Lesson 5 For Book 1

Review --- Some implication of Enthalpy change

1) Dinitrogen pentoxide, N_2O_5, can be produced by the following reaction sequence.

, where the enthalpy changes involved are +180 , -57 and -55 kJmol-1 respectively.

a) i) Explain why reaction 1 occurs in car engines.

ii) Suggest why reaction 1 is **endothermic**.

b) i) What is meant by the standard enthalpy change of formation of a compound.

ii) Write the equation which corresponds to the enthalpy change of formation of dinitrogen pentoxide.

iii) By using the data given, calculate the enthalpy change of formation of dinitrogen pentoxide.

1) $N_2(g) + O_2(g) \rightarrow 2NO(g)$

2) $NO(g) + 1/2\ O_2(g) \rightarrow NO_2(g)$ (+114.0 kJmol-1)

3) $2NO_2(g) + 1/2 O_2(g) \rightarrow N_2O_5(g)$

→ You should learn that the sign of **enthalpy change of a reaction** can be predicted/explained by considering the strength of the bonds being broken and that of the bonds being formed.

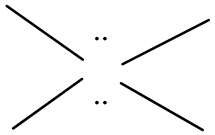
2) Please draw and then state the electronic arrangement and the molecular shape of the following molecules.

a) XeF_4 b) SF_6 c) NO

→ Be careful, electronic arrangement is not the same as molecular shape.

= electronic arrangement needs to take the lone pair electron in consideration.

e.g. XeF_4 , no of valence electrons = 8 + 7*4 = 36



molecular shape is square planar but electronic arrangement is said to be square bipyramidal.

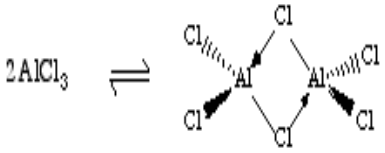
→ Be careful, when the no of valence electron is an ODD number, the species is called r_____. In HKAL, the single electron will ____ affect the shape.

Intermediate Type of Bonding

Thinking

Do you know what is the type of compound $AlCl_3$?

→ Actually, aluminium chloride is a covalent compound with ionic character. It is not a pure ionic compound and that means the bondings involved is not pure ionic bond.



→ The reason is due to the **polarization** of the compound as there is a great difference of electronegativity of the two atoms (in the form of ions).

→ In fact, aluminium chloride does not exist as monomer compound but is in the form of **dimer.** The chlorine atom donates its lone pair electron to the metal centre.

Terms for non pure ionic compound

- **Polarization of ion** refers to the d_____of the electron cloud of an **anion** caused by a **cation**.

→ The ion who can distort another ion is a _____ but **not** an anion. So, we use the term '**polarizing power**' to describe cation **only**. As for anion, we use the term '**polarizability**' to describe the ease of its electron cloud to become distorted.

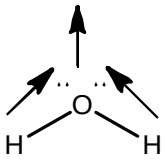
- **Polarizing power** → the ability of a cation to distort the electron distribution in a neighbouring atom, molecule or ion.
  - → depends on the charge, the size (or radius) of the cation
  - → The cation which has a h_____ positive charge and s_____ size has a greater power.
- **Polarizability** → is a measure of the ease of distortion of an anion's electron cloud by neighbouring cations.
  - → depends on the charge, the size (or radius) of the cation
  - → The anion which has a h_____ negative charge and l_____ size has a greater ease of distortion.
- **Consequency → no pure** ionic / covalent compound.

Exercise 1 Do you think that LiCl or RbCl will have a higher degree of agreement between the theoretical and experimental values of the ΔH lattice? (Ans = RbCl)

Term of non-pure covalent compound

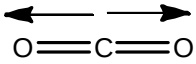
- **Electronegativity** → is the relative tendency of an atom to attract bond pair(s) of electrons towrd itself in a chemical (usually say c_____) bond.
  - → a measure of bond pair electron-attracting ability
  - → **go down a group, the value** _____ as the screening effect by the electron shells reduced the **effective** _____ **charge** → the ability is reducing.
  - → **across a period, the value** _____ as the **nuclear charge** increases

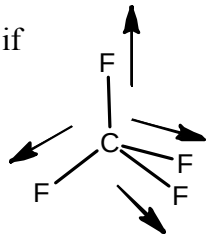
- **Bond Polarization** → originated from the difference of electronegativity of two atoms in a c_____ bond.
  → **generates** a term called **Dipole Moment**
- **Dipole Moment** → a vector **pointing** to the side of the bond which has the ____ electron density.
- **Polar Molecule** → If a molecule has a **permanent** dipole moment, the molecule **i**s said to be polar.



