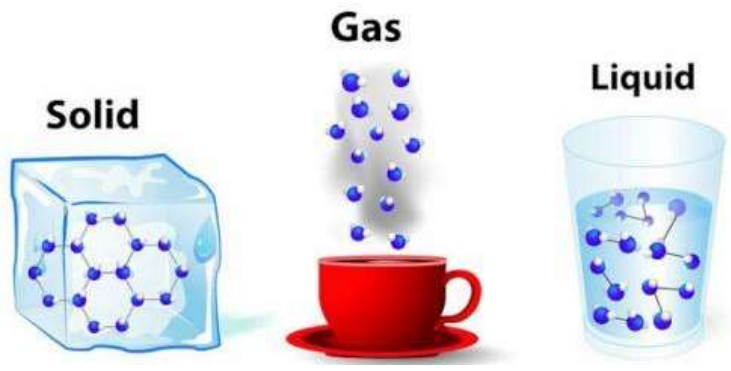
States of Matter

Chapter-2:



Kinetic theory:

- Most Matters exist in three main states- solid, liquid and gas.
- Particles in any state are at constant movement and the energy they have for their movement is known as kinetic energy.
- When a solid, liquid or a gas is heated, the particles are given more kinetic energy and, so they move faster- the lighter the particles are, the faster they move.
- The pressure of a gas is due to its particles hitting the walls of the container.

1. Video Link:

https://www.youtube.com/watch?v=wclY8F-UoTE

The comparison of the solid, liquid and gas:

Properties	Solid	Liquid	Gas
Volume	Definite	Definite	Variable, expand or contract to fill its container.
Shape	Definite	Takes up the shape of the bottom of the containers	Takes up the shape of the whole containers
Density (Closeness of particles)	Very High	Medium	Very low
Expansion on heating	Very slight	Slight	Very high
Compressibility (effect of pressure)	Negligible	Slight	Very high
Movement of particles	Vibrate in fixed position	Move about in cluster	Move about freely and always collide with each other.
Attraction between the particles	Strong	Weak	Negligible
Particles Arrangement	Very closely packed Regularly arranged in lattice	Closely packed Irregular arrangement	Very far apart Very irregular arrangement
Intermolecular Spaces	Almost none / Negligible	Minimal / Tiny spaces	Very large

Comprehensive Exercise:

Three States of matter

Total marks: 10 Total time: 10 minutes

Name of the student: .....

Compressive Exercise:

1. These questions are about three main states of matter.

(a) Draw the arrangement of particles in the liquid of the beaker above. [1]

(b) (i) In which of the states do the particles have greatest amount of kinetic energy? .....

(ii) Which of the states expands the most on heating? .....

(iii) In Which of the states do the particles just vibrate? .....

(iv) Which of the arrangement is the most common form of water? .....

[4]

(c) Answer the following questions. The first one is answered to guide you.

(i) Which two of the states are similar in terms of movement? Explain your choice.

Answer: Liquid and Gas.

Because Both in Liquid and Gas, the particles can move about.

(ii) Which two of the states are similar in terms of volume? Explain your choice. [2]

.....

.....

.....

.....

(iii) Which two of the states are opposite in terms of shape? Explain your choice. [2]

.....

.....

.....

.....

.....

(d) Which of the following statements is NOT true? Give a tick in the box. [1]

☐ A Particles in a gas are furthest apart.

☐ B Particles in a liquid move in cluster.

