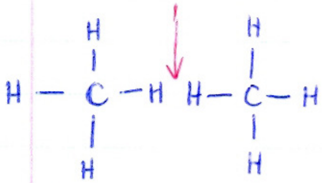
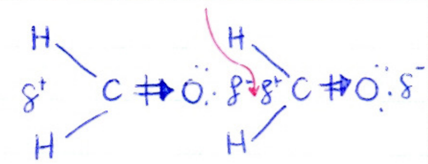
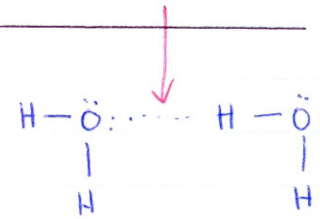
Intermolecular Forces

April. 8 / 13

- between discrete covalent molecules
  - discrete: small specific number of atoms

Van der Waal Force	Dipole Interaction	Hydrogen Bond
	 EN 2.55 3.44	

Problem with terminology

Intermolecular Force
↳ v.d.w force
↳ dipole
↳ H-bond

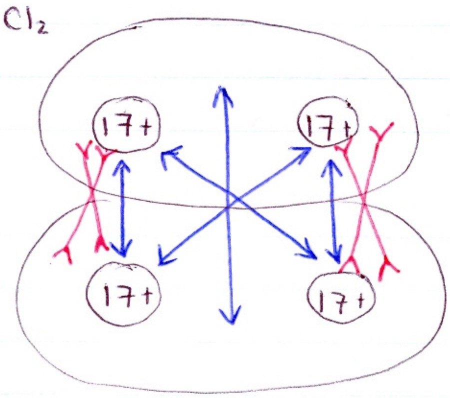
SCH 4U

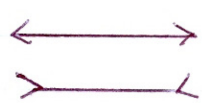
V.D.W Force
(NO)
↳ london
↳ dipole
↳ H-bond

Van der Waals Force (v.d.w)

- is the result of attraction between the nuclei in one molecule with the electron "cloud" in the neighbouring molecule (assume liquid (l) or solid (s) state - i.e no v.d.w in a gas (g) state)

eg. Cl_2





- there is a slight net attraction
- weak force

Two factors affect its strength:

↳ ① Total number of e^- / molecule size. The better is bigger

	mp.(K)	b.p.(K)	# of e^-
He	1	4	2
Ne	24	27	10
Ar	84	88	18
Kr	116	120	36
Xe	161	165	54
Rr	202	211	86

another example of number of e^-

CH_4 ↙

	M.P(K)	b.p(K)	# of e^-
•	-183	-162	10
—	-183	-89	18
	-182	-42	26
	-57	126 ← higher than H_2O	66

for large enough molecules v.d.m become significant.

↳ ② Shape - minor consideration

Highly symmetrical shape, compact molecules } increase m.p due to favourable lattice arrangement which improve ability to fit close together which therefore improves v.d.w force.

↳ decrease b.p - compact shape does not form good liquid interaction

- Long Snakey molecules
  - ↳ ↓ m.p due to poor "crystal" ability in solid state
  - ↳ ↑ b.p due to good liquid interaction

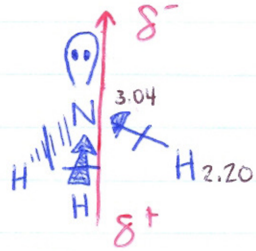
→

	m.p °C	B.P °C
	-18°C	9°C
	-129°C	36°C

Dipole Interactions

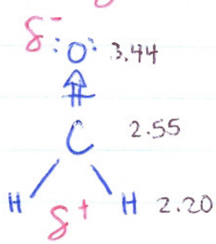
- in addition to an underlying v.d.w force
- requires ΔEN greater than 0.5
- requires asymmetrical geometry with respect to bond polarizations

eg.

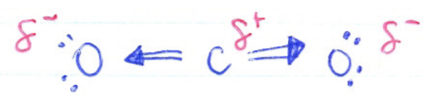


→ δ^- / δ^+ interactions are the dipole intermolecular force

eg.



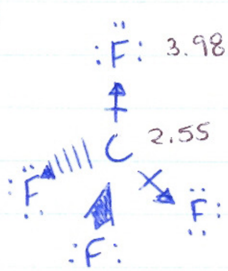
bad example:



SCH → non polar

	m.p	B.P	S.P ← sublimination point
CO_2	N.A	N.A	-78°C

eg

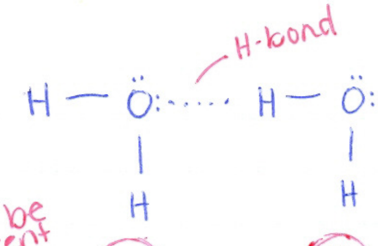


non-polar

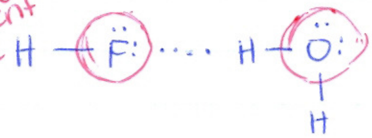
Hydrogen Bonding (H-bond)

- highly directional extreme dipole interaction
- specific requirements
  - ↳ must have a H attached to N, O or F.
  - ↳ must be a second N, O, or F with a lone pair.

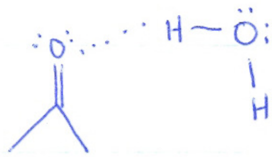
eg.



eg. can be a different molecule



eg.



↳ need high electronegativity N, O or F in order to expose a proton

no polarization consider polarization

↳ need a hard lone pair (hard = small and dense)
- only N, O and F are small enough atoms to have hard lone pairs

- exposed proton / hard lone pair interaction creates H-bond
  - somewhat quutum mechanical