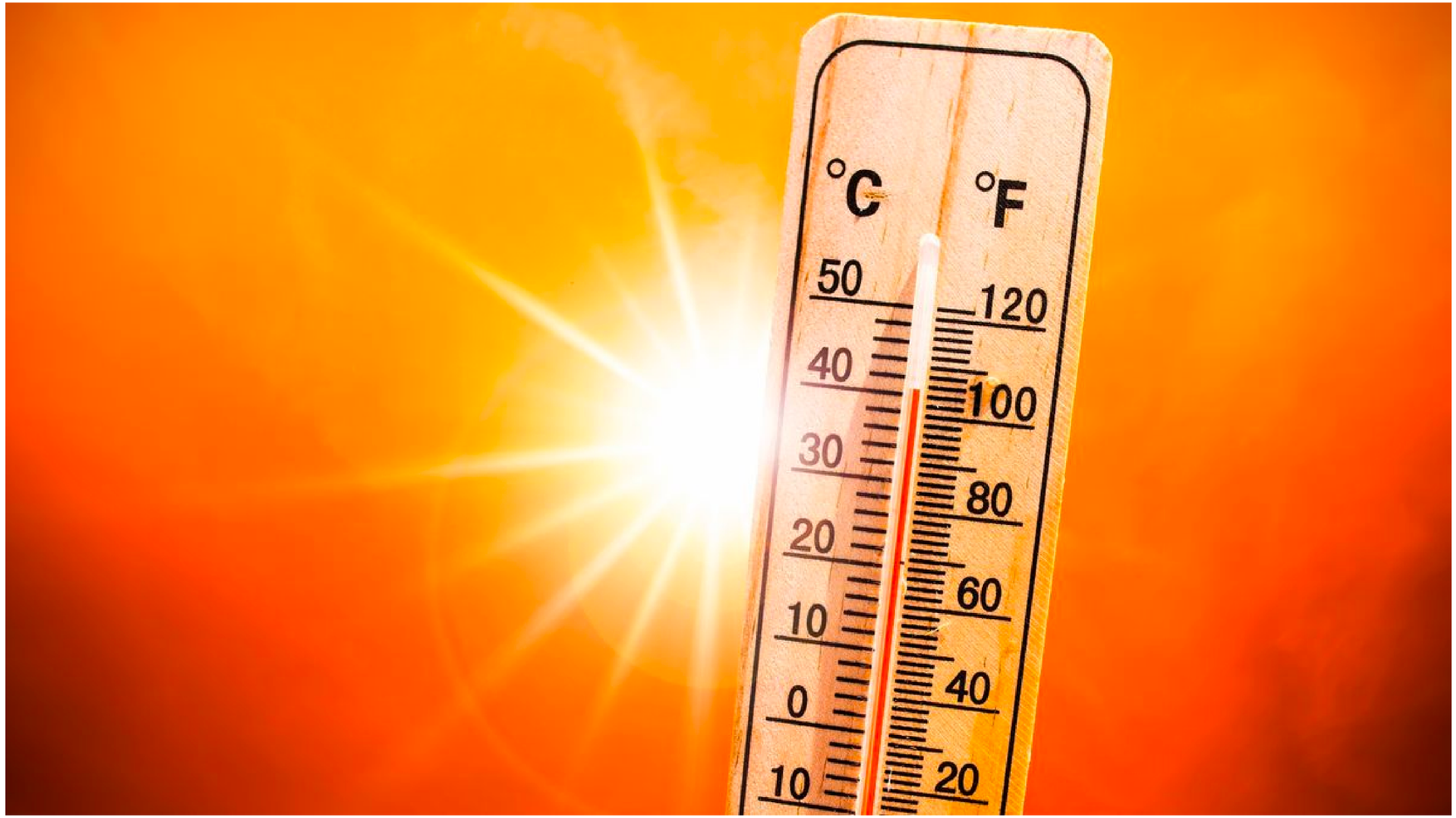
9702 C14 Temperature



What is Thermal Energy?

