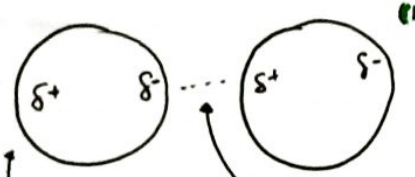
Intermolecular FORCES

VAN DER WAAL'S FORCES / INDUCED DIPOLE² FORCES

(London forces)



* present in all non polar / polar molecules / atoms!

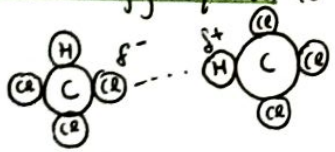
How?
- electrons move @ high speeds
- can be more on one side than other → temporary assymetric distribution of e⁻
- forms dipole
- induces dipole in neibouring atom / molecule
- atoms / molecules attracted to each other.

* only when molecules close tgt. If too far / too big = none.

Factors:
- no. of e⁻ ↑, vdw forces ↑ (more polarisable)
  ↳ ∴ down group, bp ↑
- shape long & thin, vdw forces ↑ (large area)
- shape short & fat, vdw forces ↓ (small area)

PERMANENT DIPOLE² FORCES

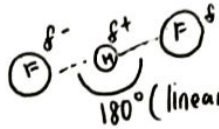
- present in polar molecules (formed with dp-dp moment) ↖ in addition to vdw
- since there is extra attraction between dipoles
  ∴ more energy required to separate molecules.



- Example, why are the bp of ethanal & propane different? (mol. mass = 44 g mol⁻¹)
  ↳ Ethanol has permanent dipole² forces & vdw forces.
  ∴ more energy needed ∴ bp ↑ (eventhough ethanol and propane have same no. of e⁻s)

HYDROGEN BOND

(a type of permanent dipole²)
- stronger than other intermolecular forces
- forms when H bonds with F, O, N (large EN diff) ↖ high charge density too



- H bonds in H_2O
  ↳ two lp ∴ each molecule forms 2 H bonds
  ↳ In ice, each H_2O molecule is bonded to 4 others in a tetrahedral formation.
  ↳ ice less dense than water due to open structure

WHY NH_3, H_2O, HF has anomalously high BP?
↳ due to H bonding, which is stronger than vdw forces & permanent dp²

(boiling temp of other hydrides increase steadily because as e⁻ ↑, vdw forces ↑)

affects:
- mp / bp
- solubility of substances in solvents
- Hardness
- Viscosity

SOLUBILITY

- particles must be separated
- forces between solute & solvent > solute-solute & solvent solvent
- polar soluble in polar cuz → form H bonds with H_2O
- non polar soluble in non polar cuz → similar intermolecular forces
  ∴ can form vdw forces with solvent.
- IONIC COMPOUNDS IN H_2O (small +ve charge)
  ↳ cations surrounded by δ⁻ O
  ↳ anions " by δ⁺ H
  ↳ bonds form between ions & H_2O molecules (ion-dipole forces)
  ↳ called hydration (hydration energy) ↗ name of energy released
  ↳ Energy needed to break bonds compensated by energy released by hydration of ions.

SIMPLE MOLECULAR STRUC. vs SIMPLE MOLECULAR STRUCTURE WITH H-BOND

- if non polar = vdw forces
  if polar = permanent dp² + vdw
- mp low. because vdw forces & permanent dp² forces easy (↑ non H bonds) to break
- Going down halides group, e⁻ ↑, ∴ vdw forces ↑
  ∴ outweighs decrease in permanent dp-dp forces (smaller EN diff)
- if polar, CAN dissolve in H_2O by reacting chemically ($HCl \rightarrow H_3O^+ + Cl^-$)
- if non polar, dissolve in non polar.

- vdw & permanent dp²
- mp ↑. because of vdw forces AND H. bonds.
- WHY HF has higher mp than other halides?
  ↳ it has H bonds as intermolecular forces (stronger)
  ↳ vdw & permanent dp-dp only for other halides
- can dissolve in H_2O cuz can form H bonds with H_2O (hydrogen halides: HCl to HI)