Chapter 4. Chemical bonding

~ covalent

~ ionic

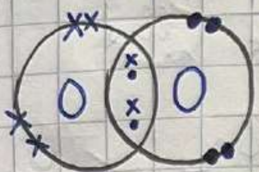
~ metallic

Covalent bond

↳ shared pair of electron

H_2

O_2

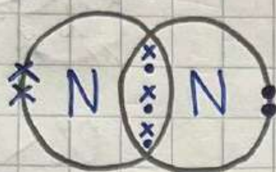


$O=O$

↑

double bond

N_2



$N \equiv N$

↑

triple bond

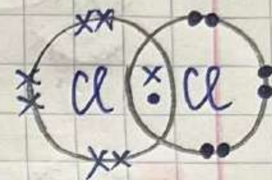
HCl

$H-Cl$

↑

single bond

Cl_2



$Cl-Cl$

↑

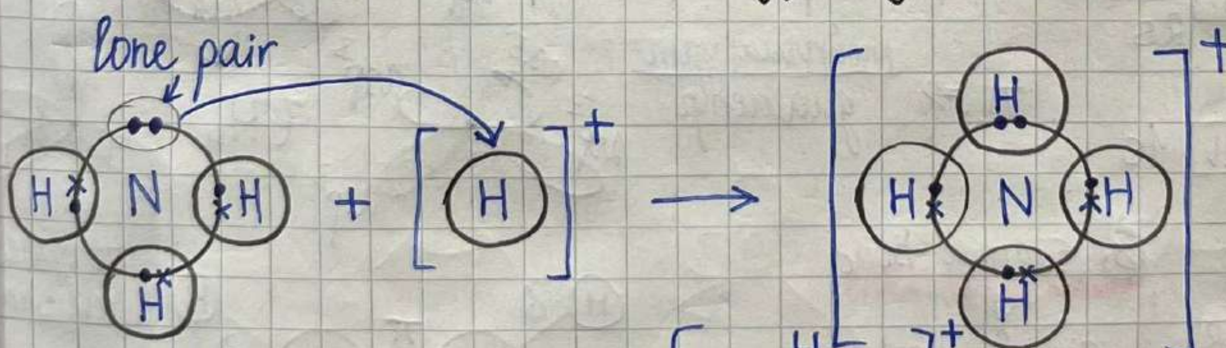
single bond

Co-ordinate bonding (dative covalent)

↳ when one atom provides both the electrons needed for covalent bond.

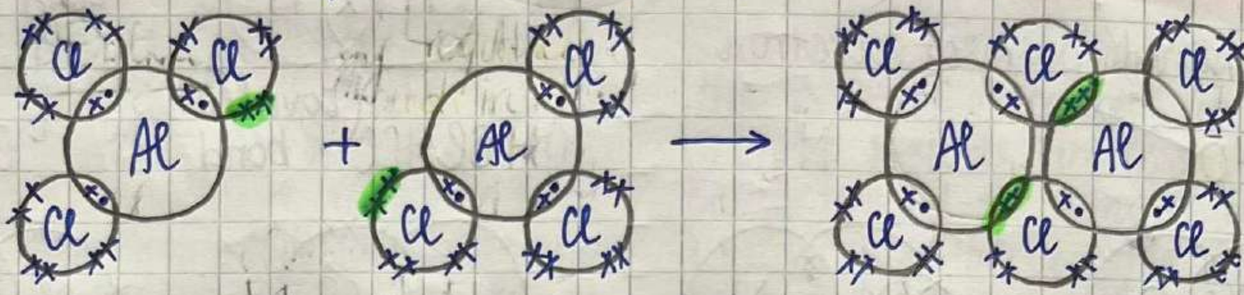
↳ 1 atom have lone pair e^-s.

