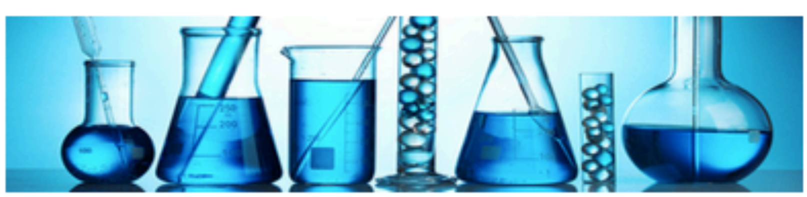
TABLE OF CONTENTS



CHEMISTRY REVISION

LECTURE 7: SOLIDS, LIQUIDS AND GASES

1) State of matter can be changed by varying temperature and pressure:
    - Gases: expand to occupy all of the space of their container. Ideal behavior described by gas laws
    - Liquids: molecules are held in this state by intermolecular forces at a certain temperature and pressure
    - Solids: atoms are held together by stronger attractive forces (i.e. metallic bonding, ionic bonding or covalent bonding

2) Intermolecular forces:

- There are three basic types: **Dispersion forces, Dipole forces and Hydrogen bonding (dipole-dipole)**
- **Dispersion forces**: the attraction between the negatively charged electron cloud and the positively charged nuclei of neighboring molecules. These forces are always present because every atom has its own nuclei and electron cloud. The magnitude of dispersion forces depends on how easy it is to distort the electron cloud of a molecule. The level of ease is called the polarizability and increases with increased size of the electron cloud (the bigger the cloud, the more dispersion forces exist; the bigger the size of the molecule, the more dispersion forces there are)

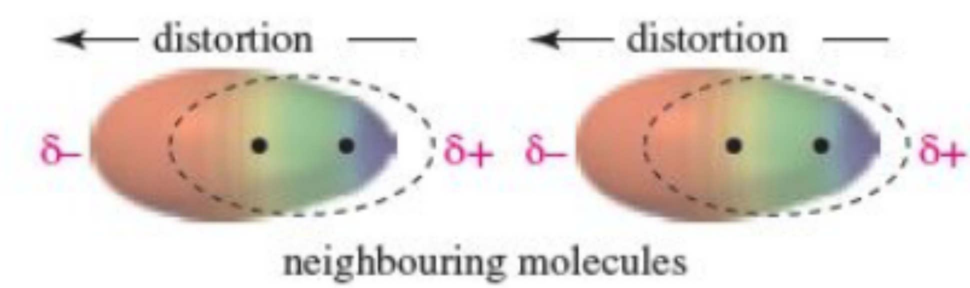
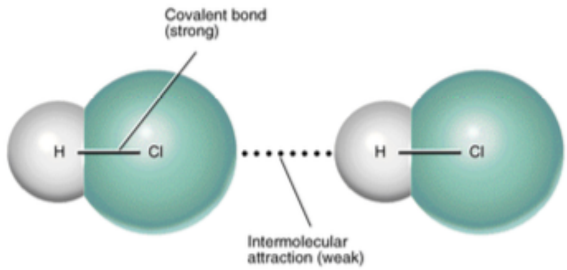
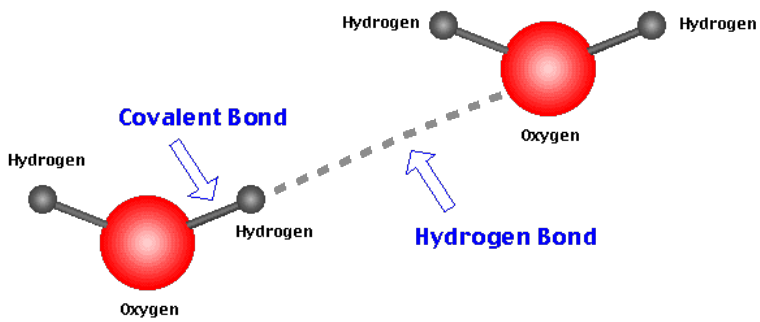


FIGURE 6.26 Exaggerated view of how dispersion forces arise.

- **Dipole forces**: a polar molecule with a permanent dipole (one side partially more negative than the other) attracts another polar molecule. These forces are stronger than dispersion forces. E.g. HCl



- Hydrogen bonds: there must be an electron-deficient hydrogen atom that can be attracted to an electron pair (i.e. O-H, F-H, N-H bonds). These bonds are strong and takes a lot of energy to overcome; which is why water has such high boiling point.



3) Kinetic energy versus intermolecular forces:

- The more kinetic energy a molecule has the lesser amount of intermolecular force it has between it and other molecules. This determines the state of matter for a substance. If the intermolecular forces are strong enough, a gas will condense into a liquid then a solid. Increasing the temperature causes the kinetic energy in the molecules increase, thus a decrease in intermolecular forces happens and this can bring a solid back to its liquid state then its gaseous state. Increasing the pressure (i.e. lowering the volume of the container) will enhance the intermolecular forces between the molecules and this has the reverse effect compared to increasing the temperature.
- In other words: more the faster a molecule moves the harder for it to bond with other stuffs.