Thermal energy = the energy possessed by an object due to its temperature

-->**Thermal energy is transferred **from a region of higher temperature to a region of lower temperature****

Thermal energy can be transferred by either
1.Conduction-through the vibrations of particles in solid, liquid and gas
2.Convection-when particles with a lot of heat energy in a liquid or gas move and take the place of particles with less heat energy
3.Radiation-through EM waves in solid,liquid and gas (as well as in vacuum)

Thermal equilibrium = regions of **equal temperature** + **no net transfer of thermal energy** between two region (for this to occur two regions need to be in contact)

Measurement of Temperature

Thermometer is device that used to measure temperature

Each type of thermometer uses a physical property of material that varies with temperature - examples of such properties include:

1.The density of a liquid

2.The volume of a gas at a constant pressure

3.Resistance of a metal

4.e.m.f of a thermocouple

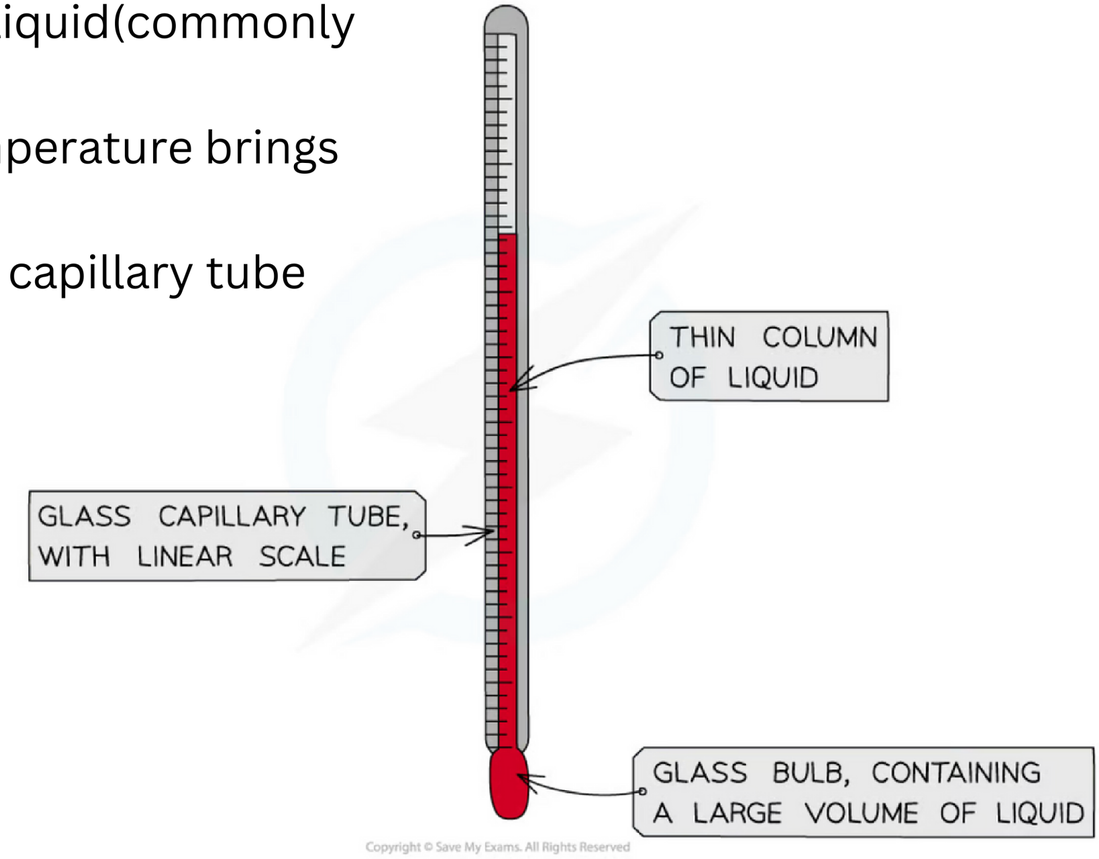
--> Thermometer must be calbirated at two or more known temperatures (usually calibrated at O°C and 100°C)

The Density of a Liquid

A liquid-in-gas thermometer depends on the density change of a liquid(commonly mercury

-->mercury has high coefficient of expansion (so small rise in temperature brings about sufficient expansion)

-->when mercury **expand** due to change in temperature, a glass capillary tube detect