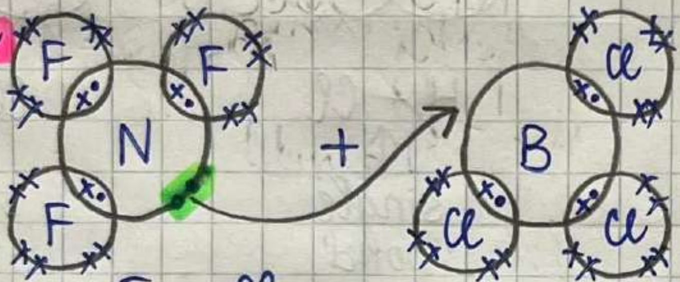
↳ Other atom having unfilled orbital to accept the lone pair. → electron deficient . gymargar

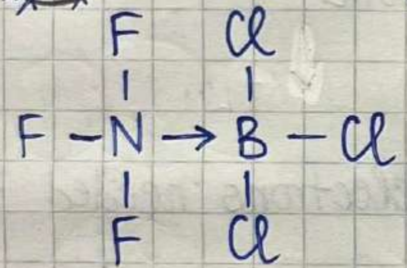


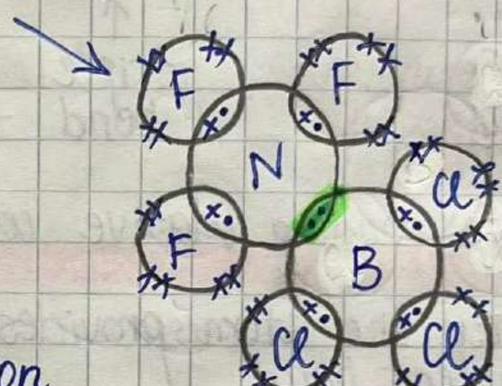
$$H-\ddot{N}-H \; (\text{with } H \text{ below } N) \; + \; H^+ \longrightarrow \left[H-\underset{\displaystyle H}{\overset{\displaystyle H \atop \uparrow}{N}}-H \right]^+$$

$Al\ 1s^2 2s^2 2p^6 3s^2 3p_x^1 3p_y^0 3p_z^0$ → unfilled orbital



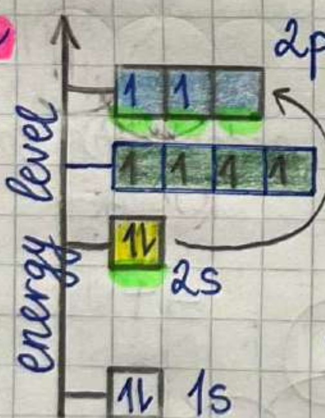






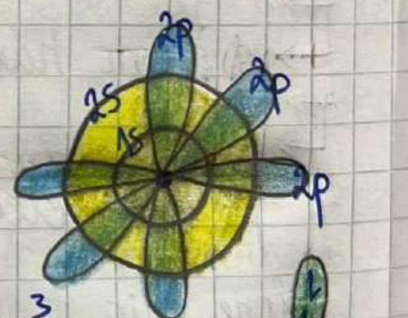
Hybridisation

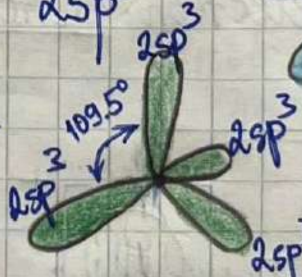
carbon



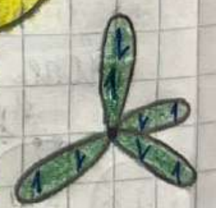
hybrid orbitals
$2sp^3$ $2sp^3$ $2sp^3$ $2sp^3$

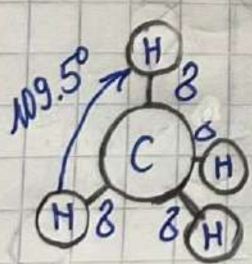
$\pi \Rightarrow \frac{\text{тойргийн урт}}{\text{диаметр}}$





