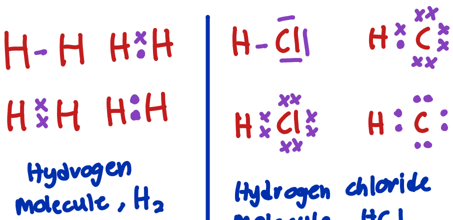
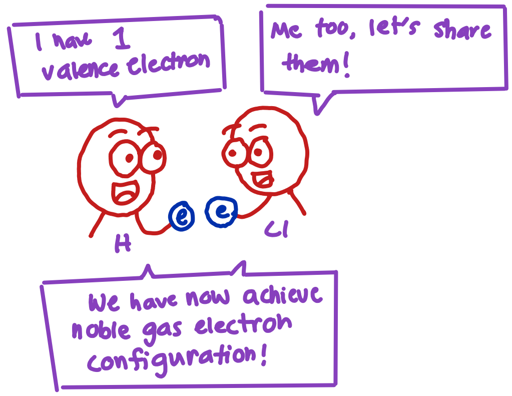
THE COVALENT MODEL

LEWIS FORMULAS

Shows all the outer (valence) electrons for each atom in the molecule





SINGLE COVALENT BOND

(1 electron pair shared between 2 atoms)

H - H   H - Cl

DOUBLE COVALENT BOND

(2 electron pairs shared between 2 atoms)

O=O   O=C=O

TRIPLE COVALENT BOND

(3 electron pairs shared between 2 atoms)

C≡O   N≡N

BOND LENGTH & BOND STRENGTH

LENGTH ↑ STRENGTH ↓

LENGTH ↓ STRENGTH ↑

THE OCTET RULE

- Covalent bonds are formed when e^- from different atoms, either from the same element or different are shared so that each atom attains a noble gas e^- configuration (the Octet Rule)

BOND POLARITY

- Covalent bond between 2 atoms of same element (eg: H_2, O_2, Cl_2) is non-polar since bonding pair of electron shared equally.
- When between 2 different atoms, the bonding will be closer to the more electronegative, thus polar bonding

$\overset{\delta+}{H} - \overset{\delta-}{Cl}$ @ $H \longrightarrow Cl$

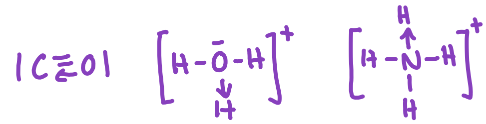
$\Delta en > 1.8$: Ionic

$\Delta en < 1.8$: covalent

$\Delta en < 0.5$: non-polar

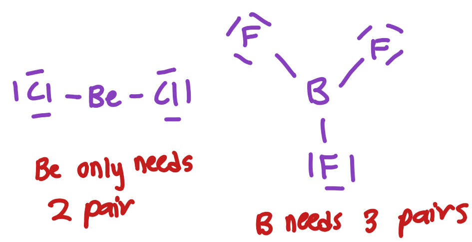
COORDINATION COVALENT BONDS / DATIVE

- Formed when both electrons in the shared pair originate from the same atom
- Exp: CO, H_3O^+, NH_4^+, Al_2Cl_6
- shown using arrow



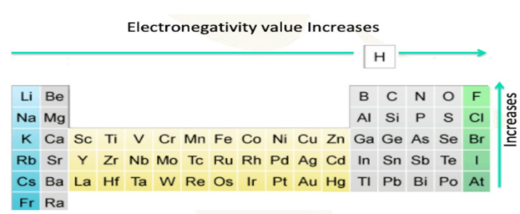
INCOMPLETE OCTET

- Some atom (usually gp 2 & 13) can form stable covalent compounds with an incomplete octet



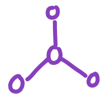
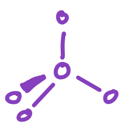
ELECTRONEGATIVITY

- Relative measure of the attraction that an atom has for a shared pair of electrons when it is covalently bonded to other atom.