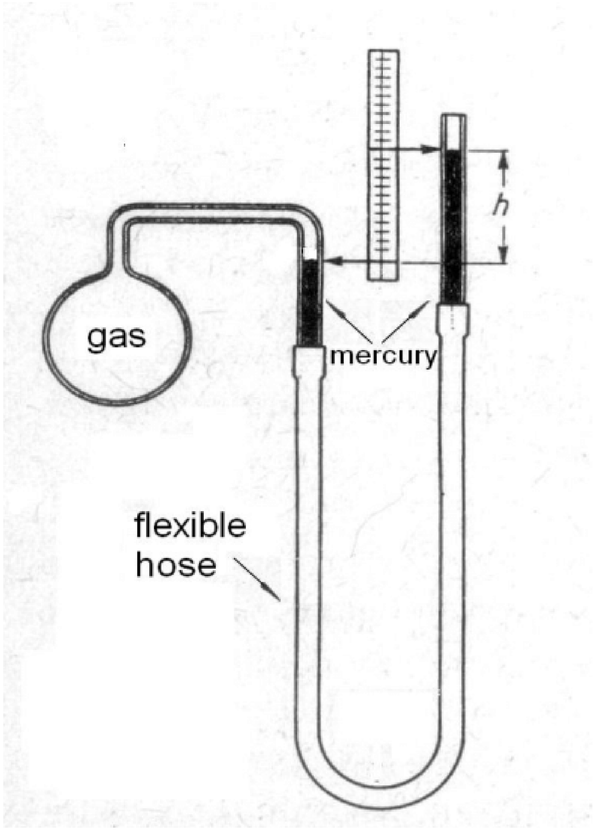
As the bulb is heated, the liquid expands and moves along the capillary tube

Volume of a Gas at Constant Pressure

At constant pressure, the volume of an ideal gas is directly proportional to its temperature (Charles's law)

As temp of gas↑, its volume↑ and vice versa

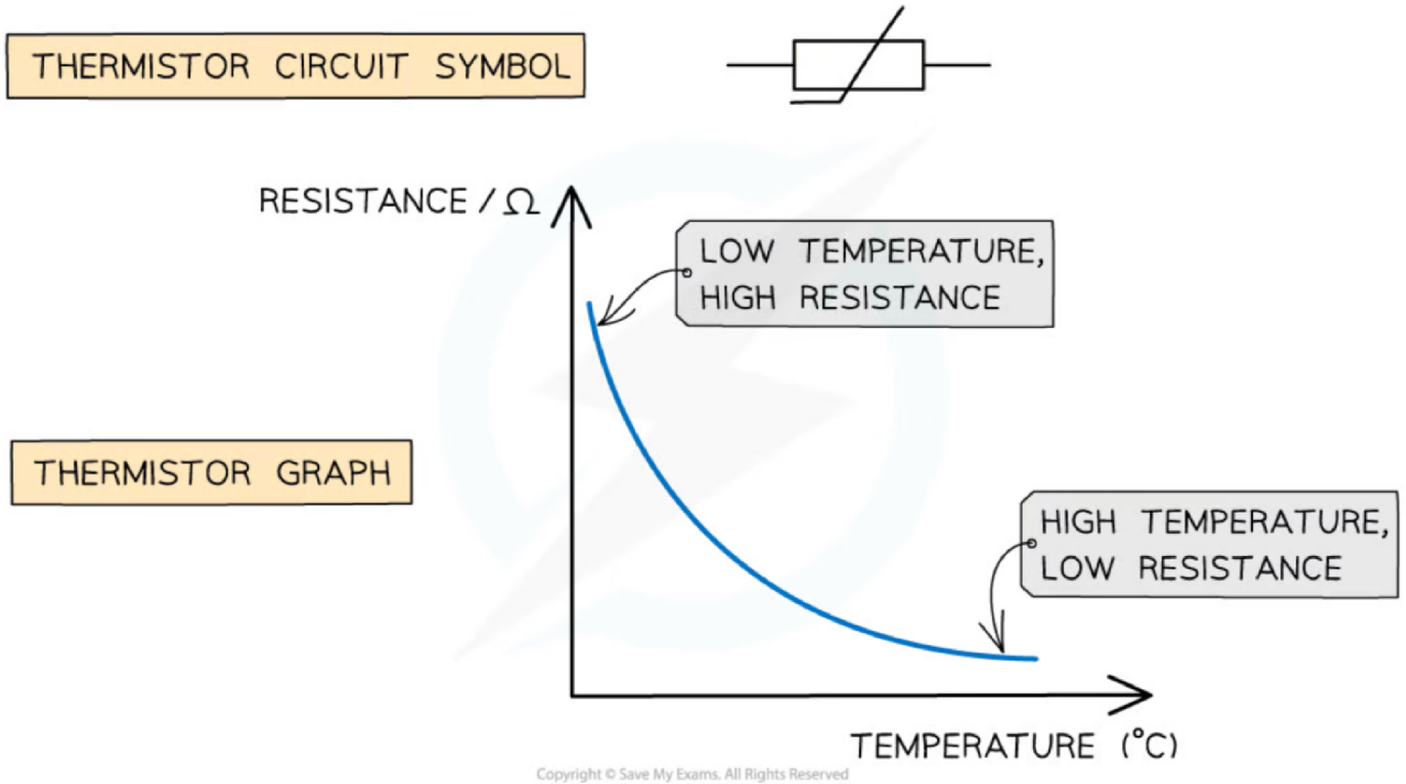
A gas thermometer must be calibrated - by knowning the temperature of a gas at certain volume, a temperature scale can be determined on how quickly the gas expands with temperature



