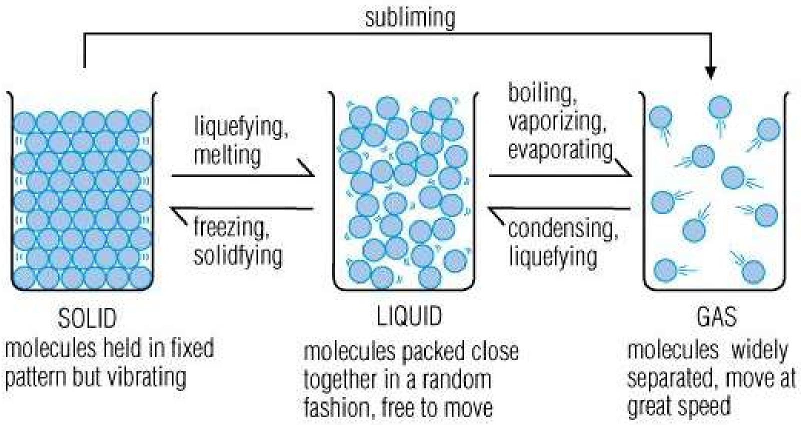
Synergy Science Knowledge Organiser
1 States of Matter

Particle Model

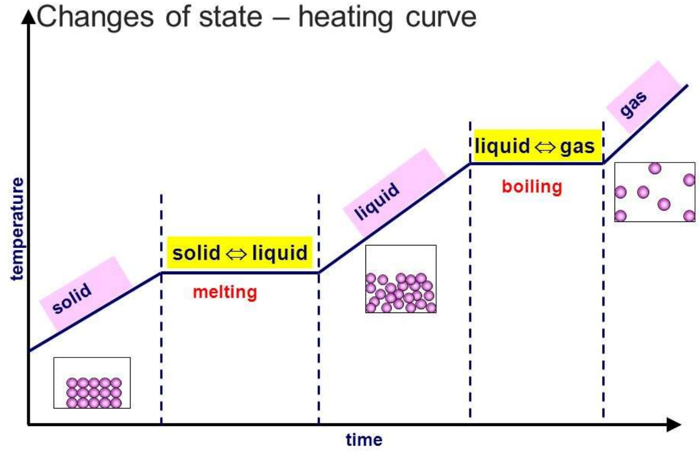
- The three states of matter are solid, liquid and gas. Melting and freezing take place at the melting point, boiling and condensing take place at the boiling point. These are physical changes.
- Energy is needed to melt a solid or to boil a liquid.
- Increasing the temperature of a substance increases its internal energy.
- The strength of the forces of attraction between the particles of a substance explains why it is a solid, a liquid, or a gas.
- When a substance is heated:
  - if its temperature rises, the kinetic energy of its particles increases
  - if it melts or it boils, the potential energy of its particles increases.
- The three states of matter are represented by a simple model. In this model, particles are represented by small solid spheres.



- Limitations of the simple model include that there are no forces between the spheres, and that atoms, molecules and ions are not solid spheres.

Reaction profiles

- **Specific latent heat of fusion –** is the change of state from solid to liquid.
- **Specific latent heat of vaporisation –** is the change of state from liquid to gas.



Pure

- A pure substance only contains one type of particle.
- A mixture contains different types of particles that are not joined together chemically.
- Pure **elements** and **compounds** melt and boil at specific temperatures. **Melting point** and **boiling point** data can be used to distinguish pure substances from **mixtures.**

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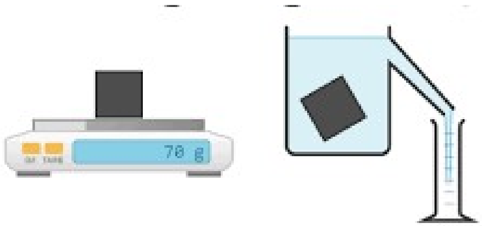
Required Practical

Irregular Object

1. Measure the mass of one of the irregular shaped objects.
2. Place a displacement can on a large bung. Put an empty beaker under the spout and fill the can with water. Water should be dripping from the spout.
3. Wait until the water stops dripping. Then pour it out.
4. Tie the object to a piece of cotton. Very carefully lower it into the displacement can so that it is completely submerged.
5. Collect all of the water that comes out of the spout in the beaker.
6. Pour the water into the measuring cylinder
7. Measure and record the volume of the collected water. This volume is equal to the volume of the object.
8. Calculate and record the density of the object.

