The Particle Theory of Matter

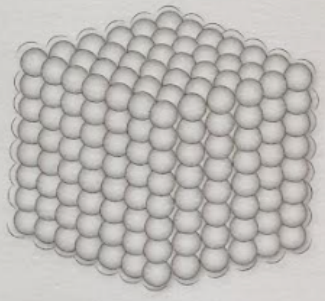
The word 'particles comes from a Latin word, *particula*, which means "small part". Scientists the word particle to describe matter that is too small to see.

Approximately 2 000 years ago a Greek philosopher (a philosopher is someone who thinks ab the world around them) called Democritis suggested that if you took a stone and cut it in h each half would have the same properties as the original stone. He reasoned that if you contin to cut the stone into smaller and smaller pieces, at some point you would reach a particle so that it could no longer be divided. He called these particles *atomos*, meaning "indivisible". Si Democritis suggested his idea, many scientists have carried out experiments and investigation improve and modify his theory. Today, it's called "The Particle Theory of Matter".

The Particle Theory of Matter

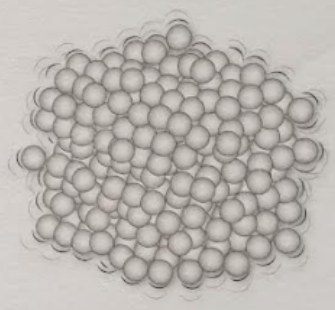
- *All matter is made of particles.*
- *Particles are always moving.*
- *Temperature affects the speed the particles are moving. The higher the temperature, the faster the particles are moving.*

We can use the Particle Theory to explain the behaviour of the three states of matter.



Solids

Particles are packed tightly together in a fixed pattern. They are gently vibrating, but are held together by strong forces.



Liquids

Particles are moving and can slide past each other. They are not held together in a fixed pattern. Particles are held together by weaker forces.

Gases

Particles are spaced far apart and move about very quickly. There are no forces are holding them together.

1. Summarise the information above by completing the following table.

	Solids	Liquids	Gases
Distance between the particles			
Movement of the particles			
Forces holding the particles together			

2. Gold is a solid at room temperature. Use the particle theory to explain the following properties of gold. Ensure you use the word '*particles*' in your answers.

(a) Gold cannot be compressed. _____

_____

(b) Gold does not flow when poured from one container to another. _____

_____

(c) A gold bar can melt if it is heated. _____

_____

(d) Draw a diagram to show the arrangement of the particles in a gold bar.

3. Water is a liquid at room temperature. Use the particle theory to explain the following properties of water. Ensure you use the word '*particles*' in your answers.

(a) Water cannot easily be compressed. _____

_____

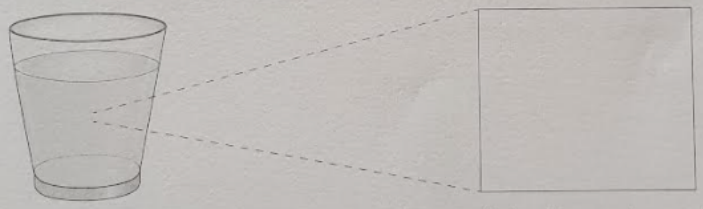
(b) Water flows when poured from one container to another. _____

_____

(c) Water is able to take up the shape of the bottom of the container it is stored in.

_____

(d) Draw a diagram to show the arrangement of the particles in a glass of water.



4. Helium is a gas at room temperature. Use the particle theory to explain the following properties of helium. Ensure you use the word '*particles*' in your answers.

(a) Helium can be compressed. _____

_____

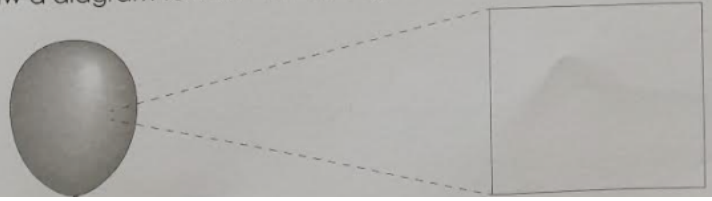
(b) Helium completely fills any container it is stored in. _____

_____

(c) Helium escapes from the container if the lid is left off. _____

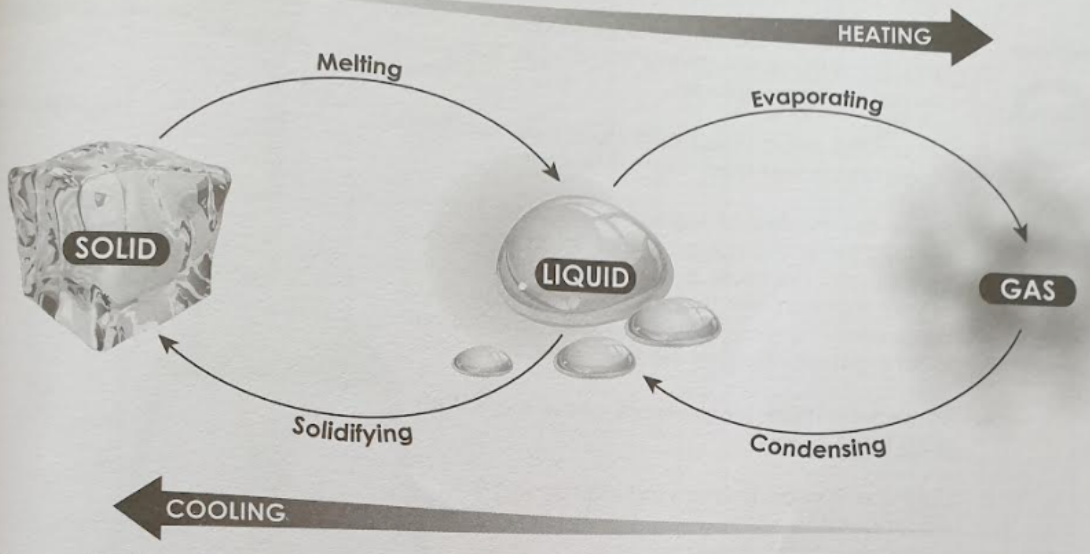
_____

(d) Draw a diagram to show the arrangement of the particles in a helium balloon.



