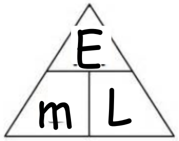
Particle Model (Page 1)

Specific Latent Heat

- When a change of state occurs, the **internal energy** increases but the temperature does not.



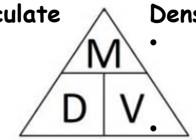
- **E = m x L**

- E = Energy in Joules (J)
- m = Mass in Kilograms (kg)
- L = Latent Heat in Joules per kilogram (J/kg)

- Specific latent heat of **fusion** is change of state between solid and liquid.
- Specific latent heat of **vaporisation** is change of state between liquid and gas.

START

How do we calculate density?



D = m / v.

Density (g/cm³ or kg/m³)
Mass (g or kg)
Volume (cm³ or m³)

Density of water?

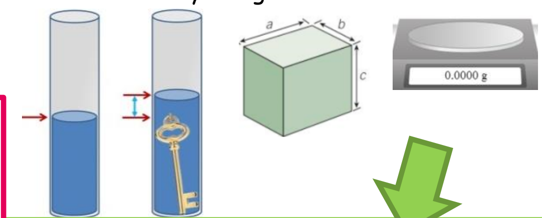
- 1 g/cm³ (same as 1000 kg/m³)

An object floats if it has a lower density than water.

- An object sinks if it has a higher density than water.

How do we find the density of an object?

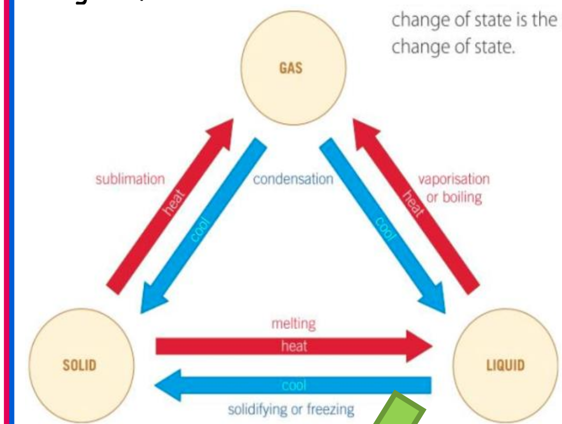
- Find the mass, using some weighing scales.
- Measure the volume by length x width x height of a regular object
- Put an irregular object into water. It will displace a volume of water equal to its own volume.
- Calculate density using the formula



Key words:

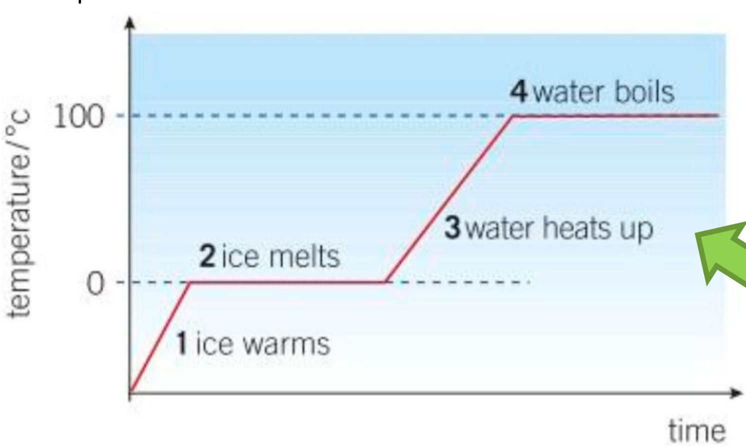
Density: How tightly packed particles are in a certain volume.
Particle: A small piece of matter, e.g. protons, electrons, atoms or molecules.
Matter: What everything is made up of.
State of matter: Solids, liquids or gases.
Melting: When solids turn into liquids.
Freezing: When liquids turn into solids.
Evaporating: When a liquid turns into a gas.
Condensing: When a gas turns into a liquid.
Internal Energy: The energy stored inside a system by the particles that make up the system.
Specific Heat Capacity: The energy needed to increase the temperature of **1kg** of a substance by **1° C.**
Specific Latent Heat: The energy needed to change the state of **1kg** a substance (without changing the temperature).
Pressure: The force per m² acting on a surface.
Pascal: The unit of pressure. 1Pa = 1N/m².

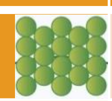
Changes of state



Changing state graphs

- While a substance is changing state, **its temperature does not change**.
- The energy goes towards breaking the bonds (melting and evaporating) or forming bonds (freezing and condensing) instead of changing the temperature.
- The slopes on the graph are when the substance is heating up and the flat lines are when the substance is changing state.
- The flat lines indicate a constant temperature.

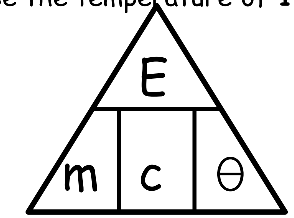


State of matter	Distance between molecules	Movement	Shape
Solid 	Close together (uncompressible)	Vibrate in one position	Fixed
Liquid 	Close together (uncompressible)	Particles move around each other.	Take shape of bottom of container
Gas 	Far apart (compressible)	Particles move randomly.	Take shape of whole container

Particle Model (Page 2)

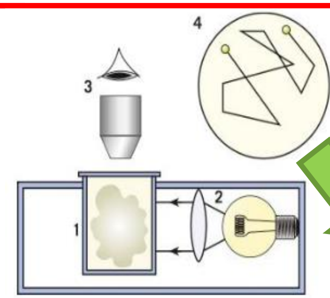
Internal energy
- Made up of the total kinetic energy and potential energy of the particles in a substance.
- Increasing temperature increases the kinetic energy of the particles and therefore the internal energy.