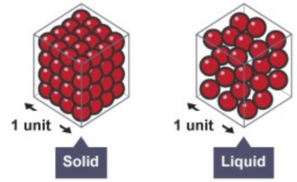


Regular Object

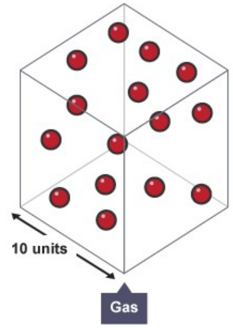
1. Measure the mass of one of the irregular shaped objects.
2. Use Vernier callipers to measure the length, width and height or the object.
3. Calculate the volume using the equation:
   volume = length x width x height
4. Calculate and record the density of the object.

Density

- Density is the amount of mass per unit volume.
- There is only a small difference between the density of a liquid and its corresponding solid, e.g. water and ice. This is because the particles are tightly packed in both states.



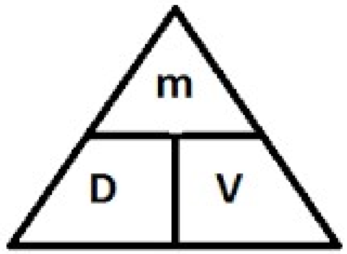
- The same number of particles in a gas spread further apart than in the liquid or solid states. The same mass takes up a bigger volume. This means the gas is less dense.



Equation

- The density of a material is defined by the equation:

density, ρ, in kilograms per metre cubed, **kg/m^3**
mass, m, in kilograms, **kg**
volume, V, in metres cubed, **m^3**



- Density = Mass/Volume
- Mass = Density x Volume
- Volume = Mass /Density

A box has a volume of 412 cm^3 and a mass of 42 g. What is its density?

E: Density = Mass / volume
S: Density = 42 / 412
A: Density = 0.1
U: Density = 0.1 g/cm^3

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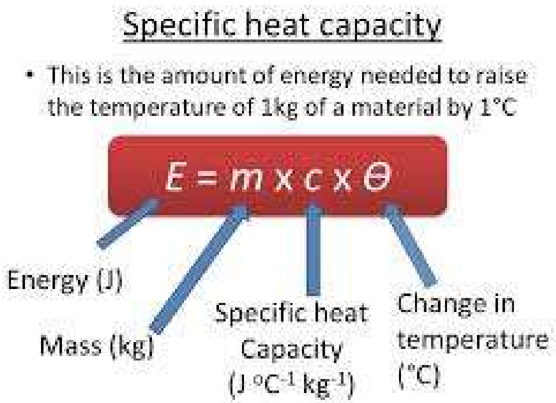
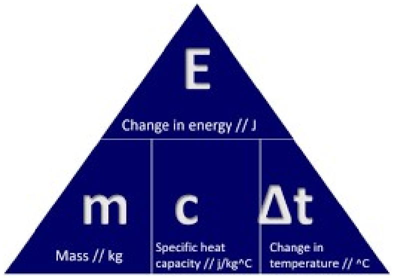
Specific Heat Capacity

- When substances melt, freeze, evaporate, condense or sublimate, mass is conserved but these physical changes differ from chemical changes because the material recovers its original properties if the change is reversed
- The specific heat capacity of a substance is the amount of energy needed to change the temperature of 1 kg of the substance by 1°C
- The greater the mass of an object the more slowly its temperature increases when it is heated
- To find the specific heat capacity of a substance use a joulemeter and a thermometer to measure the change in energy and temperature for a measure mass and then use the equation.



