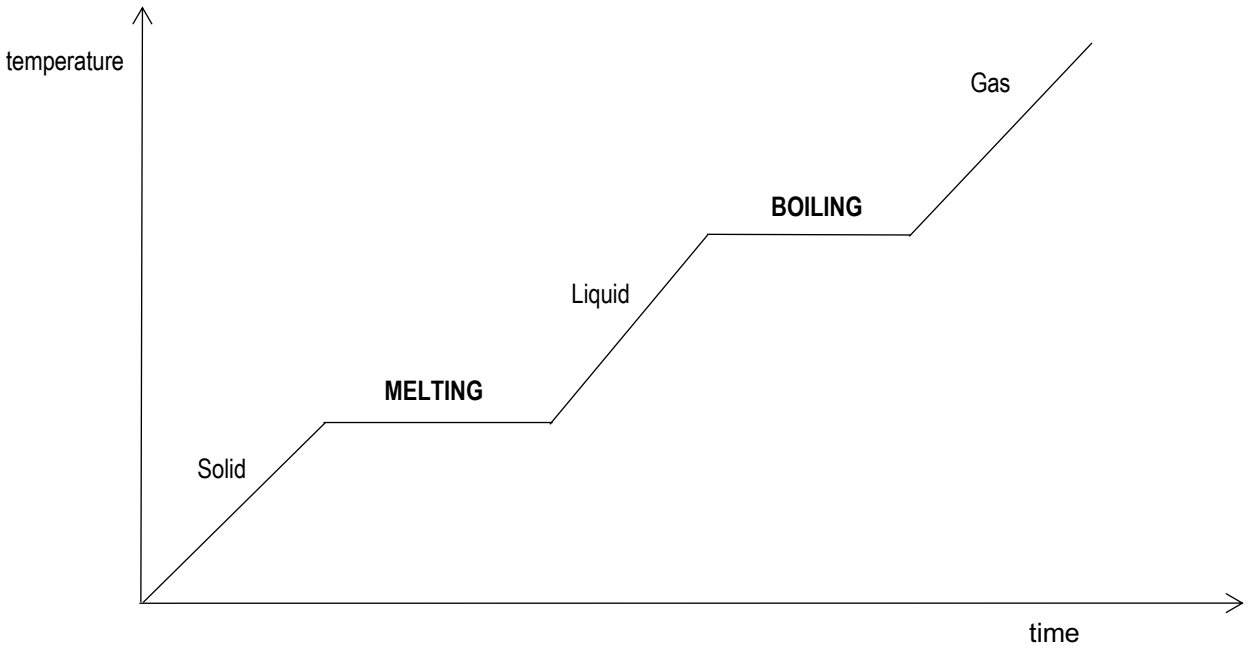
# CHANGES OF STATE

- The particles in any substance at any temperature above absolute zero are either vibrating about a fixed position (solid) or moving around (liquid or gas). Therefore they possess kinetic energy.
- The particles have different amounts of kinetic energy (some are moving faster than others).
- The temperature (T) of any substance is directly proportional to the mean kinetic energy (KE) of the particles.

**T ∝ mean KE of particles**




| Process | T and KE |
|---|---|
| Heating the solid | As the solid is heated, the particles vibrate faster increasing the mean KE of the particles. As the mean KE of the particles increases, T increases. |
| Melting | The heat energy is used to partially overcome the forces (or bonds) between the particles rather than to increase the KE of the particles. The solid melts but the mean KE of the particles remains constant and so T remains constant. |
| Heating the liquid | As the liquid is heated, the particles move faster increasing the mean KE of the particles. As the mean KE of the particles increases, T increases. |
| Boiling | The heat energy is used to overcome the forces (or bonds) between the particles rather than to increase the KE of the particles. The liquid boils but the mean KE of the particles remains constant and so T remains constant. |
| Heating the gas | As the liquid is heated, the particles move faster increasing the mean KE of the particles. As the mean KE of the particles increases, T increases. |

- At absolute zero, the particles do not vibrate and so the particles have no kinetic energy.
- The energy required to change state (without any change in T) is sometimes called latent heat.
- When a gas to cooled to a liquid and then a solid, the opposite happens. During condensation and solidifying, energy from forming forces (or bonds) is released as heat energy. This stops the T from falling further as the mean KE of the particles remains constant as it changes state.
- When a liquid evaporates (which occurs below the boiling point), some KE is used to overcome forces between particles to allow the particle to escape. As a consequence, the mean KE of the remaining particles is lower and so the T is lower. This explains why liquids cool as they evaporate.