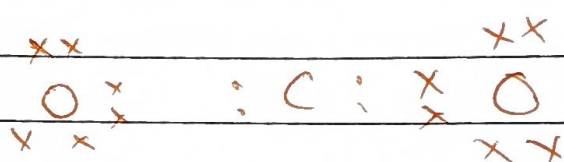


* VSEPR (Valence shell electron pair Repulsion)

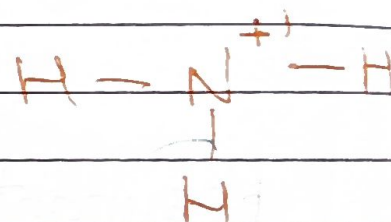
Characteristic of VSEPR

Shape of a molecule depends on shared or unshared electrons around central atom

ex

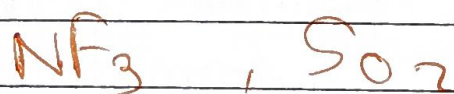


ex



When central atom surrounded by negatively charge it Repul to $\pm$

ex



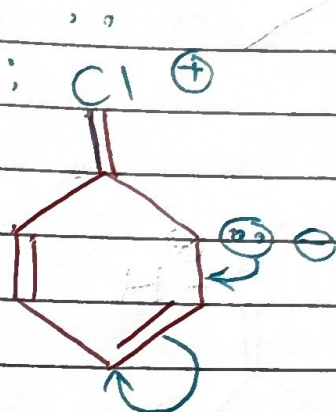
VSEPR is applicabal, Such structure that form resonance

Chlorobenzene

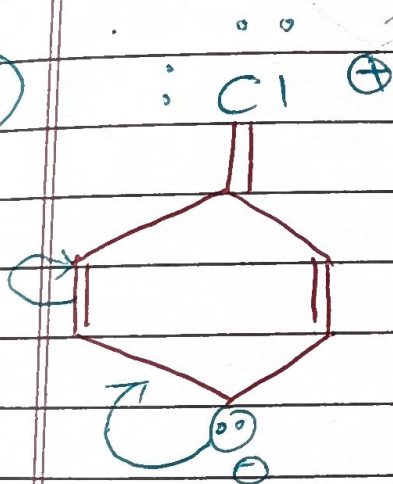
1)



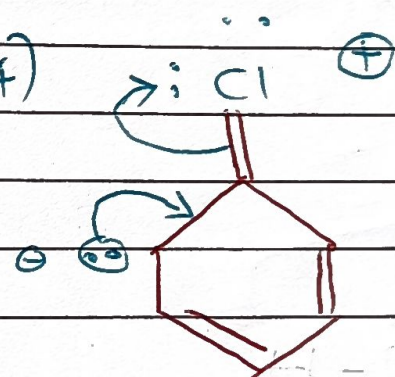
2)



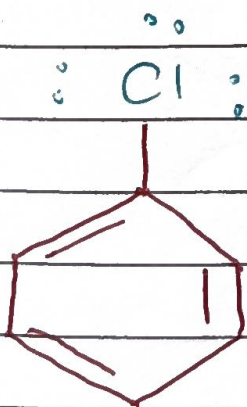
3)



4)



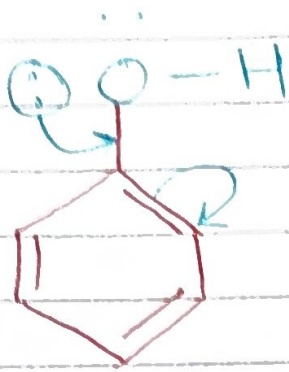
5)



