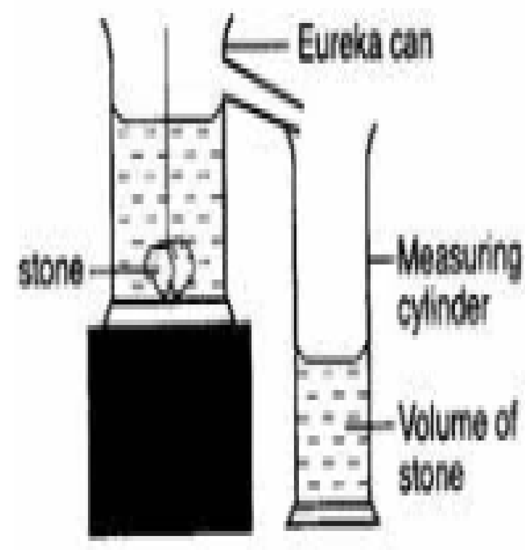
KS4: Autumn Term
SCIENCE: Particle Model

Keyword	Definition
change of state	The changing of matter from one state to another, for example from solid to liquid.
state of matter	One of three different forms that a substance can have: solid, liquid or gas.
physical change	A change in which no new substances are formed, such as changes of state.
chemical change	A change that results in the formation of new substances.
density	The mass of a substance per unit volume. It has units such as kg/m^3 or g/cm^3.
kinetic energy	A term used to describe energy when it is stored in moving things.
sublimation	When a solid changes directly to a gas without becoming a liquid first.
specific heat capacity	The energy needed to raise the temperature of 1 kg of a substance by 1 °C.
specific latent heat	The energy taken in or released when 1 kg of a substance changes state.
temperature	A measure of how hot or cold something is.
thermal energy	A term used to describe energy when it is stored in hot objects. The hotter something is, the more thermal energy it is storing. It is sometimes called heat energy.
absolute zero	The temperature at which the pressure of a gas drops to zero and the particles stop moving. It is −273 °C or 0 K.
kelvin (K)	The unit in the Kelvin temperature scale. One kelvin (1 K) is the same temperature interval as 1 °C.
Kelvin temperature scale	A temperature scale that measures temperatures relative to absolute zero.

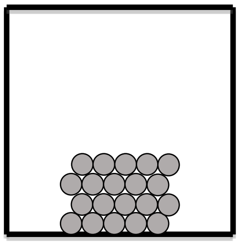
Density is a measure of how much space (volume) a particular number of particles (mass) occupies.
Practical: To find density of a substance; mass and volume must be measured.
Apparatus: Measuring cyliner, Displacement (Eureka) can, balance
Finding the mass of the substance
Use a balance (remember the unit (g)
Finding the volume
- Liquids: use a measuring cylinder (unit $=cm^3$)
- Regular solids (e.g. a cube): use a ruler and geometry
- Irregular solids (e.g. a stone), find the volume of water that is displaced when the object is submerged in water using a displacement can.
- Calculate the density (mass ÷ volume).

<u>To memorise:</u>

Density = mass ÷ volume
(kg/m^3) (kg) (m^3)
Or
(g/cm^3) (g) (cm^3)



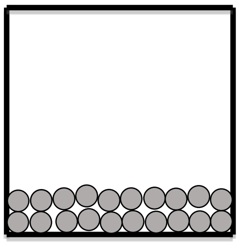
Core Practical: Investigating water part 1



solid

- Particles vibrating on the spot.
- Fixed shaped because the particles are arranged in a pattern
- Incompressible because the particles are all touching one another