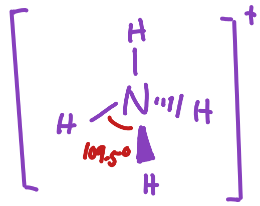
Note: H, C, F, O, N are same (2.2)

BASIC SHAPES & BOND ANGLES

no. of e^- domain	Shape	name	angle
2		linear	180°
3		trigonal planar	120°
4		tetrahedral	109.5°

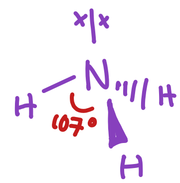
4 ELECTRON DOMAIN
(Tetrahedral)

All bonding



Ammonium Ion

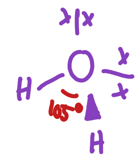
One lone pair



Ammonia

Shape of :
- ↳ E^- domain : Tetrahedral
- ↳ Molecule : Trigonal pyramidal

2 lone pairs



Shape of :
- ↳ E^- domain Tetrahedral
- ↳ Molecule : bent @ v-shaped

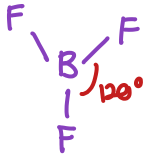
VALENCE SHELL ELECTRON REPULSION THEORY (VSEPR)

- Pairs of electrons are arranged around a central atom in a simple molecule or ion so that they are mutually repulsive (far apart)
- single, double, triple bond and lone pair considered as electron domain
- Repulsion strength:
  1. lone pair
  2. bond

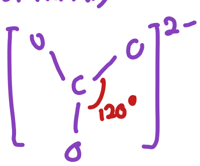
2 ELECTRON DOMAINS
(Linear)

Cl − Be − Cl	Beryllium dichloride
O = C = O	Carbon dioxide
H − C ≡ N	Hydrogen Cyanide

3 ELECTRON DOMAINS
(Trigonal Planar)

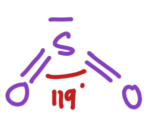


Boron Triflouride



Carbonate ion

"v shaped" @ "bent"



Sulfur oxide

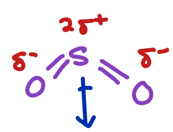
ozone

MOLECULAR POLARITY

- How to determine whether a molecule is polar or non-polar?
  1. Draw Lewis Structure
  2. Mention the shape
  3. Mention polarity of bond
  4. Dipole can / can't cancel out?

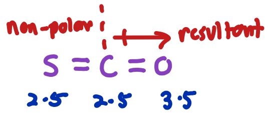
- non-polar bond, the molecule must be non-polar
- polar bond, can be polar @ non-polar, depends on the shape

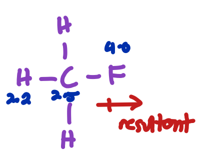
δ^- $2\delta^+$ δ^-
O = C = O
- Linear shape
- Dipoles cancel out
- non-polar molecule



- Bent shape
- there is resultant dipole
- polar molecule

Exp for polar molecule :



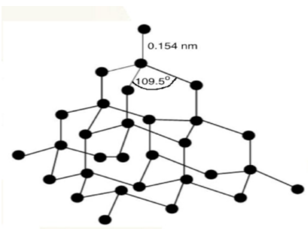


Polar	Non-polar
- Molecule with H-bond (H - F, O, N)	- diatomic molecule
- Resultant dipole	- noble gas
- 0.5 < Δen < 1.8	- molecule with only C and H
	- symmetrical shape (with all legs same atom)
	- Δen < 0.5

COVALENT NETWORK STRUCTURE

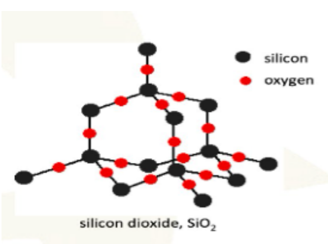
DIAMOND

- Each C are covalently bond tetrahedrally to 4 other C
- No plane of weakness, so diamond is one of the hardest natural substance.