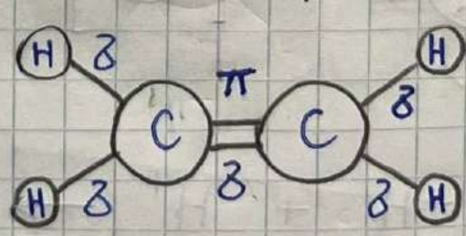
CH_4



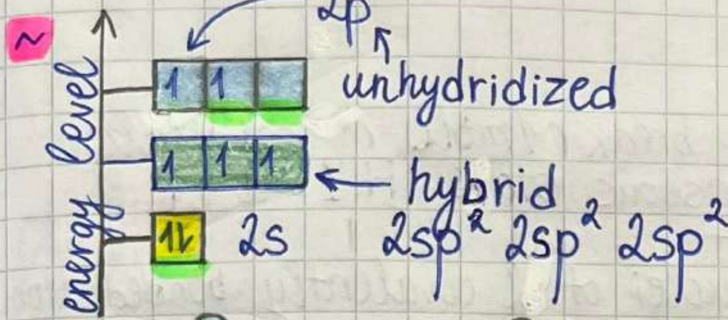


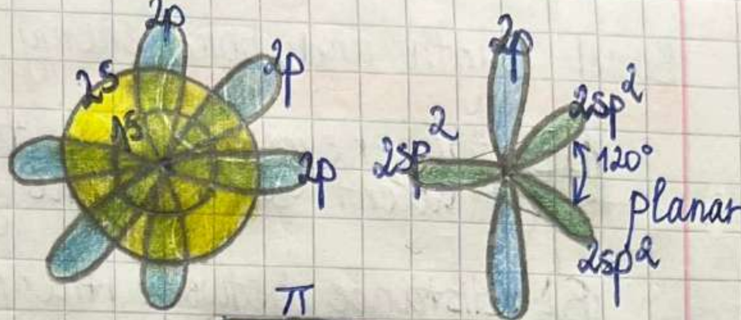
σ sigma bond
⇓
single bond

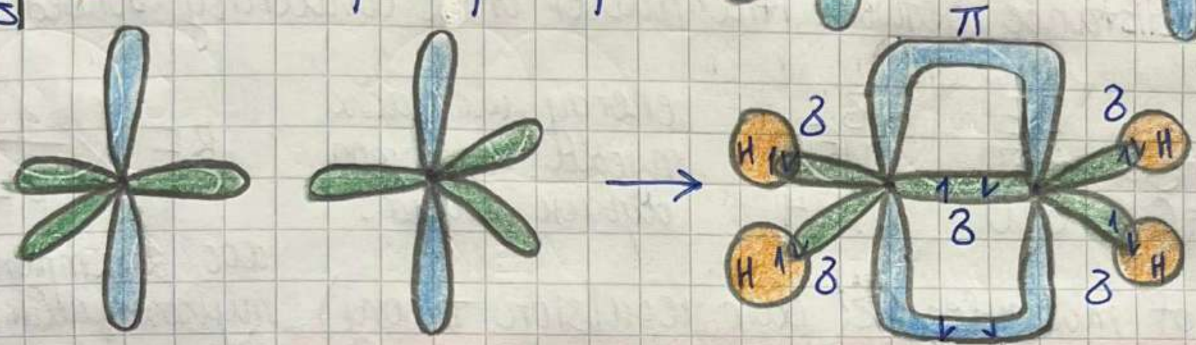
атомуудын төвийг дайрсан шулуун дээр оршино.