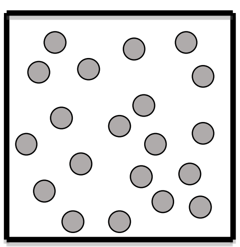
melt ↓ ↑ freeze



liquid

- Particles can move past each other
- Liquids can flow because the particles are free to move past one another
- Incompressible because the particles are all touching one another

boil ↓ ↑ condense

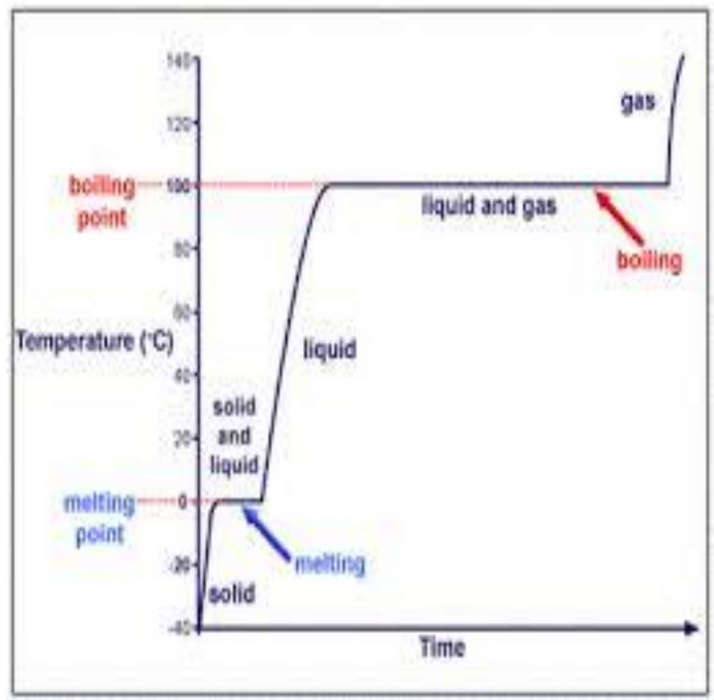


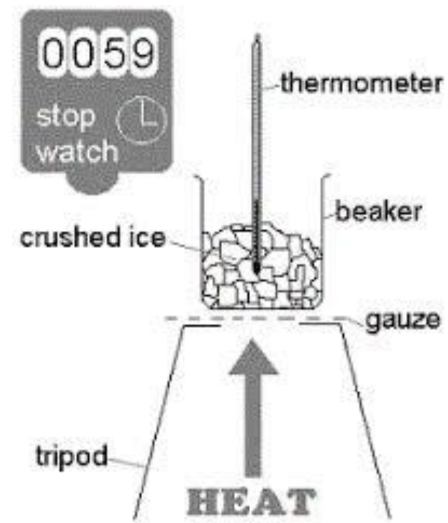
gas

- Particles collide with each others and with the walls of their container
- Gases can flow because the particles are free to move past one another
- Compressible because the particles are not touching one another

Method:

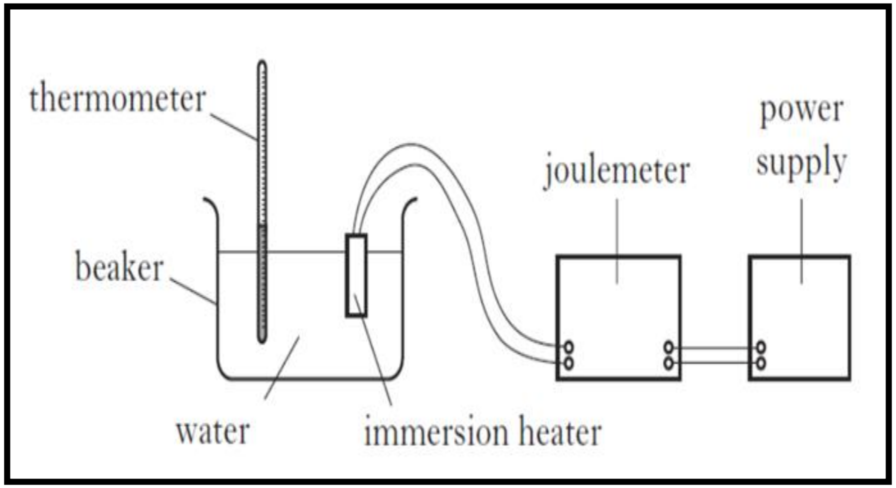
1. Fill a beaker with crushed ice.
2. Place a thermometer into the beaker and record the temperature of the ice.
3. Using a Bunsen burner, gradually heat the beaker (1/2 air hole open and half a turn of gas tap).
4. Every 20s record the temperature and the current condition of the ice (e.g. partly melted, completed melted)
5. Continue this process until the ice melts into water and this water begins to boil.
6. Plot a graph temperature against time.