Changing States

The three different states of matter can change from one state to another (i.e. a solid can change into a liquid). In order to change from one state to another the particles need to gain energy in the form of heat. When heat energy is applied to an object it causes the particles to move around more. One of the key differences between the three states of matter is how fast the particles are moving.



1. Use the diagram above, and the information from the previous pages, to complete the following paragraph.

In a block of ice the water particles are gently v_____. They are held together with s_____ forces so the block of ice keeps its shape. When the ice is h_____, the particles begin to vibrate more. This increase in particle vibration makes the d_____ between the particles i_____. As more heat is added the p_____ vibrate so much that they break away from each other and the ice m_____ into a l_____. As more heat is added, the particles gain more heat e_____ and move even faster. Because they are bumping into each other with considerable force, they begin to bounce further and further apart. Eventually the particles get so far apart from each other that the liquid e_____ into a g_____.

The process can easily be reversed by removing the particle's heat e_____. This is done by cooling them down. If the source of heat is removed, the gas particles will l_____ energy and c_____ back into a liquid. If the particles in the liquid begin slow down enough and move c_____ together, the liquid will s_____ back into a solid.

Answers

1. Summarise the information above by completing the following table.

	Solids	Liquids	Gases
Distance between the particles	Tightly packed.	Loosely packed.	Very far apart.
Movement of the particles	Slowly vibrating.	Vibrating and able to move around each other.	Moving quickly.
Forces holding the particles together	Strong forces.	Weaker forces.	Very weak forces. Effectively zero.

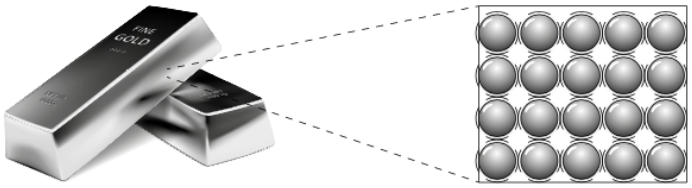
2. Gold is a solid at room temperature. Use the particle theory to explain the following properties of gold. Ensure you use the word '*particles*' in your answers.

(a) Gold cannot be compressed. **The particles within gold are very tightly packed with virtually no space between them.**

(b) Gold does not flow when poured from one container to another. **The forces holding the particles together are strong. They are fixed in position.**

(c) A gold bar can melt if it is heated. **The strong bonds holding the particles together are weakened and they can then move around each other.**

(d) Draw a diagram to show the arrangement of the particles in a gold bar.



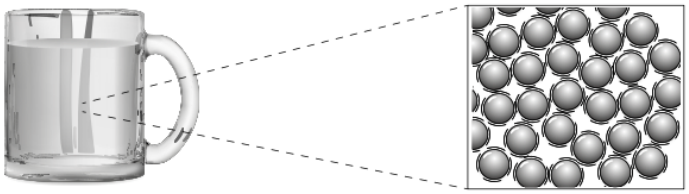
3. Water is a liquid at room temperature. Use the particle theory to explain the following properties of water. Ensure you use the word '*particles*' in your answers.

(a) Water cannot easily be compressed. **Because the particles within water are very tightly packed with virtually no space between them.**

(b) Water flows when poured from one container to another. **It is able to flow because the particles in a liquid are able to slide past each other.**

(c) Water is able to take up the shape of the bottom of the container it is stored in. **The particles are free to move.**

(d) Draw a diagram to show the arrangement of the particles in a glass of water.



4. Helium is a gas at room temperature. Use the particle theory to explain the following properties of helium. Ensure you use the word '*particles*' in your answers.

(a) Helium can be compressed. **Helium can be compressed because there is a lot of space between the particles.**

(b) Helium completely fills any container it is stored in. **Because the particles are moving about very quickly and not bound together.**

(c) Helium escapes from the container if the lid is left off. **Because the particles are not bound together.**

1. Use the diagram above, and the information from the previous pages, to complete the following paragraph.

In a block of ice the water particles are gently v**ibrating**. They are held together with s**trong** forces so the block of ice keeps its shape. When the ice is h**eated**, the particles begin to vibrate more. This increase in particle vibration makes the d**istance** between the particles i**ncrease**. As more heat is added the p**articles** vibrate so much that they break away from each other and the ice m**elts** into a l**iquid**. As more heat is added, the particles gain more heat e**nergy** and move even faster. Because they are bumping into each other with considerable force, they begin to bounce further and further apart. Eventually the particles get so far apart from each other that the liquid e**vaporates** into a g**as**.

The process can easily be reversed by removing the particle's heat e**nergy**. This is done by cooling them down. If the source of heat is removed, the gas particles will l**ose** energy and c**ondense** back into a liquid. If the particles in the liquid begin slow down enough and move c**loser** together, the liquid will s**olidify** back into a solid.