SILICON & SILICON DIOXIDE

- Both Si and Silicon Dioxide (aka. Silica) have diamond-like structure.
- In Silica, each Si is surrounded tetrahedrally by four oxygen atoms
- Silica is hard, ↑ melting point, doesn't conduct electricity, insoluble in water & organic solvents

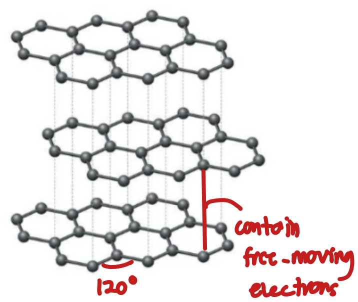


silicon dioxide, SiO_2

- Consist of a lattice of atoms all covalently bonded together to form one giant molecule held together by very strong covalent bonds.
  - ↳ Silicon
  - ↳ Silica
  - ↳ Diamond
  - ↳ Graphite
  - ↳ Buckminsterfullerene
- Strong covalent bonds, results in high melting and boiling points.
- Poor conductors of electricity (except graphite), no free-moving electrons through the structure

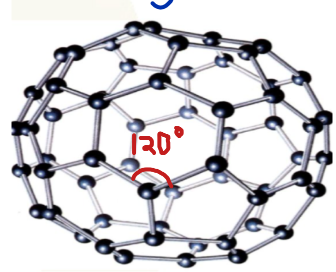
GRAPHITE

- Each C is covalently bonded in a trigonal planar to 3 other C.
- Forming hexagonal layers.
- The layers are held together by weak bonds which contain delocalised e^-
- Good conductor of electricity



BUCKMINSTERFULLERENE

- Each molecule consist of 60 C
- Not really a true covalent network structure.
- C are arranged in 5 and 6 membered rings to form a sphere
- low conductivity



LONDON DISPERSION FORCE

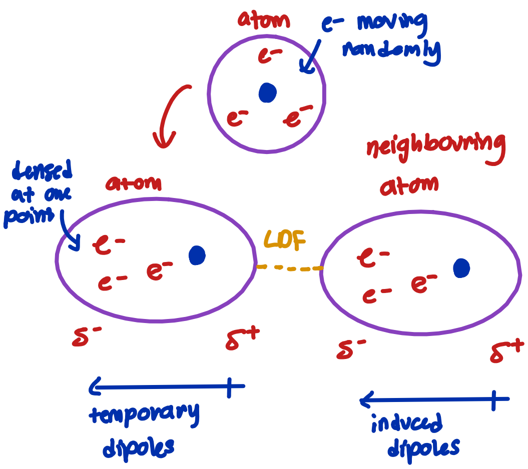
- Temporary
- Exist between all particles
  - Uneven spread of electrons at any given moment

    ⇓

  - Formation of temporary instantaneous dipoles

    ⇓

  - London Dispersion Force
- Between non-polar molecules
- Mass ↑ LDF ↑



DIPOLE - DIPOLE FORCE

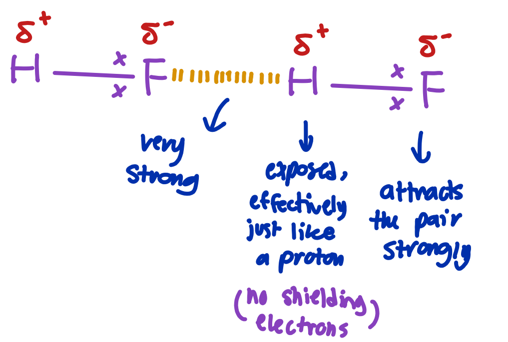
- Polar molecules are attracted to other polar molecules
- Relatively weaker than LDF

VAN DER WAAL'S FORCE

- General term for intermolecular force
- Includes LDF and Dipole-dipole

HYDROGEN BONDING

- It occurs whenever a molecule contains hydrogen atom bonded directly to 3 most en elements (F, O, N)
- Special case of dipole-dipole
- Stronger than normal dipole-dipole



INTERMOLECULAR FORCES (IMF)

ANOMALOUS BEHAVIOUR OF WATER

- Relatively high boiling point for a substance with a RMM of 18
- It expands when it freezes
- Ice has a diamond-like structure which is very open
- When ice melts, the molecules can move closer together

CHROMATOGRAPHY

- To separate different component in a mixture
-

EVIDENCE FOR HYDROGEN BONDING