Core Practical: Investigating water part 2- Specific heat capacity of water

Aim: To find the specific heat capacity of water.



Method

1. Put a polystyrene cup in a beaker onto a balance, and zero the balance.
2. Then fill the cup **almost** to the top with water and write down the mass of the water. Carefully remove the cup from the balance.
3. Put a thermometer in the water and support it as shown in the diagram.
4. Put a 12 V electric immersion heater into the water, making sure the heating element is completely below the water level. Connect the immersion heater to a joulemeter.
5. Record the temperature of the water, and then switch the immersion heater on. Stir the water in the cup gently using the thermometer.
6. After five minutes, record the temperature of the water again and also write down the reading on the joulemeter.

Considering your results:

- Divide the mass of water by 1000 to find the mass in kilograms.
- Subtract the temperature of the water after five minutes from the starting temperature to find the temperature change.
- Calculate the specific heat capacity of water using the equation.

How to Reduce unwanted heat loss:
Insulate the container which holds the substance being heated

Sources of error
Immersion heater might not be completely in the substance being heated
Heat energy not all transferred to the substance being heated, some will be transferred to the surroundings.

Equation to calculate specific heat capacity

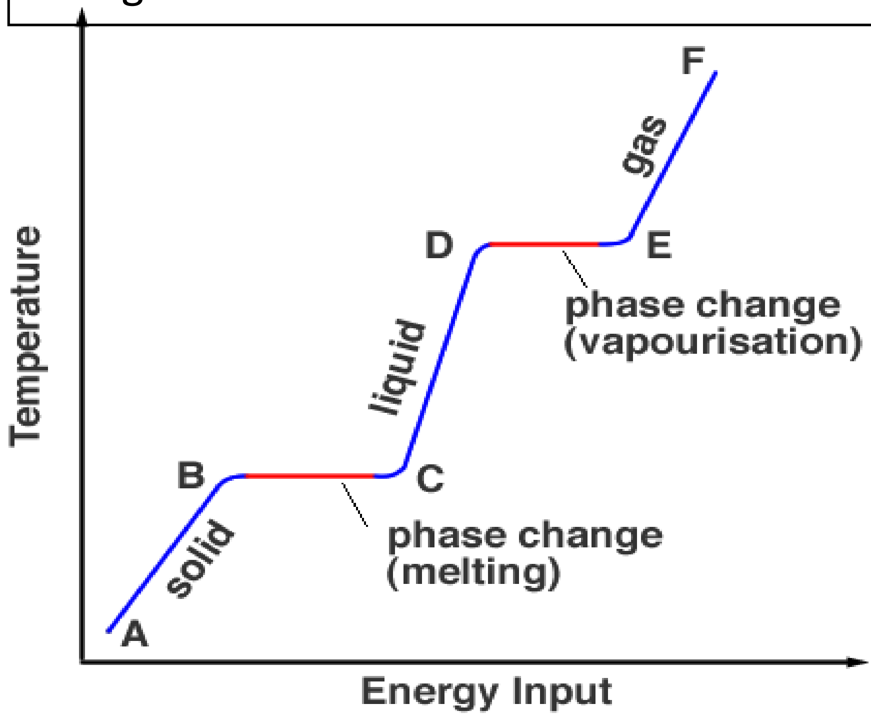
$$Q = m c \Delta T$$

Q = energy transfered (J)
m = mass of substance (kg)
c = specific heat capacity
ΔT = temperature change (K or °C)

change in thermal energy = mass × specific heat capacity × change in temperature

Specific latent heat is the amount of energy required to change the state of 1kg of a substance.