Specific heat capacity
- The energy needed to increase the temperature of **1kg** of a substance by **1° C**.
- **$E = m \times c \times \theta$**



- E = Energy in Joules (J)
- m = Mass in kilograms (kg)
- c = specific heat capacity in Joules per kilogram per degrees Celsius (J/kg°C)
- Θ = Change in temperature (°C)

How do we know gas particles move randomly?
- We can look at smoke particles to observe random motion because they are much bigger than air particles.
- You need a smoke cell and a microscope.
- You can see in the image (4) that the smoke cell (particle) moves haphazardly and completely randomly.



Particles when heated from solid to liquid to gas
- Solids are arranged in 3D structures with strong forces holding them in place. This makes them strong.
- When heated, particles vibrate more and more until the bonds begin to break and the solid starts turning to a liquid.
- In a liquid the particles are close together and have relatively strong forces of attraction to each other. This holds the particles at the surface from escaping.
- When heated, the particles move more quickly and begin to escape from the surface. It is turning into a gas.

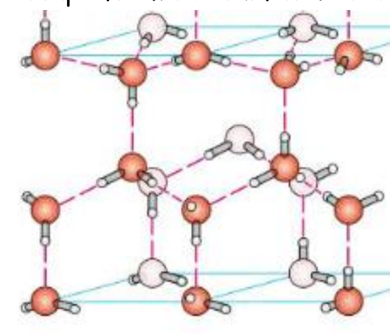


Figure 1 *Molecular model of ice*

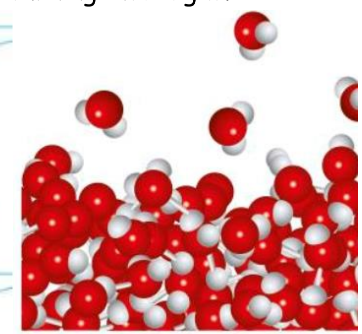
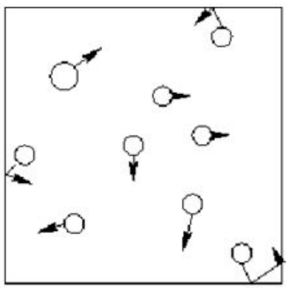


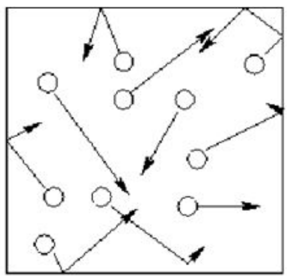
Figure 2 *Molecules in water*

How can we burst a can?

Heat it up
- Adding energy will **increase the temperature** of the liquid inside.
- Increasing the temperature increases the kinetic energy of the particles.
- This means they have more speed and will have more violent collisions.
- Hence they exert more force on the inside of the container so the pressure increases.

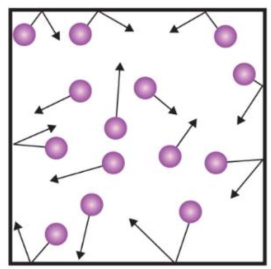


Cold



Hot

Squeeze it
- If we squeeze it we are **reducing the volume**.
- There is less space between the particles.
- This means that there will be more collisions.
- More collisions means there will be more force on the inside of the container.



What is pressure?
- The particles in gases and liquids move about randomly.
- They **collide** with each other and the walls of their container.
- These collisions cause a force on the inside of the container.
- **Pressure** is the force on an area (**force per unit area**) caused by these collisions. (**Measured in Pa (Pascals)**).

Particle Model Questions

1. Define Density.
2. Give the equation for density, explain each of the terms and name the units for each.
3. Explain how you would calculate the density of an irregular object, including the equipment needed.
4. Write and explain the changes of state.
5. Explain the movement, arrangement and shape of the three states of matter.
6. Draw a change of state graph for lead. Its melting point is $327.5^\circ\ C$ and its boiling point is $1749^\circ\ C$.
7. What is specific latent heat of fusion?
8. What is specific latent heat of vaporisation?
9. Which part of a change of state graph shows the existence of specific latent heat?
10. 0.008kg of water evaporated after 18,400J of energy was added. What is the specific latent heat of water?
11. What is internal energy?
12. Define specific heat capacity?
13. What does it mean if I have an object with a high specific heat capacity?
14. Describe how the particles in ice change when heated enough so that they melt, then evaporate.
15. What is pressure?
16. What are the units of pressure?
17. Why does heating a system increase the pressure?
18. Why does squeezing a system increase the pressure?
19. What happens to the pressure inside a deodorant can when you spray it? Why?
20. How could we show that gas particles move randomly?
21. Why does 1kg of ice have less energy than 1kg of water if they are both at $0^\circ\ C$?