tetrahedral shape



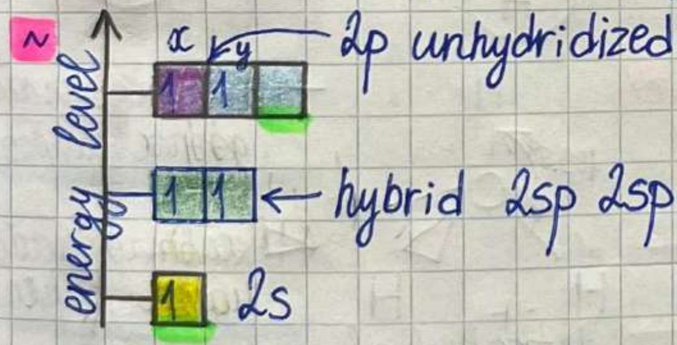


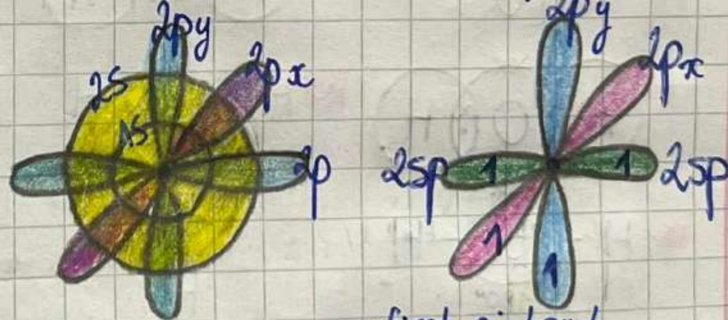


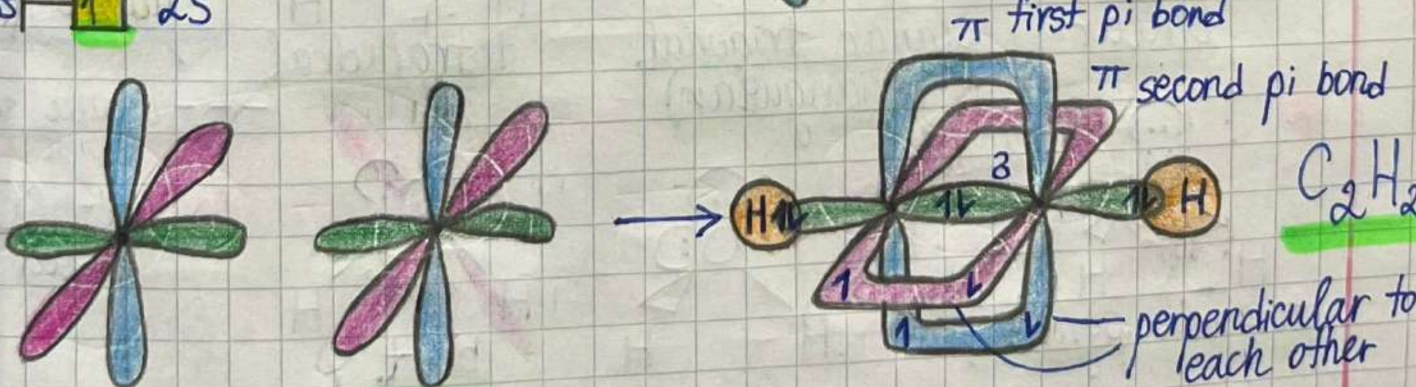
C_2H_4

~ Sigma bond = hybridized orbital + hydridized orbital
= hybridized orbital + s orbital

~ Pi bond = unhybridized p orbital + unhydridized p orbital







C_2H_2

Bond length and bond energy.

BE: the energy required to break 1 mole of particular covalent bond in the gaseous state. [$kJ\ mol^{-1}$]

BL: distance between the nuclei of 2 covalently bonded atoms.

	BE	BL
C−C	350	0.154
C=C	610	0.134

energy их байх тусам хоорондоо ойрхон байна.

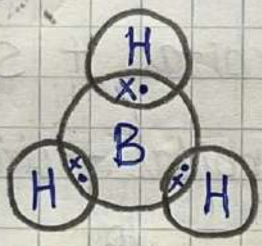
$$BE \propto \frac{1}{BL}$$

Shapes of molecules (e⁻ pair repulsion theory)

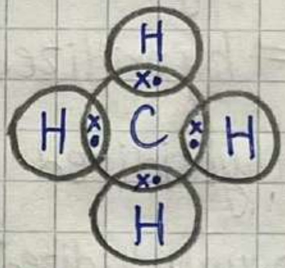
хос электроны түлхэлцлийн онол

~ BeH_2

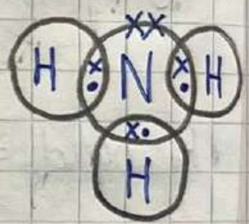
~ BH_3



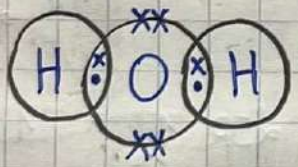
~ CH_4

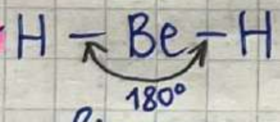


~ NH_3

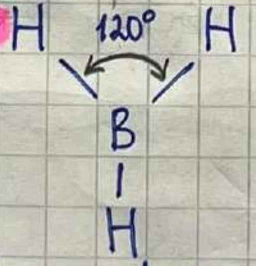


~ H_2O

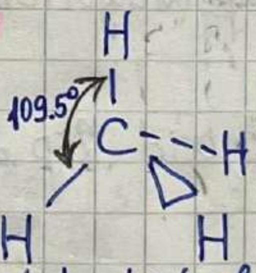


~ 

linear

~ 

planar trigonal (triangular)