Energy is needed to make a substance melt or evaporate. The amount of energy depends on the mass of the substance and on its specific latent heat. The energy transferred during a change of state is called **latent heat**. **For heating**, latent heat is the energy ***gained*** to cause a change in state. **For cooling**, it is the energy ***released*** by a change in state.



Specific latent heat equation

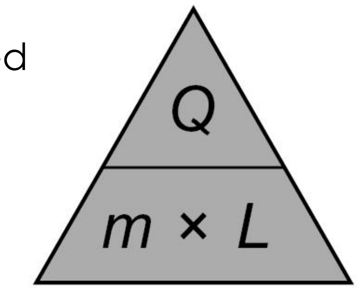
thermal energy needed for a change of state (J) = mass (kg) × specific latent heat (J/kg)

Q= mL

Q = thermal energy needed for a change of state (J)

m = mass (kg)

L = specific latent heat (J/kg)



Exam style questions:

1. Brick has a specific heat capacity of 840J/kg°C.
Calculate how much energy the 800kg heater in photo A stores when the bricks are 40°C above the air temperature in the room.
2. The specific latent heat of evaporation for water is 2257kJ/kg. How much energy does it take to evaporate 5kg of water at 100°C?

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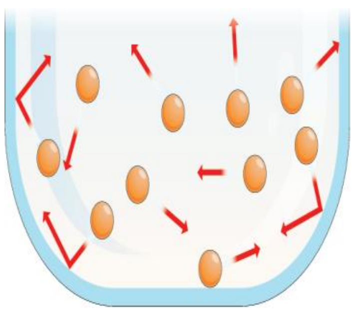
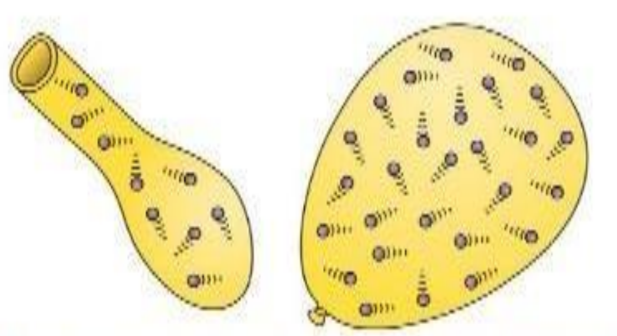
Gas Pressure

Gas particles are far apart and move around quickly. The temperature of a gas is a measure of the average kinetic energy of the gas particles. Pressure increases if a gas is heated because the particles will collide with the walls of the container **more frequently** and with **greater speed.**



Why do balloons get bigger as you blow them up? When you blow up a balloon, you are filling it with air particles. The more air particles you add, the bigger the balloon.



▲ The more particles you blow into a balloon, the bigger the balloon.

Topic Equation

To memorise:

Density = mass ÷ volume

(km/m^3) (kg) (m^3)

Equations to be able to use:

change in thermal energy = mass × specific heat capacity × change in temperature

thermal energy for a change of state = mass × specific latent heat

- 273°C **Absolute zero** 0 Kelvin

No movement of particles

Question:

What is the boiling point of water in Kelvin?

Boiling point = 100°C +273= 373K

Useful Links:

https://phet.colorado.edu/en/simulation/states-of-matter-basics

-Schoology

https://www.bbc.co.uk/bitesize/guides/z2gjtv4/revision/6

UNITS to Learn:

Kelvin = (K)

Thermal energy = J

Specific heat capacity = J/kg°C

Specific latent heat = J/kg