Resistance of a Metal

Thermistor:

As a thermistor get hotter, its resistance decreases



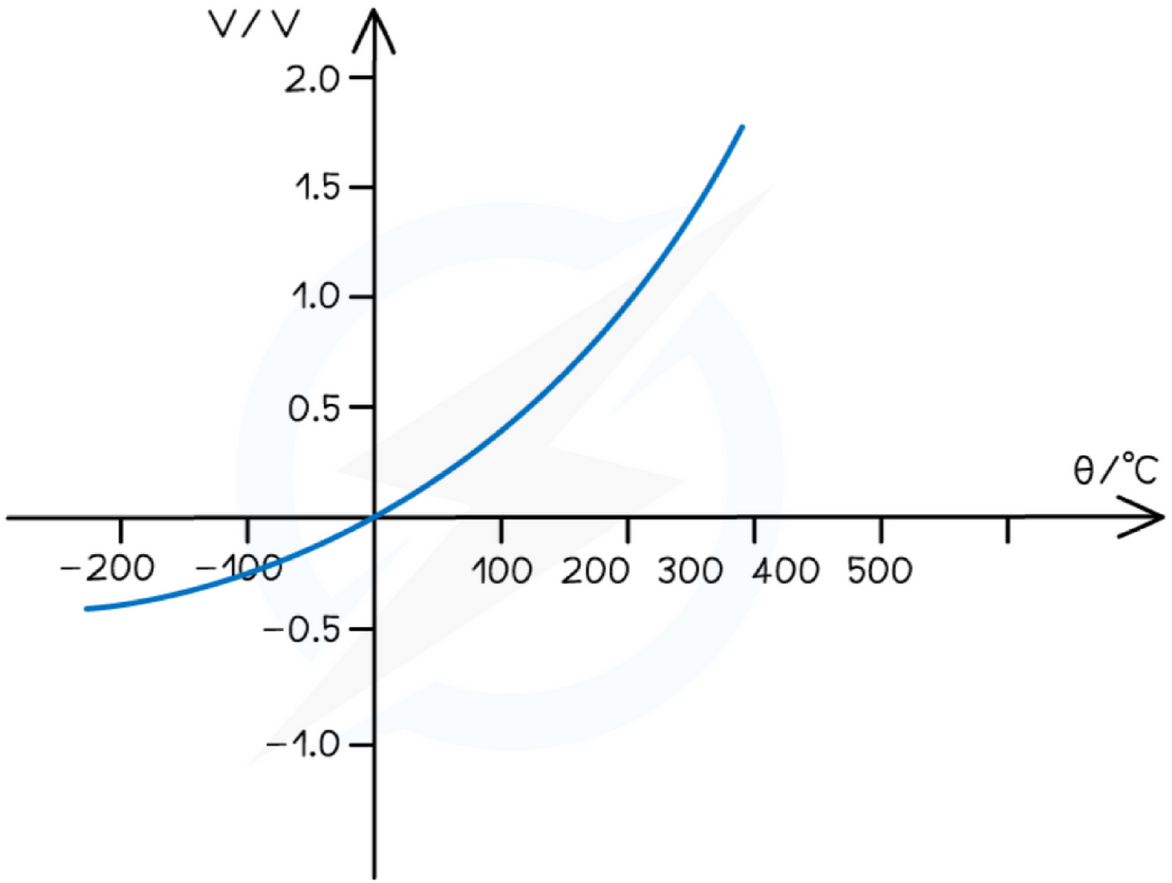
As the temperature of a thermistor increases, its resistance decreases