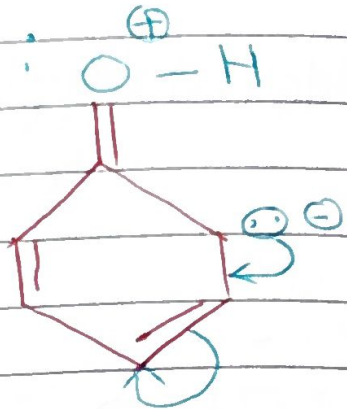
Phenol

2

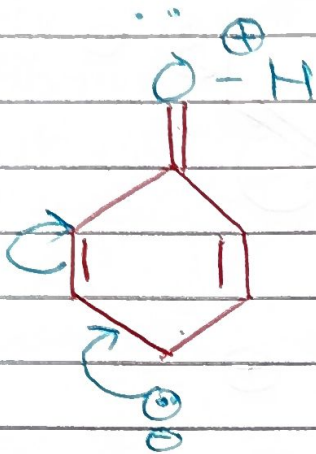
1)



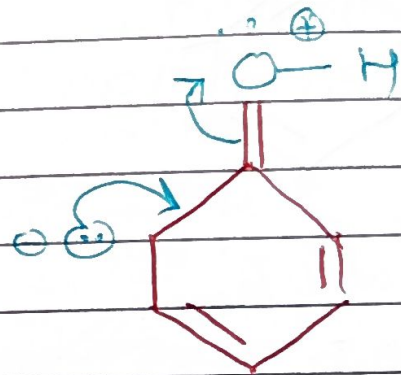
2)



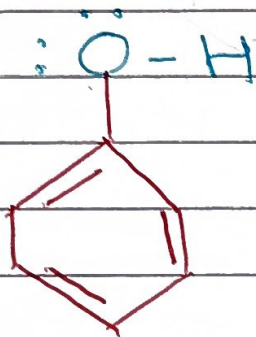
3)

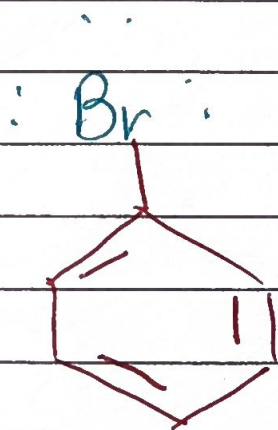
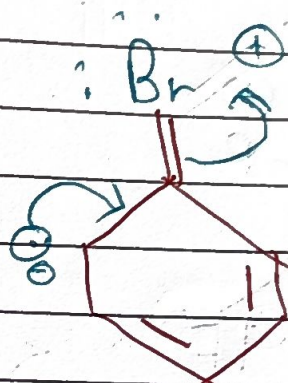
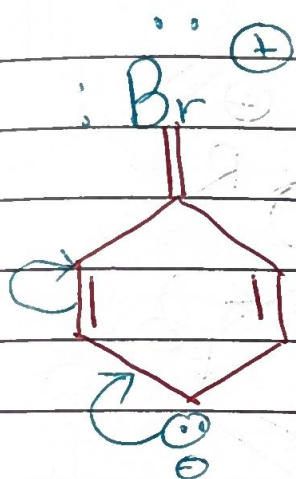
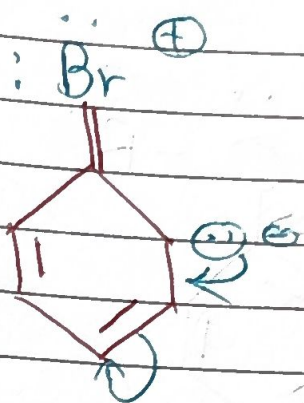
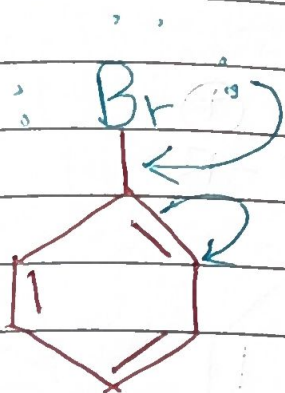


4)



5)





Rules of VSEPR

- 1) Electron pairs arrange themselves in such a way that repulsion between them is minimum.
- 2) The molecule acquires minimum energy and maximum stability.
- 3) Lone pair of electrons also contribute in determining the shape of the molecules.
- 4) Repulsion of other electron pairs by the lone pairs (L.P) stronger than that of bonding pair (B.P)