→ Dipole moment is a vector. It can be **cancelled** if there are two or more vectors pointing **opposite** to each other.

= **non** _____

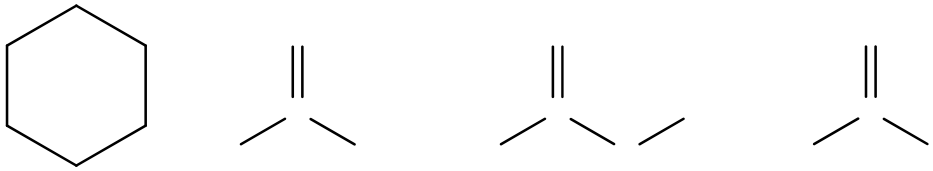




→ CO_2 and CF_4 have more than 1 dipole moment but NO p_____dipole moment.

Thinking How about organic molecules?

Do they have a permanent dipole moment?



→ polar molecule can be **deflected** by a charged metal rod.

→ Polar or not / affects the reactivity of organic compounds and the physical properties of a compound e.g. melting point, boiling point, viscosity and vapour pressure of a solution (HKAL 2009) because it determines the extent of the **Intermolecular force** involeved.

Intermolecular Force

- Intermolecular forces refer to the attraction/ in_____ between molecules. Actually, there are three types of intermolecular forces, i.e., Dipole-Dipole interaction, Dipole-induced dipole interaction and induced-induced dipole (London force).

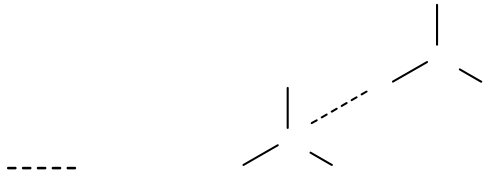
1) **Dipole-Dipole** = coulombic attractions between polar molecules.

→ polar molecule has a permanent dipole moment due to the difference of the electronegativity of the involved atoms.

2) **Dipole-induced Dipole** = coulombic attractions between a polar molecule and a Non polar molecule

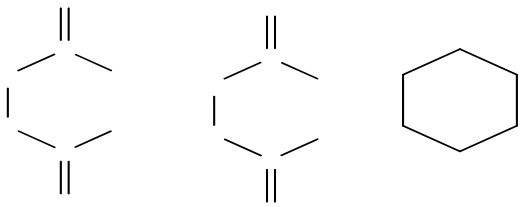
→ non polar molecule may have no dipole moment or no **net** dipole moment.

3) **London Force** = coulombic attractions between non-polar molecules.
   → instantaneous dipole moment of a non-polar molecule may happen from time to time due to the frustration of electron clounds.
4) **Hydrogen Bond** = has a shorter range and is stronger than the above



→ **Definition** = A hydrogen bond can be formed when a hydrogen atom is situated between two or above very electronegative atoms (N, O, F) / or a group of electronegative atoms.

Exercise 2 Intermolecular Hydrogen Bond vs Intramolecular Hydrogen Bond
Arrange the following compounds in the order of decreasing Boiling Point.



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Remarks

1. Let them be A, B and C so as to help you anwer the question easier.
2. Intramolecular Hydrogen bond **within a molecule (A)** will reduce the chance of forming Intermolecular hydrogen bond … so A has a lower boiling point than B.
3. Polar molecular should have a _____ boiling point than non polar ones.

Some Basic Method to **do comparison** of some physical properties
(For Organic or inorganic compounds)

1. **Melting Point** --- depends on the packing e_____ of the molecules in their S_____ lattice. / strength of the intermolecular forces
2. **Boiling Point** --- depends on the strength of the intermolecular forces, i.e. van deer Waal's forces vs inter/intra _____ bond.
3. **Viscosity** --- depends on the strength of the intermolecular forces, e.g. no of Carbons involved, van deer Waal's forces vs inter/intra _____ bond.
4. **Vapour pressure** --- volatility → intermolecular force involved in the **solution**.
5. **Solubility** --- depends on the molecules and the solvent used (*polar or not*).

Exercise 3 Consider HCl, H_2SO_4 and H_3PO_4 , arrange them in the order of the above four physical properties in ascending order. (> >)