THE PARTICLE MODEL

Distinguishing properties of solids , liquids and gases:

	Solids	Liquids	Gases
Arrangement	The particles in a solid are arranged in a fixed pattern	The particles in a liquid are not arranged in any fixed pattern	The particles in a gas are arranged in a random manner
Separation	The particles of a solid are very close to each other	The particles in a liquid are close to each other	The particles of a gas are further apart from each other
Motion	The solid particles can only vibrate in their fixed(mean) positions	The liquid particles can slide past over each other	The gas particles are free to move everywhere rapidly

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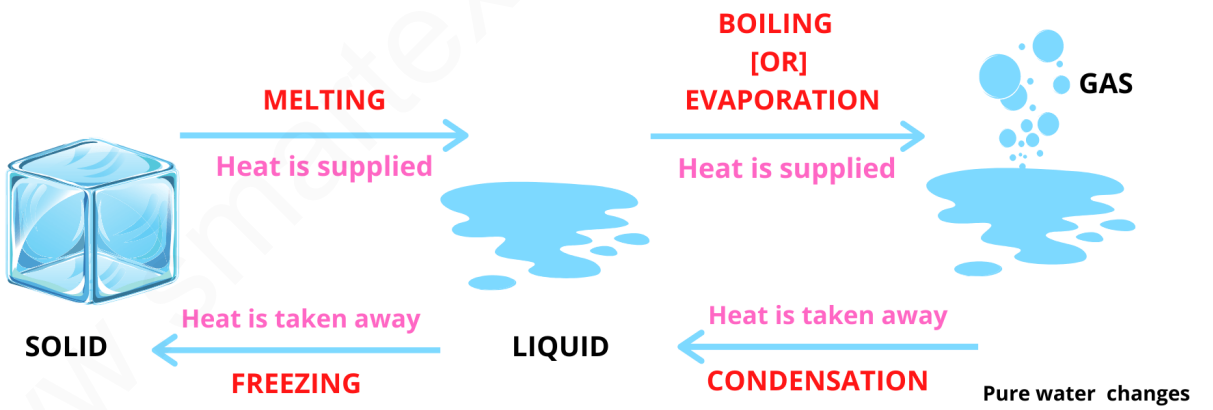
CHANGES IN THE STATES OF MATTER



Pure ice does not melt until the temperature reaches 0 °C

Pure ice melts at 0 °C and stays in the liquid state till the temperature is between 0 °C and 100 °C

Pure water changes into the gaseous form in the two ways:
1. Evaporation: This happens over a range of temperatures.
2. Boiling: This happens only a 100 °C

The forces and distances between particles (atoms, molecules, ions and electrons) and the motion of the particles affects the properties of solids, liquids and gases

In a solid:

- The molecules are arranged in a three dimensional structure.
- Each molecule vibrates about a fixed mean position.
- When a solid is heated its molecules gain kinetic energy and vibrate more.
- If sufficient heat is provided, then enough energy may be given to the molecules so that they weaken their bonds from the neighbouring molecules in the lattice structure. When this happens, the solid melts or sublimes.

In a liquid:

- The molecules are in contact with each other and also move around freely.
- The forces of attraction between the liquid molecules are weak compared to solids , so they can slide past over each other. Hence they can flow and do not have a fixed shape.
- The forces of attraction are strong enough to stop the molecules from leaving the liquid surface.
- When a liquid is heated, some of the molecules gain enough kinetic energy to break away from the other molecules and leave the liquid surface and change to a gaseous form.

In a gas:

- The forces of attraction between gas molecules is negligible. So a gas can flow and has no fixed shape.
- The molecules move about freely in the container, colliding with each other and with the walls of the container.
- When a gas is heated, its molecules gain kinetic energy and move more rapidly and collide more frequently , thus exerting gas pressure.