E.M.F of a Thermocouple

A thermocouple is an electrical device used as the sensor of a thermometer
It consists of two wires of different metals attached to each other, producing a junction on one end --> the opposite ends are connected to a voltmeter

When this junction is heated, an e.m.f is produced between two wires which is measured on the voltmeter

The greater the difference in temperature between the wires, the greater the e.m.f



Scale of Thermodynamic Temperature

The celsius scale,°C is based on the properties of water
(on 1 atmosphere of pressure // 101KPa) :
-Freezing point of water = 0°C
-Melting point of water = 100°C
However, as the pressure change the freezing point +
melting point will change

The Kelvin scale is known as the thermodynamic scale
--> thermodynamic scale is said to be an **absolute scale** that is **not defined(not depend) in terms of property of any substance**

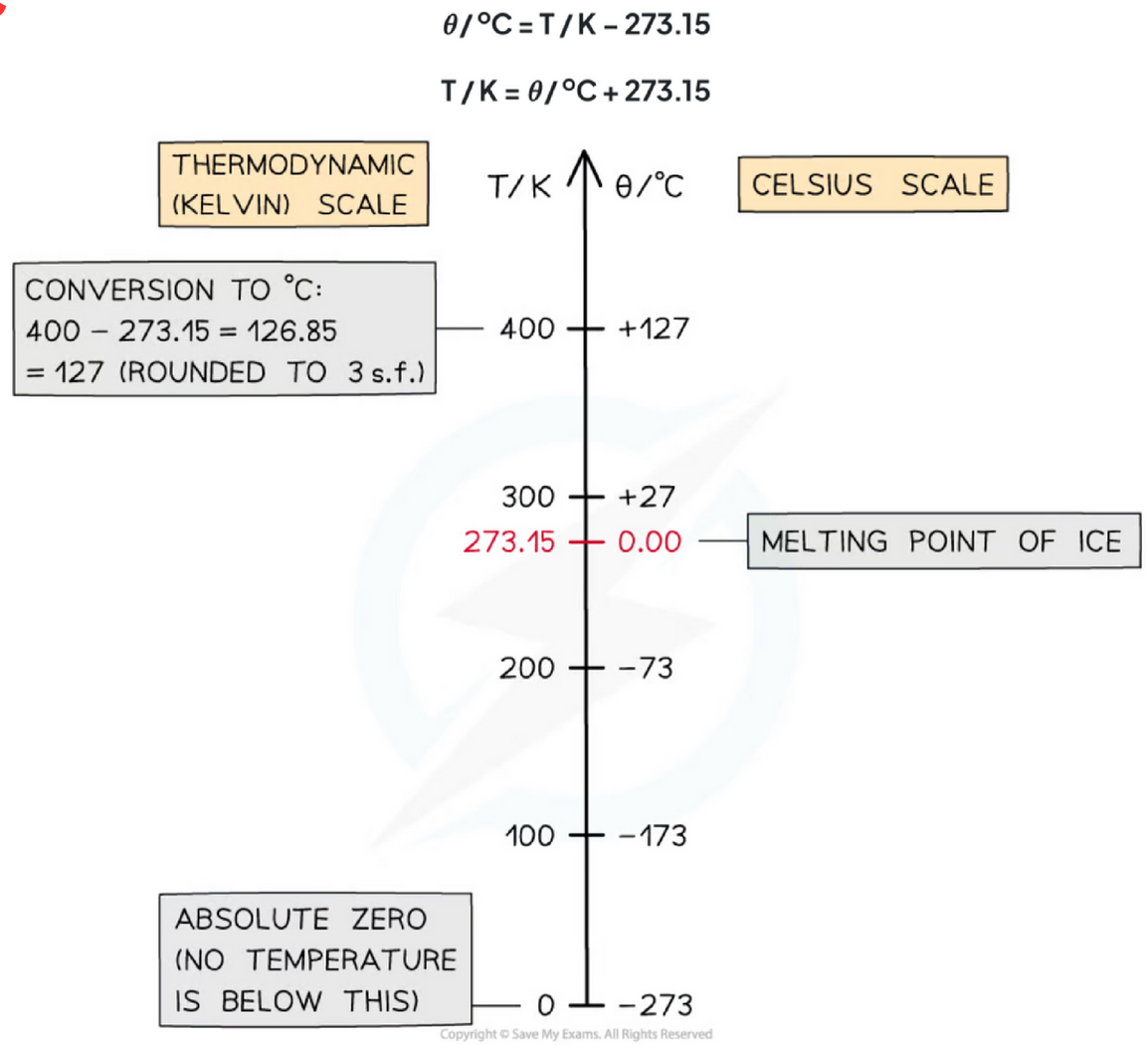
Kelvin Scale

0K = -273.15°C

On the thermodynamic(or Kelvin) temperature scale, absolute zero is defined as:

absolute zero = the temperature at which the atoms and molecules in all substances have zero kinetic and potential energy + also the lowest temperature possible, 0K.

For a system at 0K, it is not possible to remove any more energy and this means a temperature in Kelvin will **never** be a negative value



Conversion chart relating the temperature on the Kelvin and Celsius scales

Specific heat capacity

Specific heat capacity = the amount of thermal energy required to raise the temperature of 1kg of a substance by 1°C