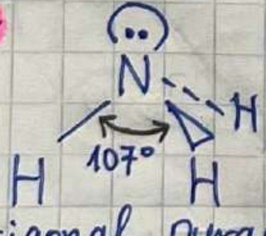
~ 

tetrahedral

— нэг хавтгай дээрх холбоо

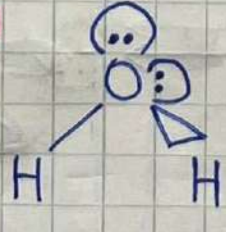
◁ хавтгайгаас наашаа гарсан

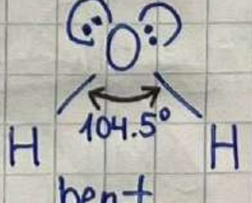
--- цаашаа гарсан

~ 

stronger repulsion

trigonal pyramid

~ 



bent

~ H−Cl linear

- Lone pair of e^-s have a more concentrated e^- charge cloud than bonding pair of e^-s.

l.p ⇒ lone pair

s.p ⇒ shared pair

l.p − l.p > l.p − s.p > s.p − s.p

Inter molecular forces.

Electronegativity: the ability of a particular atom, which is covalently bonded to another atom, to attract the bond pair of e^-s towards itself.

- EN increases across a period from group I to group 17.
- Decreases down the group — $\boxed{F > O > N > Cl}$
- Metals have lower EN — metals < H < non-metals

Hydrocarbon - carbon, hydrogen

Polarity in molecules.

$H^{+\delta} \overset{\times}{:} Cl^{-\delta}$

$+\delta \longrightarrow -\delta$

dipole : positive and negative poles.

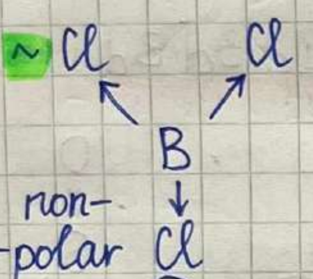
↳ the centre of positive charge does not coincide with the centre of negative charge → electron distribution is symmetric

↳ Two atoms are partially charged ↗ that bond is polar

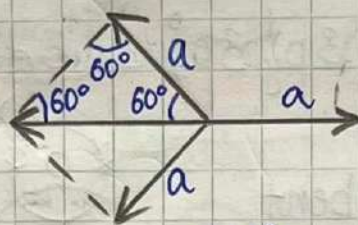
~ Cl ← Be → Cl

non-polar

~



non-polar



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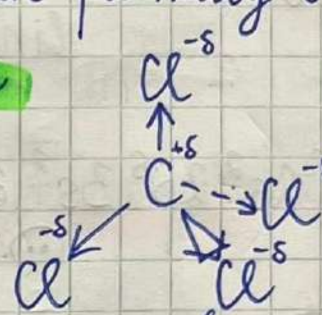
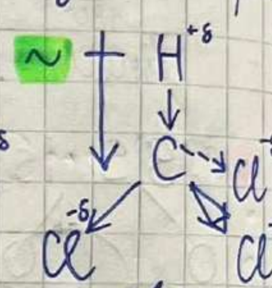


