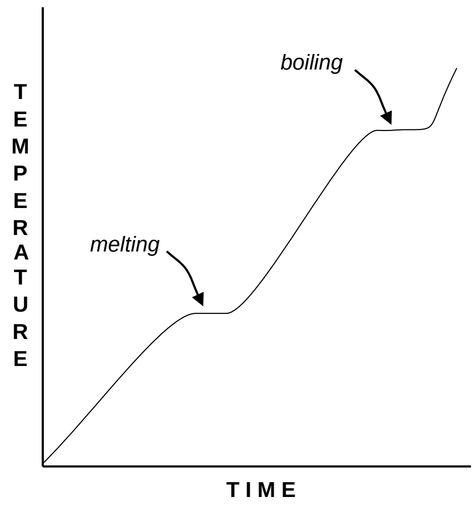
# STATES OF MATTER

*Introduction* There are 3 states of matter . . . GAS, LIQUID and SOLID. The basic differences are ...

**SOLIDS**

- High degree of order in solids
- Particles **vibrate about fixed positions** relative to their neighbours.
- Heating provides more energy and the vibrations increase
- Particles eventually have enough energy to overcome the attractive forces - solid melts.
- Energy is used in separating the particles and the temperature stays constant
- Type of bonding and structure determine the amount of energy required.

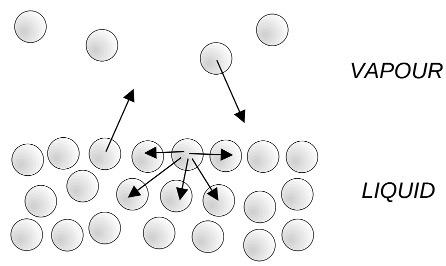



**LIQUIDS**

- Half way between the ordered solid state and the disordered, random gaseous state
- Molecules are in a state of random motion
- Liquids flow to take shape of bottom of container
- Molecules near the surface are attracted back by their neighbours - **surface tension**

*Evaporation*

- Molecules near the surface having enough energy to overcome the attractive forces of their neighbours can escape into the vapour phase
- Not all molecules possess enough energy
- There is a distribution as in gases
- The temperature liquids is proportional to the average energy of the molecules; as the more energetic ones escape, the temperature drops.




*Vapour Pressure* If a liquid is placed in a sealed tube and the space above it evacuated, any molecules which escape from the surface of the liquid will be contained and thus exert a pressure. As more molecules enter the space, the possibility of some re-entering also increases. Eventually a state of dynamic equilibrium exists where as many particles are leaving as are returning. The pressure at this stage is known as the Saturated Vapour Pressure (SVP). This value is constant for a particular liquid at constant temperature. The value increases exponentially with temperature as can be seen in the diagram below.

*Boiling* When its vapour pressure reaches that of the atmospheric (or applied) pressure.

**Decreasing the applied pressure lowers boiling point**
Liquids can be distilled below their normal boiling point; avoids the risk of decomposition

**Increasing the pressure raises boiling point** ; pressure cookers work on this principle.

**GASES** Particles are at their most random and have the highest energies
Their volume is greatly affected by changes in temperature and pressure.

**Kinetic Theory**

- Developed to explain the properties of gases as describes by the gas laws
- Based on a series of postulates or assumptions
- A gas which obeys is known as an IDEAL GAS and obeys Boyle's Law
- Gases which obey Boyle's Law also obey the Gas Equation PV = NRT

*Assumptions*

- Gases are made up of tiny particles, "molecules" in a state of rapid, random motion.
- Average kinetic energy of particles is directly proportional to the temperature in Kelvin.
- All collisions are perfectly elastic i.e. there is no loss of kinetic energy.
- Collisions between the molecules and the walls of the container give rise to pressure.
- The volume of molecules is negligible compared to the volume of the gas as a whole.
- Attractive forces between particles are negligible.

*Limitations*

- Boyle's Law breaks down at **very high pressures** and **very low temperatures**

**high pressure** *at high pressures the volume of particles take up a larger proportion of the volume occupied by the gas. Boyle's Law assumes they occupy negligible volume. Intermolecular forces are also greater as particles get closer together,*

**low temperature** *at low temperatures the particles have little energy and so can be pulled together by attractive forces. Boyle's Law assumes that attractive forces are negligible.*

## Physical Properties - Summary

| *Bonding* | *m pt. / b pt.* | *electrical conductivity* *solid* | *-* *liquid* | *solubility in water* |
|---|---|---|---|---|
| ionic | high | none | good | mostly good |
| macromolecular | very high | none | none | insoluble |
| molecular | low | none | none | insoluble |
| metallic | usually high | good | good | insoluble |

Information on *'Calculations using PV = nRT'* and the *'Physical properties of crystals'* can be found in other notes.