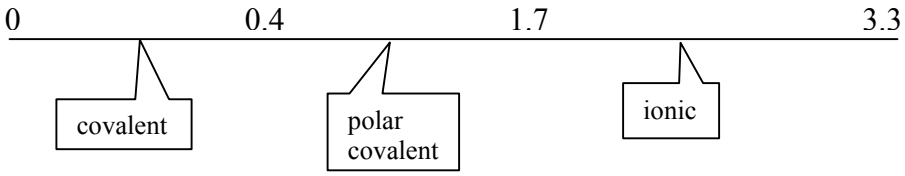
2.4 Electronegativity, Polar Bonds, and Polar Molecules

Definitions

- Polar covalent bonds
- Polar molecule
- Van der Waals forces
- Dipole-dipole force
- London dispersion force
- Hydrogen bond

Electronegativity Differences



Polar Covalent Bonds

- When 2 oxygen atoms bond they share electrons equally. They both have the same electronegativity value and therefore pull equally on the shared electrons.
- When hydrogen and nitrogen atoms bond the nitrogen has a much higher electronegativity than the hydrogen and it pulls hydrogen's electrons closer to it.
- We use δ to denote a small difference and we use + or – to give the type of difference
- E.g. Ammonia

Polar Molecules

- Polar covalent bonds don't always make the molecule polar
- E.g. Polar bonds in a non polar molecule (CCl_4)

- E.g. Polar bonds in a polar molecule (NH_3)

- The following rules can be used to predict, from the molecular formula, whether a molecule is polar or non-polar.

Polar Molecules

Type	Examples	
AB	$CO_{(g)}$	diatomic with different molecules
HA_x	$HCl_{(g)}$	any molecule with a single H
A_xOH	$NaOH_{(s)}$	any molecule with OH at one end
N_xA_y	$NH_{3(g)}$,$NF_{3(g)}$	containing N and other atoms
O_xA_y	$H_2O_{(1)}$,$OCl_{2(g)}$	containing O and other atoms
$C_xA_yB_z$	$CHCl_{3(l)}$,$C_2H_5OH_{(l)}$	containing C and 2 other kinds of atoms

Non-polar Molecules

Type	Examples	
A_x	$Cl_{2(g)}$, $N_{2(g)}$	elements
C_xA_y	$CO_{2(g)}$,$CH_{4(g)}$	containing C and only 1 other kind of atom

Intermolecular Forces

- Intermolecular Force: the force of attraction and repulsion between molecules.
- Real world examples: surface tension and capillary action
- Intermolecular forces are much weaker than covalent bonds. As an approximate comparison, if covalent bonds are assigned strength of about 100, then intermolecular forces are generally 0.001 to 15.

E.g.	$H_2O_{(l)} \rightarrow H_2O_{(g)}$	41 kJ/mol	(intermolecular)
	$H_2O_{(l)} \rightarrow H_{2(g)} + ½\ O_{2(g)}$	242 kJ/mol	(intramolecular)

- A general term for 2 types of intermolecular forces termed as **van der Waal's forces**

Dipole-Dipole Force

- Dipole-dipole force: a force of attraction between polar molecules
- The force is due to the simultaneous attraction of one dipole by its surrounding dipoles.
- The strength of the dipole-dipole force is dependent on the polarity of the molecule.
- Give rise to the rule: like dissolves like.

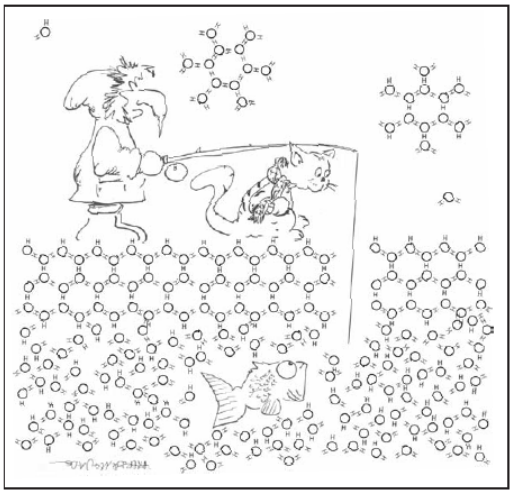
London Dispersion Force

- London Force is the simultaneous attraction of an electron by nuclei within a molecule and by nuclei in adjacent molecules.
- The strength of the London force is directly related to the number of electrons in the molecule.
- If it has electrons it will have London Forces.
- Can also be explained as an ever-changing temporary dipole-dipole force.

Hydrogen Bonding

- Hydrogen bonding is the attraction of hydrogen atoms bonded to N, O, or F atoms to a lone pair of electrons of N, O, or F atoms in adjacent molecules.
- Often explains the high boiling point of hydrogen compounds.
- E.g. Water

- Things to think about: Covalent bond → sharing electrons
  Hydrogen bond → sharing a proton



Homework:

- Practice: 1,2,3,4,5,6,7,8,9,10,11
- Section: 1,2,3,4