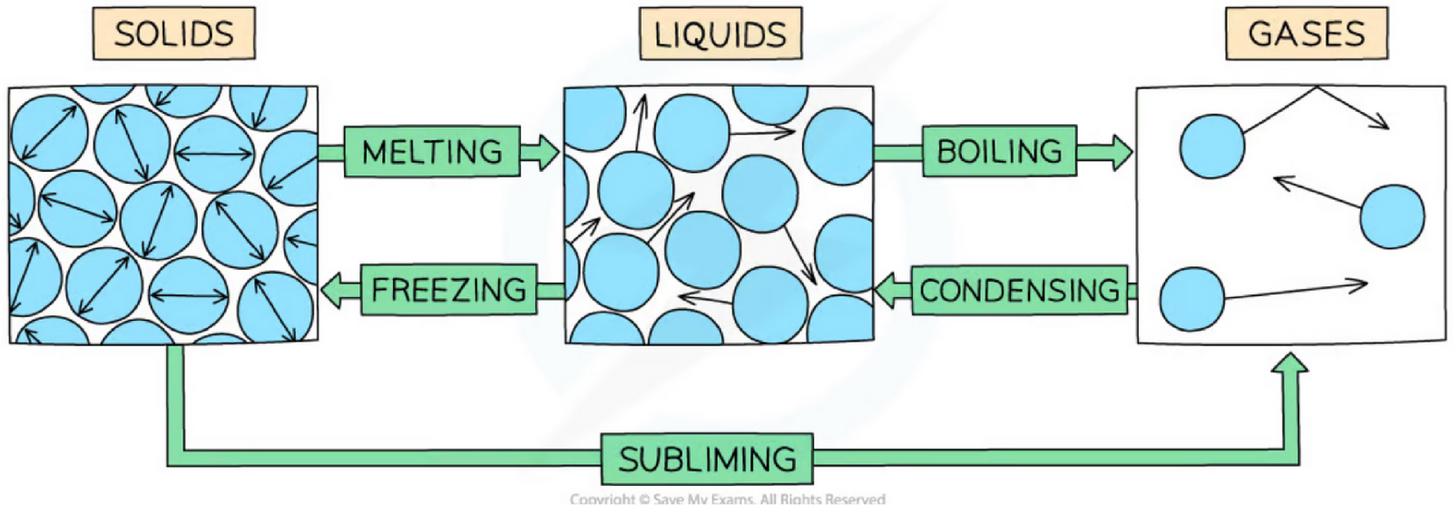
$$\Delta Q = mc\Delta\theta$$

- Where:
  - ΔQ = change in thermal energy (J)
  - m = mass of the substance you are heating up (kg)
  - c = specific heat capacity of the substance ($J\,kg^{-1}K^{-1}$ or $J\,kg^{-1}\,°C^{-1}$)
  - $\Delta\theta$ = change in temperature (K or °C)

If a substance has a low specific heat capacity, it heats up+cool down quickly
If a substance has a high specific heat capacity, it heats up+cools down slowly (e.g. water)

Latent Heat Capacity

Energy is required to change the state of substance



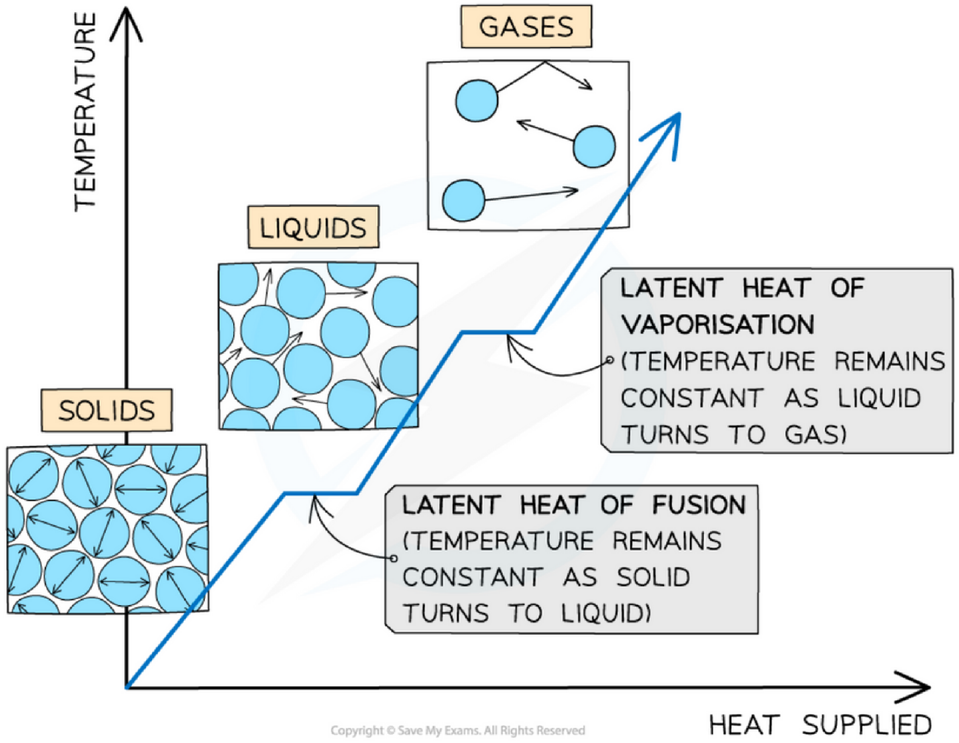
When a substance changes state, there is no temperature change

-->the energy supplied to change the state is called the **latent heat**

latent heat = the thermal energy supplied to change the state of 1kg of mass of a substance without any change of temperature

The specific latent heat of fusion = the thermal energy required to convert 1kg of solid to liquid with no change in temperature

The specific latent heat of vaporisation = the thermal energy required to convert 1kg of liquid to gas with no change in temperature



The changes of state with heat supplied against temperature. There is no change in temperature during changes of state

Calculating Specific Latent Heat

- The amount of energy Q required to melt or vaporise a mass of *m* with latent heat *L* is:

$$Q = Lm$$

- Where:
  - Q = amount of thermal energy to change the state (J)
  - L = latent heat of fusion or vaporisation (J kg^{-1})
  - m = mass of the substance changing state (kg)