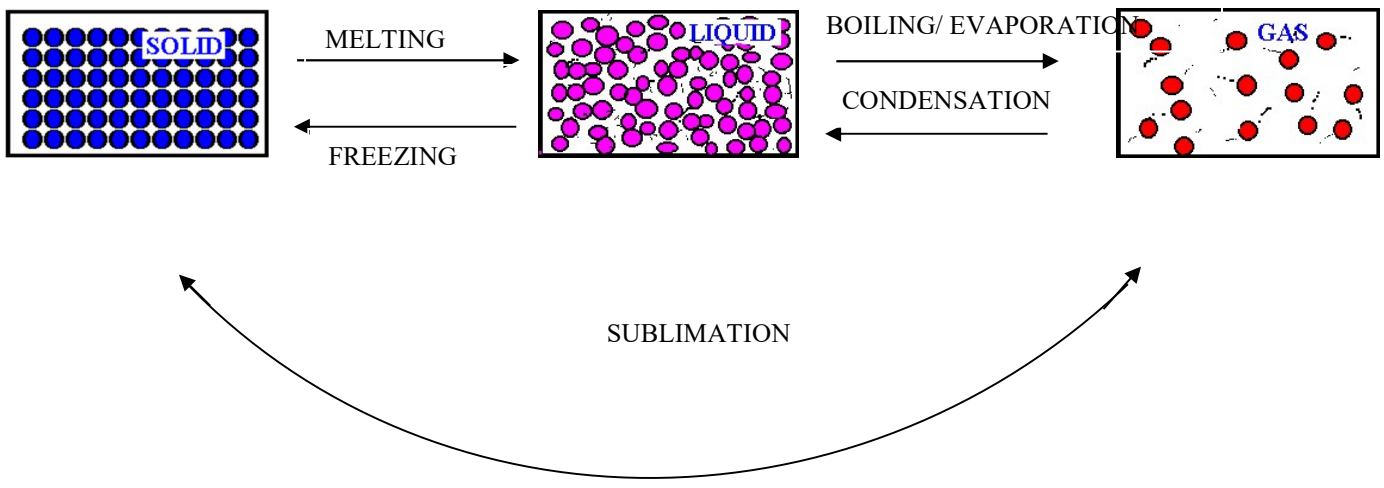
☐ C Particles move faster with greater potential energy.

Total 10 marks for the question.

Thank You!

Change of states:

3. Video link: https://www.youtube.com/watch?v=xYU7RSoOZ0U



Melting: The change of state of a substance from solid to liquid at a particular temperature is called **melting**.
The particular temperature at which a substance melts at atmospheric pressure is called **melting point (mp)** of the substance.

e.g. when heated, a pure sample of ice melts at exactly 0^0C.

This means melting point of water is 0^0C.

Freezing is an opposite occurrence to melting.
Melting point and **freezing point** of a substance is the same.

For example, when liquid water is cooled at atmospheric pressure, it freezes (**solidifies**) at 0^oC.
So, freezing point of water is 0^oC.

Boiling: The change of state of a substance from liquid to a gas at a particular temperature is called boiling.

The particular temperature at which a substance boils at atmospheric pressure is called **boiling point** (b.p.) of the substance.
e.g. When heated, a pure sample of liquid water boils at exactly 100^0C at atmospheric pressure.
This means boiling point of water is $100\ ^0$C.

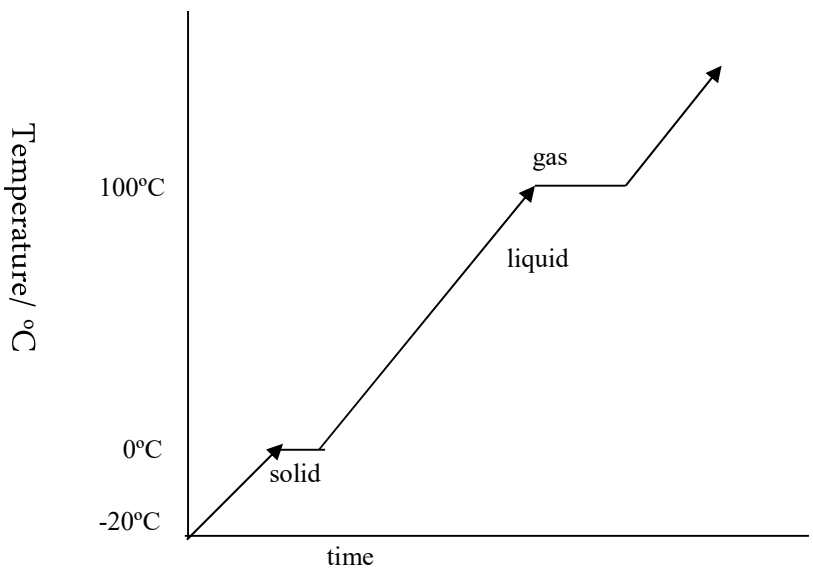
Condensation is an opposite occurrence to boiling.
The change of state of a substance from gas to a liquid at a particular temperature is called Condensation.
Boiling point and the **temperature of condensation** of a substance is the same.

For example, when steam is cooled at atmospheric pressure, it condenses (liquefies) at 100 °C.

Water can exist in states, solid (ice), liquid (water) and gas (steam).

The figure below is obtained when a sample of ice is heated with a steady source of energy.

Figure-



When a change of state takes place eg. Solid ⟶ Liquid or liquid ⟶ gas, the temperature remains constant for a while until the total change is complete despite a continuous heating.

The energy which is not used to raise the temperature is called latent heat (or latent energy).