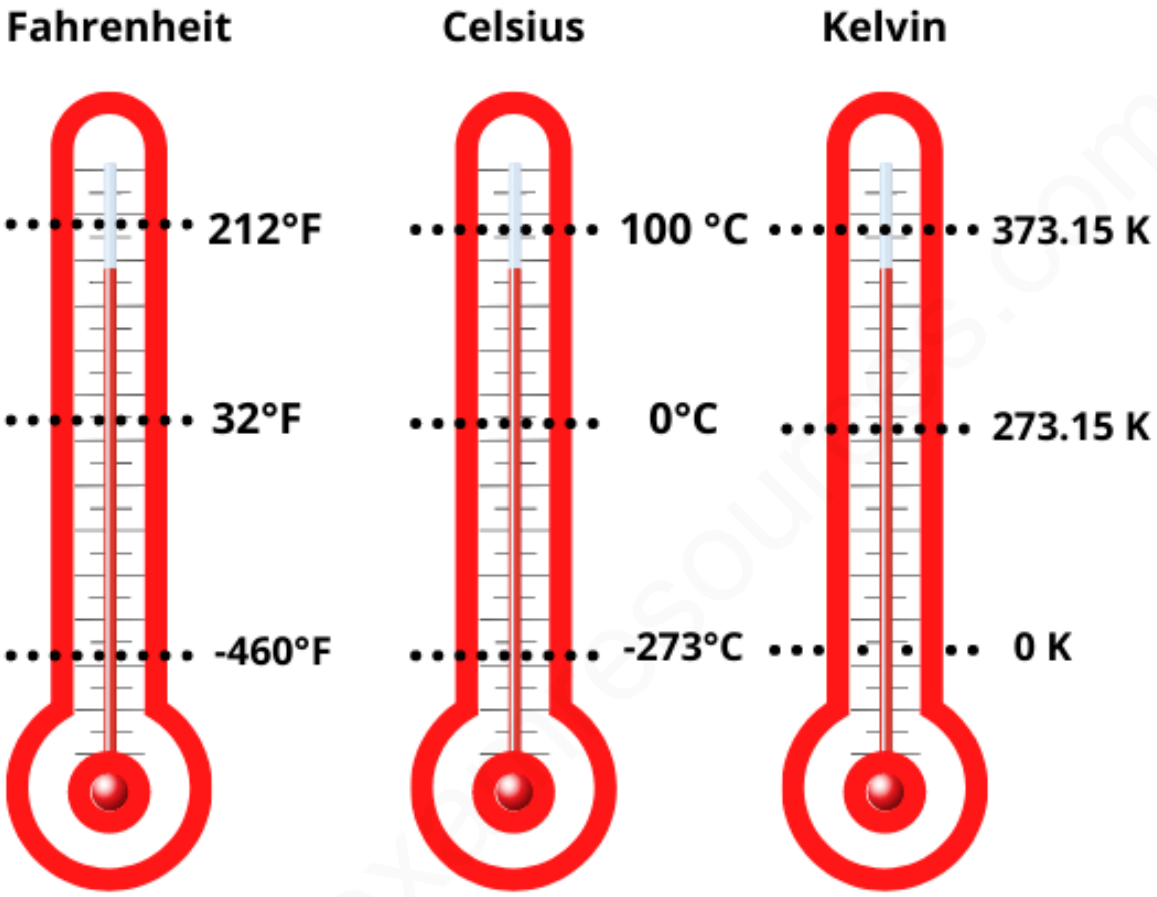
Relationship between the motion of particles and temperature

- Temperature refers to the degree of hotness or coldness of a substance.
- The motion of the particles is increased by raising the temperature. Conversely, the motion of the particles is reduced by lowering the temperature, until, at the absolute zero (0 K), the motion of the particles cease altogether.
- Since the particles are in motion, they have kinetic energy. Also, all the particles will not have the same energy. Also the energy of the particles is constantly changing as they undergo changes in speed. Thus, for a given sample of matter, we can only talk about the average kinetic energy of the particles. Temperature is thus defined as a measure of the average kinetic energy of the particles.
- **Three scales used to record temperatures are:**
  - ✓ The Celsius scale. On this scale, melting point of pure ice has a temperature of 0 °C, and the boiling point of pure water is shown as 100°C.
  - ✓ The Fahrenheit scale: This scale shows the melting point of pure ice as 32^0F and the boiling point of pure water as 212^0F
  - ✓ The Kelvin scale: The freezing point of pure water on the Kelvin scale is 273.15 K, while the boiling point of pure water is 373.15 K.

NOTE:

To convert Celsius temperature to Kelvin temperatures, simply add 273.16. The temperature of 0 K or -273^0C is known as the ABSOLUTE ZERO .It is the lowest temperature which can be obtained where the particles has the least kinetic energy.

TEMPERATURE SCALES



The pressure and the changes in pressure of a gas in terms of the motion of its particles and their collisions with a surface

- The pressure of a gas results from collisions between the gas particles and the walls of the container.
- Each time a gas particle hits the wall, it exerts a force on the wall.
- An increase in the number of gas particles in the container increases the frequency of collisions with the walls and therefore the pressure of the gas.
- The forces exerted by particles colliding with surfaces, create a force per unit area[pressure] on the walls of the container.