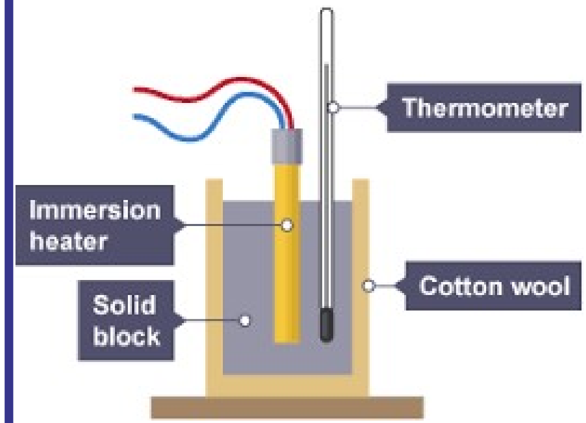


How much energy is needed to raise the temperature of 3 kg of copper by 10°C? The Specific Heat Capacity for copper is 385 J/Kg°C

E: E = m x c x t
S: E = 3 x 385 x 10
A: E = 11 500
U: E = 11 500 J

Required Practical

1. Place the immersion heater into the central hole at the top of the block.
2. Place the thermometer into the smaller hole and put a couple of drops of oil into the hole to make sure the thermometer is surrounded by hot material.
3. Record the temperature of the block.
4. Connect the heater to the power supply and turn it on for ten minutes taking note of the ammeter and voltmeter readings.
5. After ten record the highest temperature that it reaches.



The block has a mass of 1 kg and the heater was running for 10 minutes = 600 seconds.

Ammeter (A)	Voltmeter (V)	Initial temperature (°C)	Final temperature (°C)
3.65	10.80	15	38

E: energy transferred = potential difference × current × time
S: energy transferred = 10.80 x 3.65 x 600
A: energy transferred = 23 700
U: energy transferred = 23 700 J

E: Specific heat capacity $= \frac{\text{energy}}{\text{mass x change in temperature}}$

S: Specific heat capacity $= \frac{23\ 700}{1 \text{ x } (38 - 15)}$ $\quad \frac{23\ 700}{1 \text{ x } 23}$ $\quad \frac{23\ 700}{23}$

A: Specific heat capacity = 1 030
U: Specific heat capacity = 1 030 J/Kg°C

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Changes of State

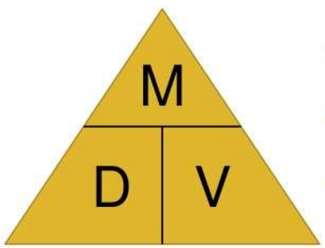
Substance	Melting point (°C)	Boiling point (°C)
Water	0	100
Oxygen	-219	-183
Ethanol	-15	78

Room temperature is 20°C. At room temperature are these substances a solid, liquid or gas?
Water:
Oxygen:
Ethanol:

Density

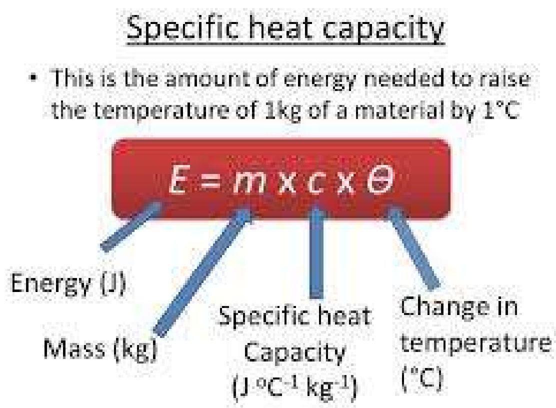
Object	Mass (g)	Volume (cm^3)	Density (g/cm^3)
Steel cube	468	60	
Steel sphere	33	4.19	
Stone	356	68	

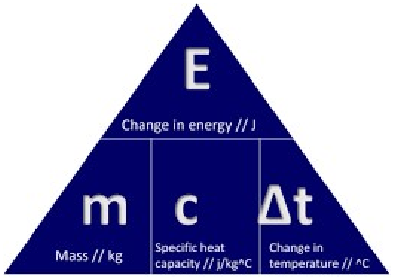
Calculate the density of each object



- Density = Mass/Volume
- Mass = Density x Volume
- Volume = Mass /Density

Specific Heat Capacity





A kettle is filled with water. The water in the kettle requires 160 kilojoules of energy to increase its temperature from 25 °C to the boiling temperature of 100 °C. Calculate the mass of water in the kettle.

The specific heat capacity of water is 4.2×10^3 J per kg per °C.

Task 1 Highlight the numbers in the question

Task 2 Calculate the mass of water in the kettle

E:

S:

A:

U:

Highlight the keywords: solid, liquid, gas, melting point, boiling point, evaporation, condensation, melting, freezing, density, Vernier callipers