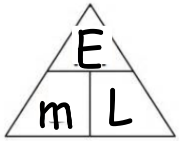
Particle Model (Page 1)

START

Specific Latent Heat

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



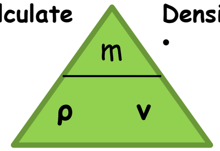
- **E = m x L**

- 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.

How do we calculate density?

$\rho = m / v$



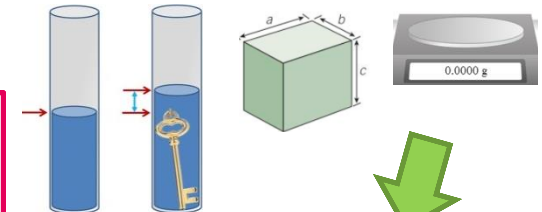
Density, ρ (kg/m^3)
Mass, m (kg)
Volume, v (m^3)

Density of water?

- 1 g/cm^3 (same as 1000 kg/m^3)
- 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?

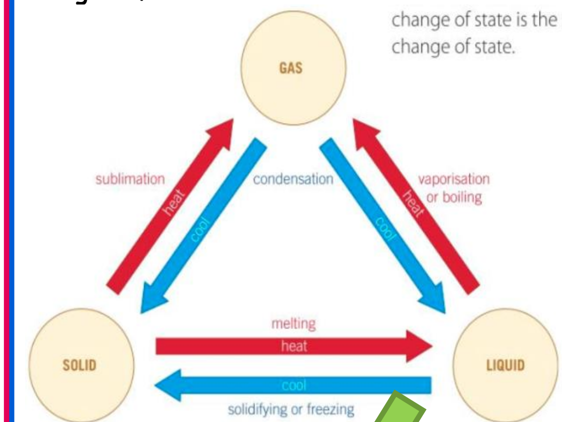
- Find the mass, using some weighing scales.
- Measure the volume by length x width x height of a regular object
- Put an irregular object into water. It will displace a volume of water equal to its own volume.
- Calculate density using the formula



Key words:

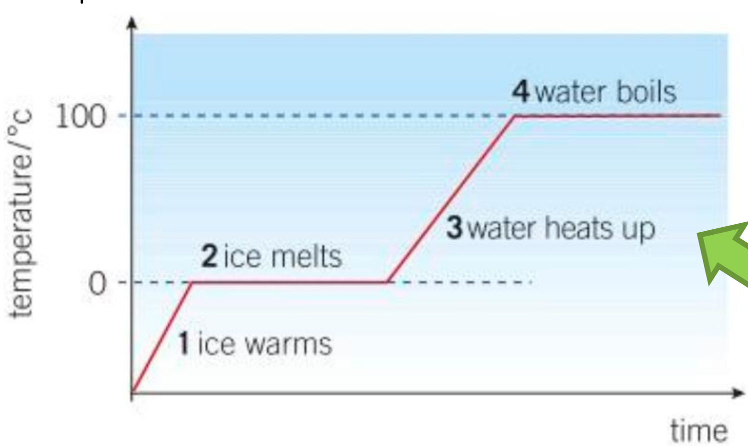
Density: How tightly packed particles are in a certain volume.
Particle: A small piece of matter, e.g. protons, electrons, atoms or molecules.
Matter: What everything is made up of.
State of matter: Solids, liquids or gases.
Melting: When solids turn into liquids.
Freezing: When liquids turn into solids.
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 m^2 acting on a surface.
Pascal: The unit of pressure. 1Pa = $1N/m^2$.

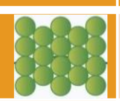
Changes of state



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.

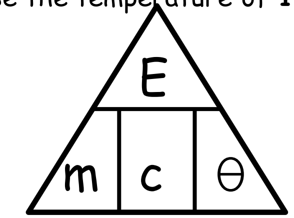


State of matter		Distance between molecules	Density	Movement	Shape
Solid		Close together (incompressible)	Dense	Vibrate in fixed positions	Fixed
Liquid		Close together (incompressible)	Dense	Particles move around each other.	Take shape of bottom of container
Gas		Far apart (can be squashed)	Much less dense	Particles move randomly.	Take shape of whole container

Particle Model (Page 2)

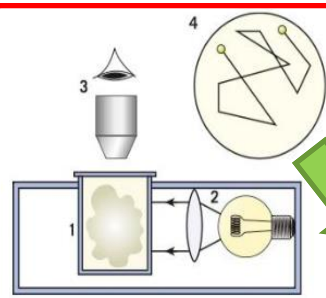
Internal energy
- Made up of the total kinetic energy and potential energy of the particles in a substance.
- Increasing temperature increases the kinetic energy of the particles and therefore the internal energy.

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



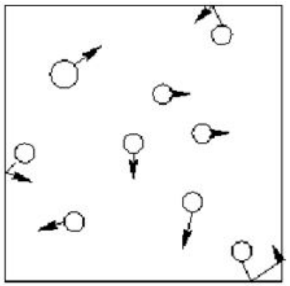
- E = Energy in Joules (J)
- m = Mass in kilograms (kg)
- c = specific heat capacity in Joules per kilogram per degrees Celsius (J/kg°C)
- Θ = Change in temperature (°C)

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.

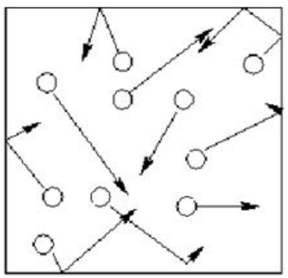


How can we burst a can?

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.

FINISH

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.