non-polar

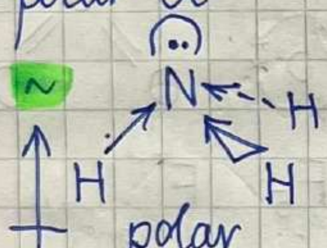
~



polar

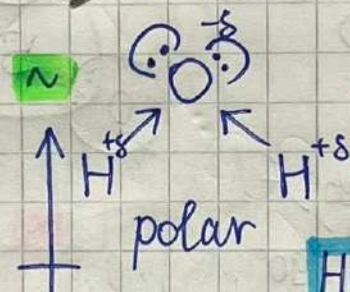
Carbohydrate - carbon, hydrogen, oxygen

~



polar

~



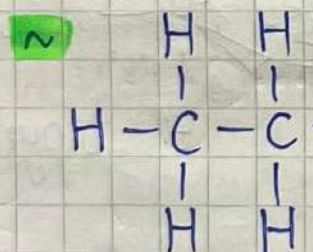
polar

• Non-polar ⇒ no lone pair

• Polar ⇒ have lone pair

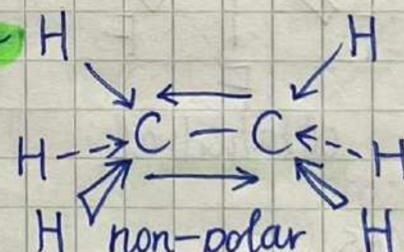
Hydrocarbons are non-polar.

~



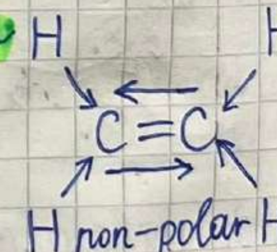
C_2H_6

~



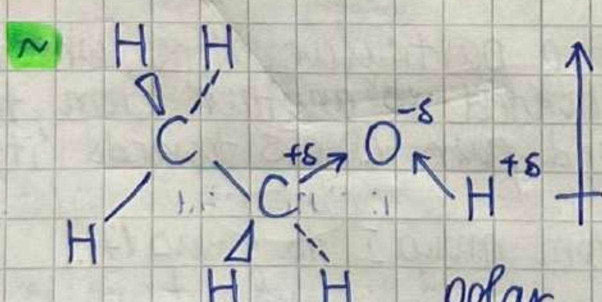
non-polar

~



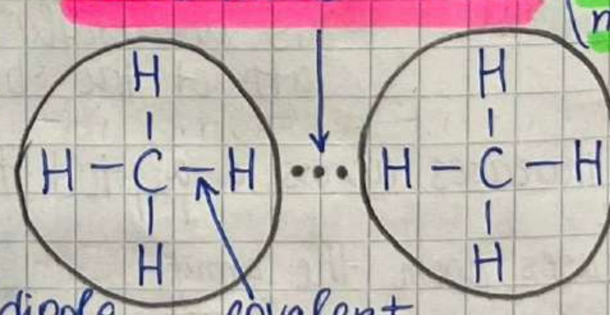
non-polar

~



polar

Vanderwaals forces. (between molecules)



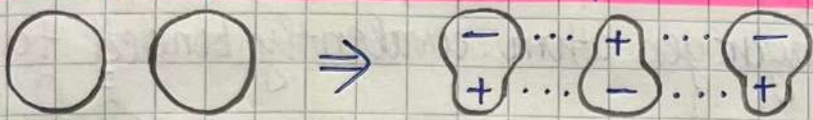
covalent bond (between atoms)

1. temporary dipole - induced dipole force (non-polar)

stronger

2. permanent dipole - dipole force (polar)

Temporary dipole - induced dipole force



weak force

- Forces
  - → electron share
  - → attraction between opposite charges

~ Non-polar molecules have low melting point

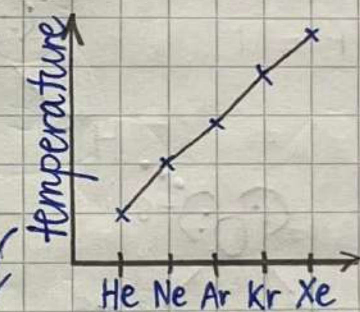
Permanent dipole-dipole force

$C^{+\delta}H^{+\delta}Cl_3^{-\delta}$

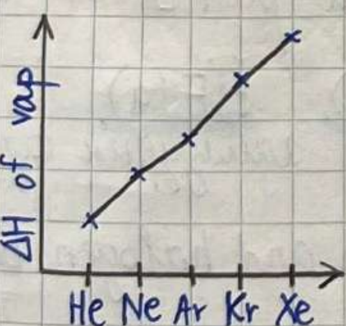
stronger than non-polar molecule's force

Vander waals forces increases with:

- → number of electrons in molecule
- → contact point between molecules



~ Increase in electron number, force, melting point



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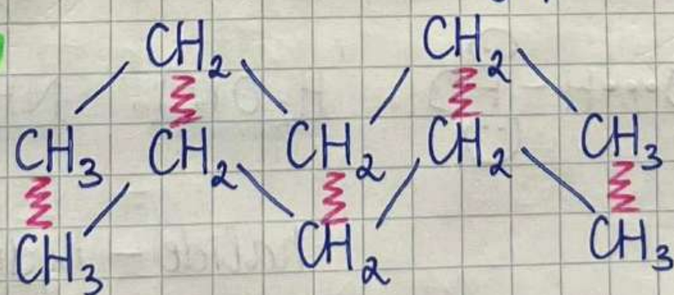
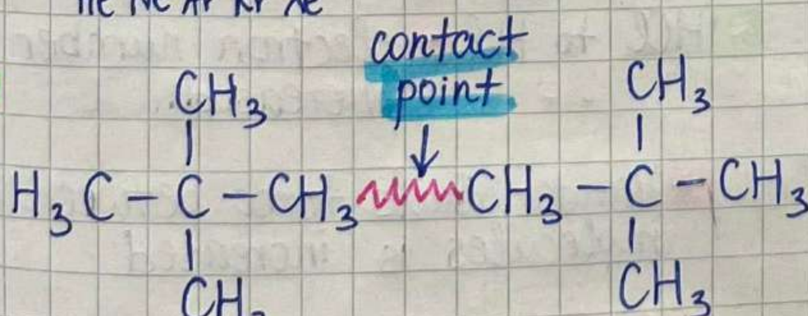


b.p = 36°C

~



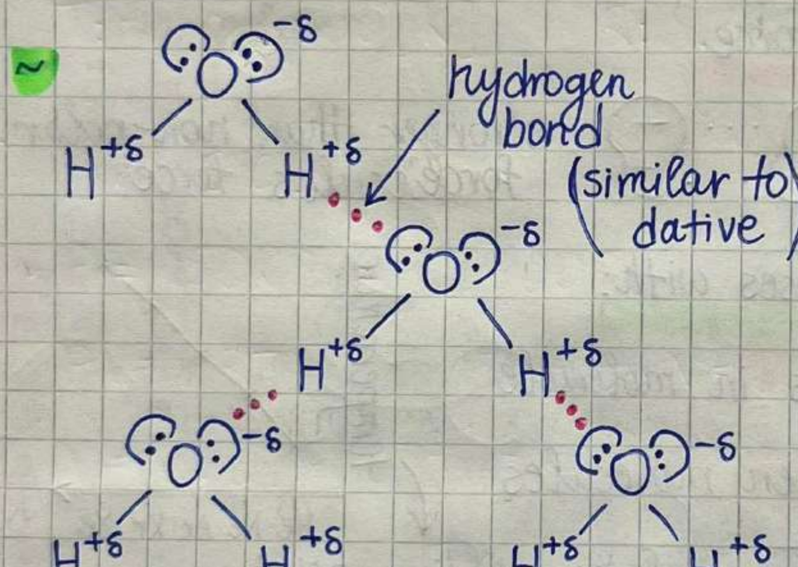
b.p = 10°C

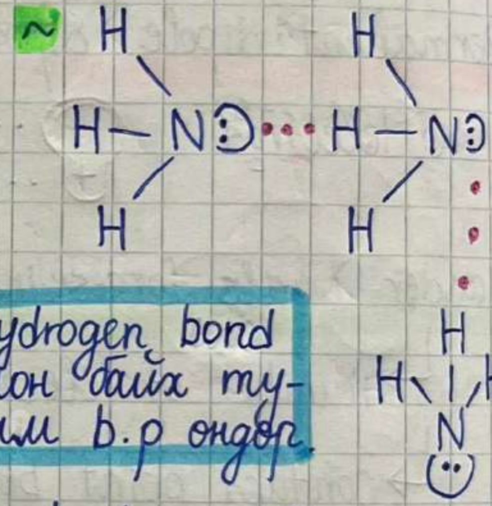
Branch олон байх тусам contact point багасна.