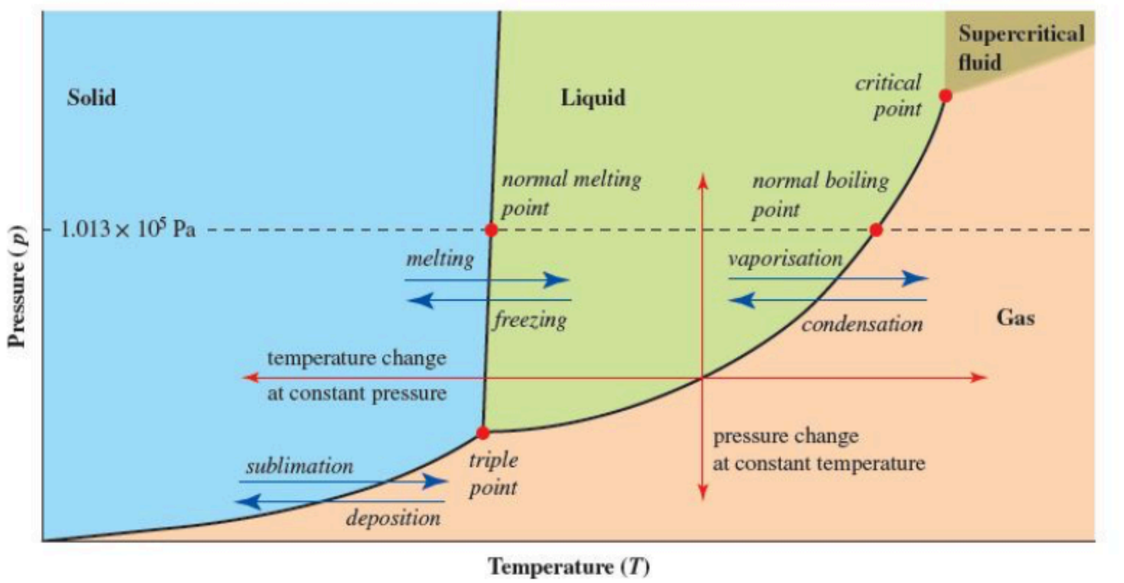
4) Boiling point:

- The boiling point is the temperature at which the average kinetic energy of molecular motion balances out the attractive energy of intermolecular attractions (i.e. they are equal)

5) Phase changes: due to heat or pressure

- More heat = more intermolecular forces being overcome ➔ Phase change
- More pressure = more intermolecular forces are enhanced ➔ Phase change

- From solid to liquid: **melting**; from liquid to gas: **vaporization**; from gas to solid: **deposition**; from solid to gas: **sublimation**; from gas to liquid: **condensation**; from liquid to solid: **freezing**
- There's also a thing called: **supercritical fluid**



6) Vapor pressure:

- In a liquid, molecules must have a range of kinetic energies, which increases when temperature increases. Weaker intermolecular forces lead to higher vapor pressure because there would be more gas molecules present. Normal pressure is different from vapor pressure. As normal pressure (the volume of the container) increases, the molecules are allowed to move more freely, thus lead to an increase in kinetic energies and decrease in intermolecular forces ➔ more molecules will be able to escape to become gas and increase the vapor pressure.

7) Boiling points of organic molecules:

- Larger molecules tend to get higher boiling points because of their larger intermolecular forces

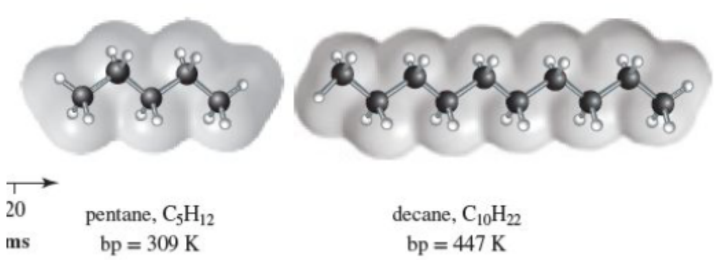


FIGURE 6.29 The boiling points of alkanes increase with the length of the carbon chain, because a large electron cloud is more polarisable than a small one.

- Molecules with stronger intermolecular forces (i.e. dispersion, dipole, hydrogen bonds) have higher boiling points. Polar molecules tend to be stronger than non-polar molecules.

8) Gas laws:

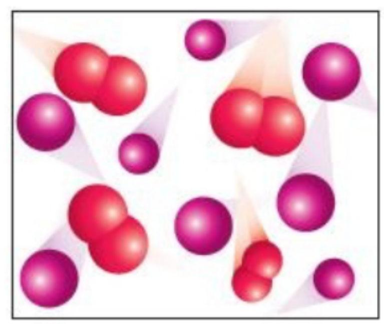
- To work with gas laws, we have to assume that intermolecular forces between the gas molecules do not exist; as well as neglecting the sizes of the molecules.
- Definition: an ideal gas (IG) is a gas whose molecules' volumes and forces between the molecules are so small that they don't affect the behavior of the gas at all.

9) Table of Gas laws:

Name	Description	Equation
Ideal Gas Equation	The fusion of Boyle, Charles and Avo's laws	**$PV = nRT$**
Boyle's Law	Inverse relationship between volume (V) and pressure (P)	$V \propto 1/P$ ➔ $V_1P_1 = V_2P_2$
Charles' Law	Proportional relationship between volume (V) and temperature (T)	$V \propto T$ ➔ $V_1/T_1 = V_2/T_2$
Avogadro's Law	Proportional relationship between volume (V) and number of moles of gas molecules (n)	$V \propto n$ ➔ $V_1/n_1 = V_2/n_2$

10) Ideal Gas Equation:

- R: universal constant = 8.314
- P: pressure (kPa)
- V: volume (L)
- N: number of moles (mol)
- T: temperature (K) = Celsius + 273



20.0 L at 273 K
0.300 mol gas mixture
$p_{O_2} = 1.13 \times 10^4$ Pa
$p_{He} = 2.27 \times 10^4$ Pa
$p_{total} = 3.40 \times 10^4$ Pa

11) Dalton's law of partial pressure:

- The pressure used in the Ideal Gas Equation is the total pressure of all of the gases present in the mixture. If there were more types of gas present, then each should exert its own amount of pressure and contributes to the total pressure. To find partial pressure of a gas, use the IGE to calculate its own amount of pressure.