Brownian motion

Note:

1. The random motion of microscopic particles in a suspension is evidence for the kinetic particle model of matter

2. The microscopic particles may be moved by collisions with light fast-moving molecules and correctly use the terms atoms or molecules as distinct from microscopic particles

Explain Brownian motion in terms of random collisions between the microscopic particles in a suspension and the particles of the gas or liquid

NOTE: The microscopic particles may be moved by collisions with light fast-moving molecules and correctly use the terms atoms or molecules as distinct from microscopic particles

Define Brownian motion:

Brownian motion is the random collisions between the microscopic particles in a suspension and the particles of the gas or liquid

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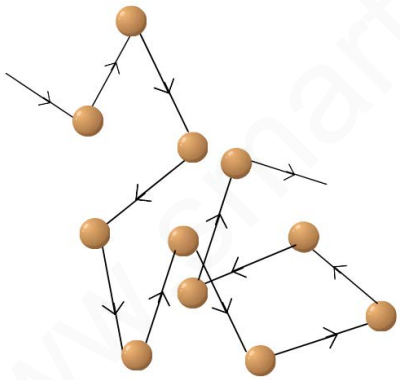
Brownian motion is represented by the following diagram.

BROWNIAN MOTION



- Motion is described as random and zig- zag.
- Collisions happen because the microscopic particles in a suspension collide with the particles of gas or liquid

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Random motion of particles(pollen grains) in a suspension was observed by Robert Brown. This was the evidence for the kinetic molecular model of matter.

Application based questions:

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5 **(a)** A microscope that produces a very high magnification is used to observe the Brownian motion of smoke particles in air.

Fig. 5.1(a) shows the apparatus used with the microscope. Fig. 5.1(b) represents the view through the microscope and shows one of the smoke particles being observed.

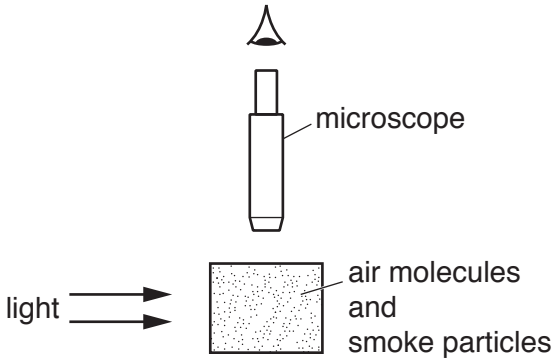

Fig. 5.1(a)

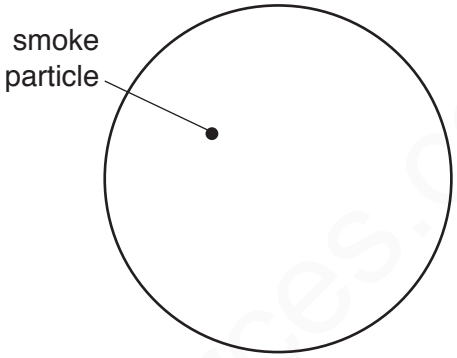

Fig. 5.1(b)

(i) On Fig. 5.1(b), draw a possible path for the smoke particle. [2]

(ii) Describe how air molecules cause the smoke particle to follow the observed path.

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.....[2]

MARKSCHEME:

5(a)(i)	path shows three or more straight line sections	**B1**
	with sudden changes of direction **and** at least two different lengths	**B1**
5(a)(ii)	air molecules travelling in random (directions)	**B1**
	collide with the smoke particle	**B1**

(b) A syringe is used to transfer smokey air from above a flame to a small glass container.

Extremely small solid smoke particles are suspended in the air in the container.

The container is brightly illuminated from the side and viewed through a microscope.

(i) The movement of the suspended smoke particles is called Brownian motion. Describe this Brownian motion.

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.....[2]

(ii) Explain what causes the motion of the smoke particles.

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.....[2]

(b) (i) (the particles move) <u>randomly</u> B1

(the particles move) slowly **OR** through small distances **OR** disappear **OR** zigzag **OR** directions change **OR** erratic **OR** straight lines between collisions B1

(ii) air <u>molecules</u>/<u>particles</u> collide with smoke particles (at high speed) B1
fast(er) air molecules **OR** move randomly **OR** many collisions B1

3 (a) Fig. 3.1 represents the path taken in air by a smoke particle, as seen in a Brownian motion experiment. The smoke particles can be seen through a microscope, but the air molecules cannot.

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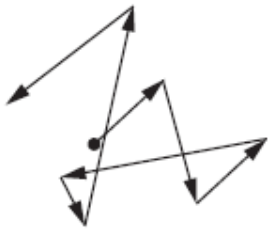

Fig. 3.1

(i) State what causes the smoke particles to move like this.

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..... [1]

(ii) What conclusions about air molecules can be drawn from this observation of the smoke particles?

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..... [2]

MCQ:

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14 Viewed through a microscope, very small particles can be seen moving with Brownian motion.

Which line in the table is correct?

