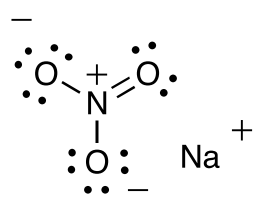
Formal Charge:

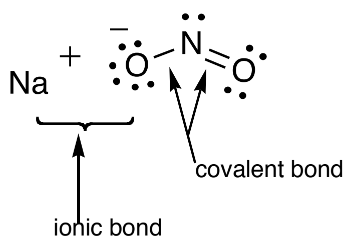
1. Sodium Nitrate – $NaNO_3$



Double bonded oxygen:
+8 (number of protons)
-2 (1s electrons)
-4 (unshared electrons)
½ x 4 = -2 (1/2 of shared electrons)
0

Single bonded oxygen (both):
+8 (number of protons)
-2 (1s electrons)
-6 (unshared electrons)
½ x 2 = -1 (1/2 of shared electrons)
-1

2. Sodium nitrite ($NaNO_2$)



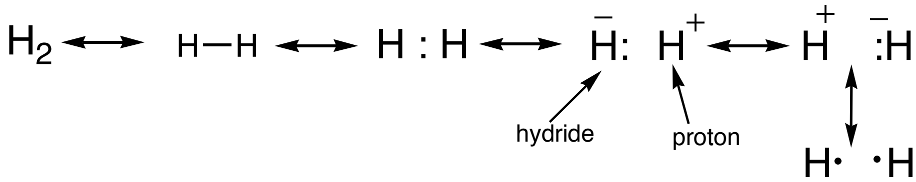
- between Na^+ and NO_2^- → ionic bond
- between N and O in NO_2^- → covalent bond

Double bonded oxygen:
+8 (number of proton)
-2 (1s electron)
-4 (unshared electrons)
½ x 4 = -2 (1/2 of shared electrons)
0

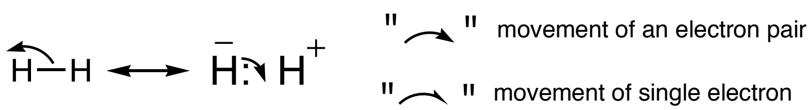
Single bonded oxygen:
+8 (number of proton)
-2 (1s electron)
-6 (unshared electrons)
½ x 2 = -1 (1/2 of shared electrons)
-1

Resonance:
- move the electrons, keeping the position of atoms same → gives different picture of same molecule
- maintain inert gas configuration around each atom
- avoid separation of charges
- avoid like-charges on adjacent atoms

Eg. Hydrogen gas, H_2:



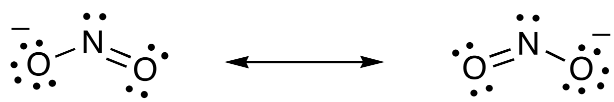
- they are all resonance forms but not necessarily correct
- H-H is the best resonance form
- Double headed arrow (↔) is used indicate resonance forms



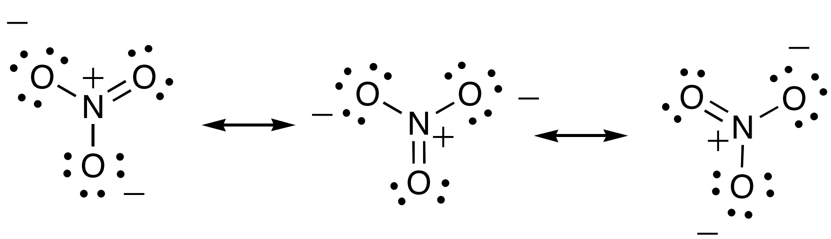
* this is called "arrow pushing" → bookkeeping of electrons

Resonance structure:

1. nitrite anion (NO_2^-)



2. nitrate anion (NO_3^-)



Intermolecular forces: (forces present between molecules)

- steric effects – repulsion of filled (inert gas configuration) shells of electrons
- Attractive intermolecular forces:
  - i) Hydrogen bonding – strongest on per atom basis (eg. base recognition in forming DNA helix)
  - ii) Dipole-dipole interaction
  - iii) London forces (temporary dipole) – weakest on per atom basis (hydrophobic bonding – interaction of protein with drugs)

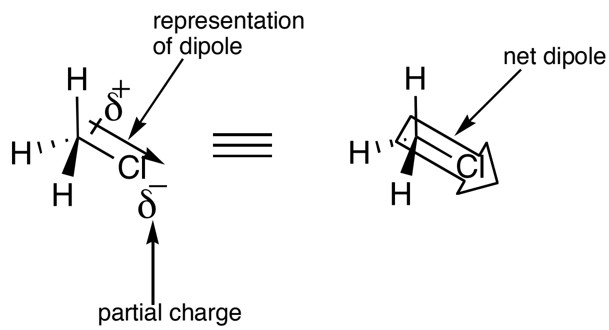
Electronegativity:

- An atom's desire for electrons (negative charge).
- in Periodic table, electronegativity increases as you go from left to right (up to inert gases which are not electronegative) and as you go upwards
- Eg. Fluorine is the most electronegative atom

Dipole moment:

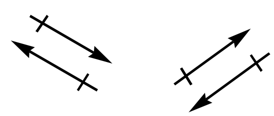
Eg.