Хамгийн чухал зүйл бол electron number. Дараа нь contact point болон temporary, permanent-ыг харна.

Hydrogen bond

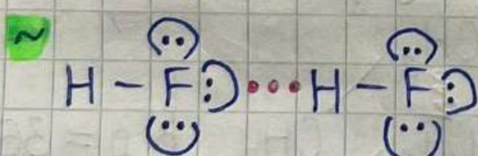
- ↳ stronger force between molecules
- ↳ one molecule have hydrogen atom covalently bonded to F, O, N
- ↳ second molecule have F, O, N atom with available lone pair of electrons



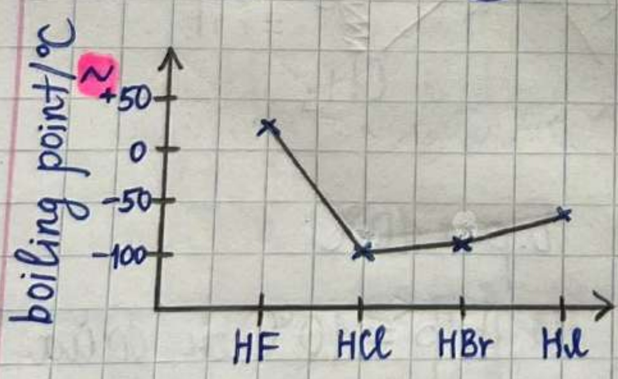


Hydrogen bond олон байх ту-сам b.p өндөр

↳ hydrogen
↳ lone pair } олон ⇒ олон hydrogen bond



$H_2O(l)$ $NH_3(g)$ $HF(g)$ хайлуурын хүчил



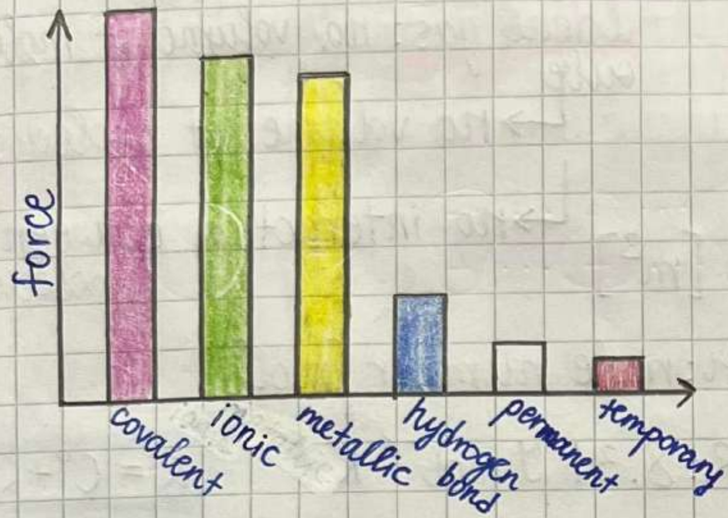
~ HF – hydrogen bond is formed

halide – hydrogen and halogen bond

~ HCl to HI – electron number is increased

– Vander waals force between molecules is increased

– Boiling point increased



Ionic bond

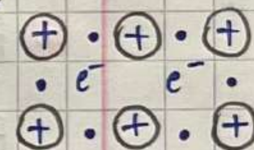
~ electrons are transferred from one atom to another

$Mg(g) \longrightarrow Mg^{2+}(g) + 2e^-$ cation

$\underset{\text{chlorine}}{Cl} + e^- \longrightarrow \underset{\text{chloride}}{Cl^-}$ anion

~ attraction between opposite charged ions

~ giant ionic structure



Metallic bond

~ atoms lose outer shell electrons and produce positive charged cation and free electrons. (main group)

~ attraction between cations and free electrons forms metallic bond

$Na \longrightarrow Na^+ + e^-$

$Mg \longrightarrow Mg^{2+} + 2e^-$

$Al \longrightarrow Al^{3+} + 3e^-$

$\downarrow$ higher melting point, electrical conductivity

~ free electron number is higher per atom

* shell number is increased as go down the 1A group
* attraction force weakens between cation and free electrons
* shielding effect become higher
* same number of outer shell electron