0625/01/O/N/08

	type of motion of particles	particles are suspended in
A	vibration	a liquid or a gas
B	vibration	a solid, a liquid or a gas
C	random	a liquid or a gas
D	random	a solid, a liquid or a gas

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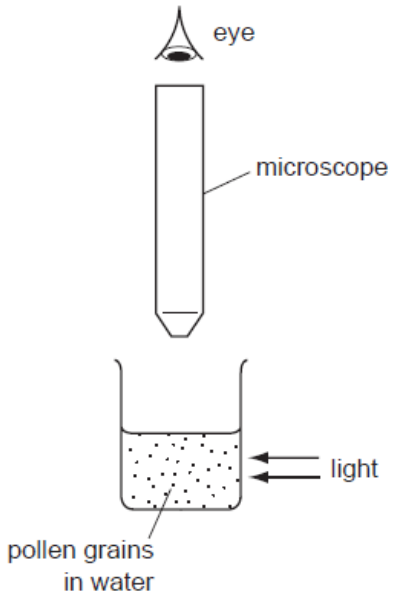
10 Very small pollen grains are suspended in water. A bright light shines from the side.

Looking through a microscope, small specks of light are seen to be moving in a random, jerky manner.



0625/12/O/N/12

What are the moving specks of light?

A pollen grains being hit by other pollen grains

B pollen grains being hit by water molecules

C water molecules being hit by other water molecules

D water molecules being hit by pollen grains

14 Viewed through a microscope, very small particles can be seen moving with Brownian motion.

Which line in the table is correct?

0625/01/M/J/05

	type of motion of particles	particles are suspended in
A	vibration	a liquid or a gas
B	vibration	a solid, a liquid or a gas
C	random	a liquid or a gas
D	random	a solid, a liquid or a gas

14 Diagram 1 shows apparatus being used to observe smoke particles.

Diagram 2 shows how a smoke particle moves randomly. **0625/01/M/J/07**

diagram 1

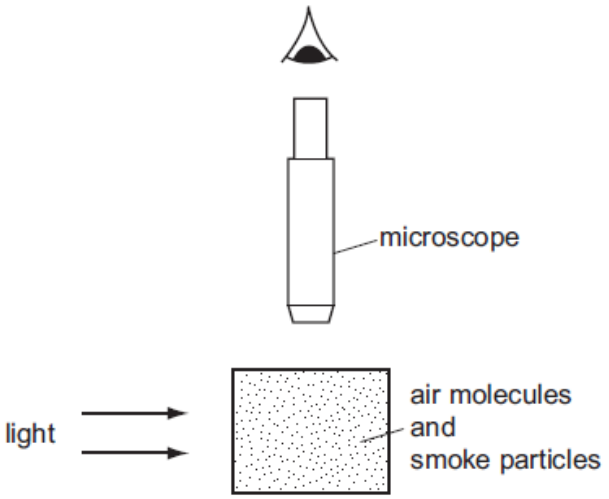
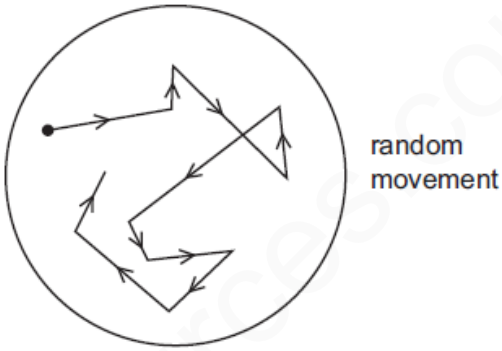


diagram 2



Why do the smoke particles move randomly?

A They are hit by air molecules.

B They are less dense than air.

C They are moved by convection currents.

D They gain energy from the light.

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15 Brownian motion is observed by looking at smoke particles through a microscope.

How do the smoke particles move in Brownian motion? **0625/12/O/N/09**

A all in the same direction

B at random

C in circles

D vibrating about fixed points

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12 Extremely small pollen grains in water are viewed through a microscope. The grains are seen to move continually and randomly.

0625/12/F/M/15

What is the reason for this random movement?

A The grains are moved by randomly moving water molecules.

B The grains are moved by random convection currents in the water.

C The grains are moved by random rays of light reflecting off them.

D The grains are moved by the random motion of their own atoms.

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14 Brownian motion is observed when using a microscope to look at smoke particles in air.

What causes the smoke particles to move at random?

M/J/17-P22

A Smoke particles are hit by air molecules.

B Smoke particles are moved by convection currents in the air.

C Smoke particles have different weights and fall at different speeds.

D Smoke particles hit the walls of the container.

Where the markschemes are not given in the revision notes, you need to refer to the markschemes from the past exam papers by referring to the code