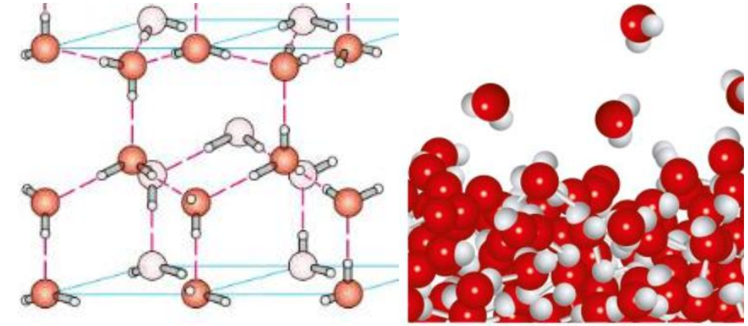
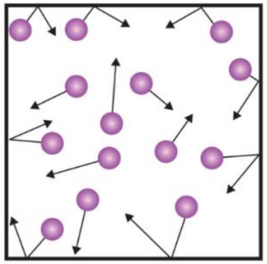


Figure 1 *Molecular model of ice* Figure 2 *Molecules in water*



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)**).

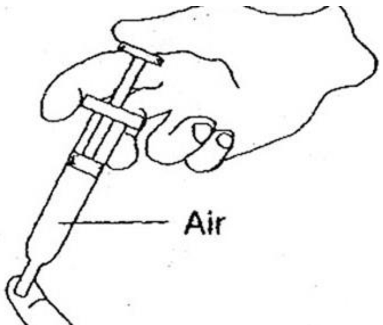
Particle Model (Page 3 - Triple)

Volume and Pressure

- The volume of a fixed mass of gas depends on its pressure and on its temperature.
- Pressure changes will cause the gas to expand or contract.
- When we compress a syringe full of gas we reduce the volume, causing the pressure to increase.
- So long as the compression happens slowly, the temperature remains constant.

Work

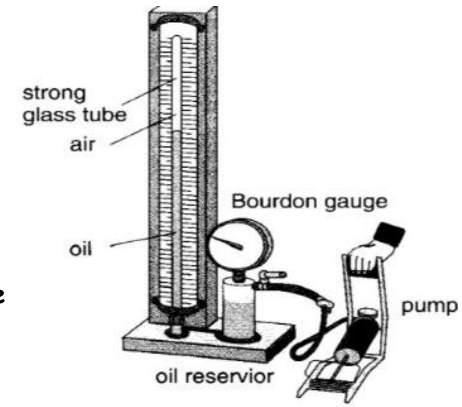
- Using the example from earlier, to compress a gas in a syringe work must be done (you have to physically push the syringe).
- This energy transfer is caused by you applying a force.



- Slow compression: force overcomes the gas pressure to reduce volume.
- Quick compression: internal energy is increased and so is temperature.
- This happens because when we
- compress the gas slowly it loses the extra energy to its surroundings.

Testing the variation of pressure and volume of a fixed mass of air.

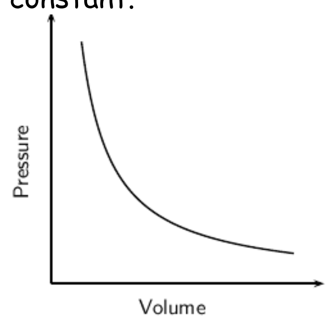
- The diagram shows gas trapped by oil in an inverted glass tube,
- **The pressure of the air is measured in Pascals (Pa) using a pressure gauge.**
- **The volume is measured in metres cubed (m^3) using the vertical scale along the tube.**
- ***A pump is used to increase the pressure of the gas.***



- **The tube is thick so that it can withstand the pressure of the gas.**
- **The volume of the gas in the tube is measured at different pressures as the pressure is slowly increased from atmospheric pressure in stages.**
- ***Measurements show that;***
  - **The pressure increases as the volume decreases.**
  - **The pressure decreases as the volume increases.**
- ***Safety precautions include goggles and keeping the tube behind a safety screen.***

Boyle's Law

- Pressure multiplied by volume for a system is always constant.
- $$p \times V = constant$$



- Where p is pressure,
- V is volume
- 'constant' is just a number.
- Each system will have a different constant.
- The relationship is inversely proportional, as shown in the graph.
- Increasing the volume in which a gas is contained, at constant temperature, can lead to a decrease in pressure.

Initial Pressure and Final Pressure

- Sometimes you might be asked to calculate the final pressure or volume of a system from given values.
- The constant in Boyle's law remains the same for the system even when the volume or pressure has changed.
- This means we can expand the previous equation to;
- $$p_i \times V_i = p_f \times V_f$$
- Where the small 'i' means 'initial' (before the system has changed).
- Where the small 'f' means 'final' (after the system has changed.
- So, a gas can be compressed or expanded by pressure changes. The pressure produces a net force at right angles to the wall of the container.

FINISH

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° C and its boiling point is 1749° 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° C?

Triple Physics Questions

1. When a fixed mass of gas expands slowly at constant temperature, write how the volume and the pressure of the gas changes.
2. Calculate the unknown quantities in the table below

	Initial pressure in Pa	Initial volume in m^3	Final pressure in Pa	Final volume in m^3
a	100000	0.00020	50000	
b	100000	0.00030		0.00015
c	120000		100000	0.00060
d		0.00015	60000	0.00045

3. A bicycle pump contains 20cm^3 of air at a pressure of 100kPa. The air is then pumped in a single stroke through a valve into a tyre of volume 100cm^3., which contains air at the same pressure. Calculate the pressure of the air in the tyre after the stroke. Assume the volume of the tyre doesn't change.
4. A cylinder contains air trapped by a piston. Explain why the temperature of the air in the cylinder increases if the piston is used to compress the air suddenly.
5. Describe the effect of taking a balloon underwater: why does the balloon compress as it gets deeper? Why do scuba divers suffer from decompression sickness if they surface too quickly?