1. Methyl chloride, CH_3Cl, $ClCH_3$

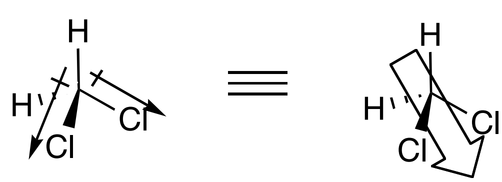


- H and C have similar electronegativity values
- Cl is very electronegative – due to the fact that it only needs one electron to get inert gas configuration
- Electron density is pulled towards chlorine atom – so a net dipole toward chlorine atom – net dipole is the vector sum of individual bond dipoles

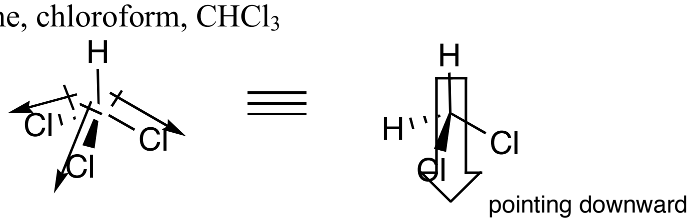
* dipoles in different molecules tend to line-up with each other (partial positive / negative charge on the molecule)



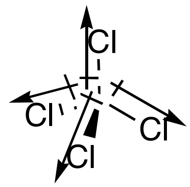
2. Dichloromethane, methylene chloride, CH_2Cl_2



3. trichloromethane, chloroform, $CHCl_3$



4. tetrachloromethane, carbon tetrachloride, CCl_4 (TOXIC)

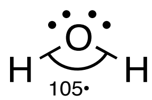


- net-zero dipole

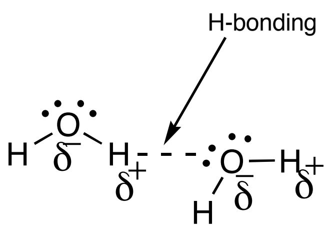
Hydrogen bonding:

- need hydrogen directly attached to a very electronegative atom (halogen, O, N) for Hydrogen bonding between molecules of same type
- strongest intermolecular attractive force

eg. H-O-H (water)



- oxygen is electronegative and it is sp^3 hybridized



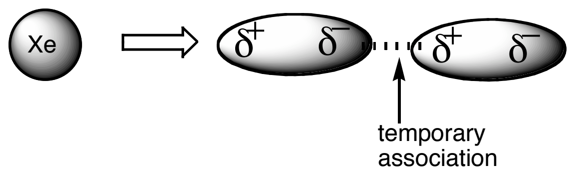
- leads to high boiling point and high melting point by self association
-

- HF, H_2O and NH_3 form hydrogen bonds
- $(CH_3)_3N$ forms no hydrogen bond itself, but if dissolved in water, it forms hydrogen bonds with water

London Forces (temporary dipole):

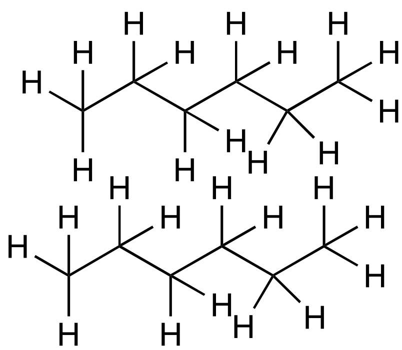
- also know as dispersion forces
- principle effect in hydrophobic interaction

Atoms	boiling point	
		Small atom
He	-269 ^oC	↓
Ne	-246 ^oC	↓
Ar	-186 ^oC	↓
Kr	-153 ^oC	↓
Xe	-108 ^oC	large atom



- the larger the atom (expanded electron density), the easier the formation of dipoles

Hydrophobic interaction: - hexane

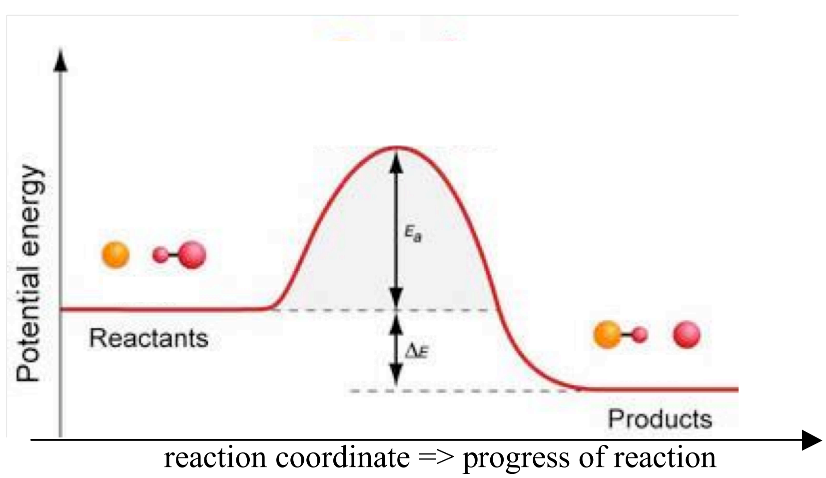


- two hexane molecules have a small attraction to one another at room temperature (hydrophobic interaction)
- longer alkane chains can have such large forces to become solid-like wax

Reactivity:

CH_4 (Methane)	+ $2O_2$	$\xrightarrow{\text{heat}}$	CO_2	+	$2H_2O$

Energy diagram for reaction



Reactants: CH_4 and O_2
Products: CO_2 and H_2O
E_a: activation energy
$\Delta E = \Delta G$: energy (enthalpy) change for the reaction
* this reaction is an exothermic reaction, heat is released during reaction