Latent energy is used to weaken or overcome the intermolecular forces to separate the molecules during the melting or boiling.

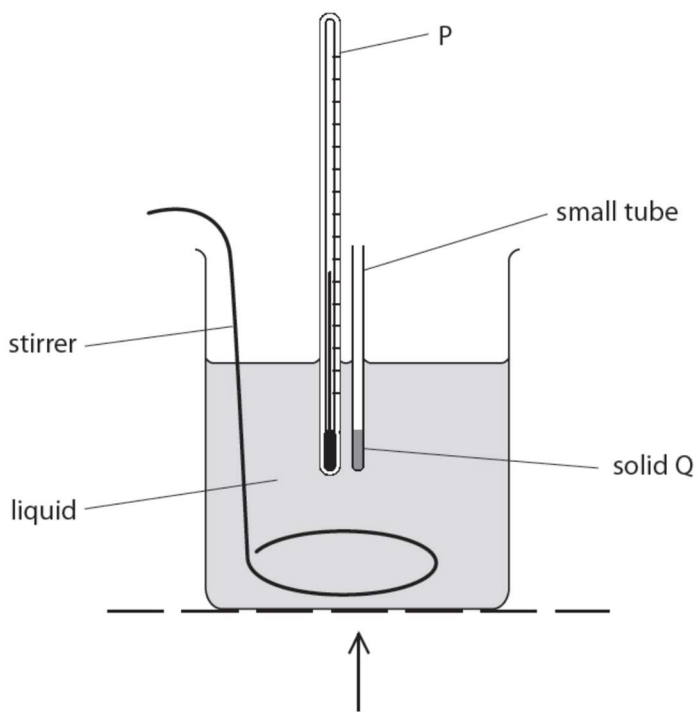
NOTE: All pure substances have particular/definite melting and boiling temperature. *

Q. Describe an experiment to show that a sample of water is pure.

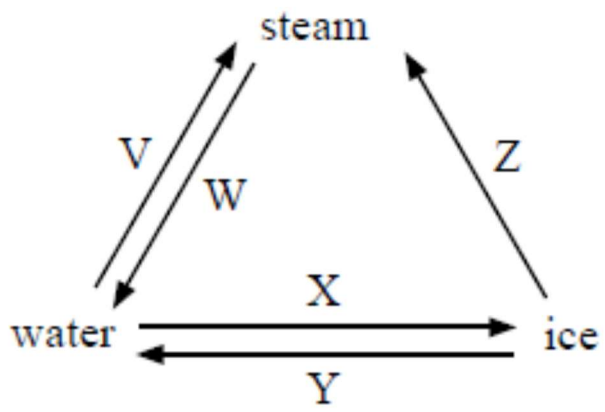
Answer:

Experiment : Water is heated and its temperature is measured with a thermometer.

Observation : It boils at exactly 100 °C.



Comprehensive Test: The main three states of matter are solid, liquid and gas.
The diagram shows the relationships between ice, water and steam.



(a) (i) What is the name given to the change of state indicated by **Y**? .....

(ii) Which letter indicates sublimation? .....

(iii) What must be provided for the change of state indicated by **V** to occur? .....

(iv) In which state are water molecules **not** free to move around? .....

(b) Melting and boiling points of water are 0°C and 100°C respectively.
Liquid water may be boiled or evaporated.

(i) State a **similarity** and a **difference** between **evaporation** and **boiling** of water.

Similarity: .....

Difference: .....

(2)

(ii) State the most expected physical state of water.

At -70 °C : .....

At 120 °C : .....

(2)

(iii) Describe an experiment and result to prove that a sample of liquid water is pure.

Experiment: .....

.....

Result: .....

.....

(2)

Total 10 marks for the Test on Change of State

Evaporation:

A liquid can change into a gas without boiling. This is, when a liquid evaporates.

Here, the liquid turns into its vapour at a temperature below its boiling point.

This is a spontaneous process.

The rate of evaporation of a liquid increases, if .....

(i) Temperature of the liquid increases.

(ii) Flow of air on the surface of the liquid increases.

(iii) Surface area of the liquid increases.

Comprehensive Exercise:

Q. A substance X, boils at 69.3 °C and melts at –13.8 °C.

(a) What is the 'temperature of condensation' of X? [1]

(b) What is the physical state of X, at

(i) Room temperature (25 °C)? [1]

(ii)100 °C? [1]

(c) A person demands to find gaseous X at 30 °C?

Do you think the person is right? Explain. [2]

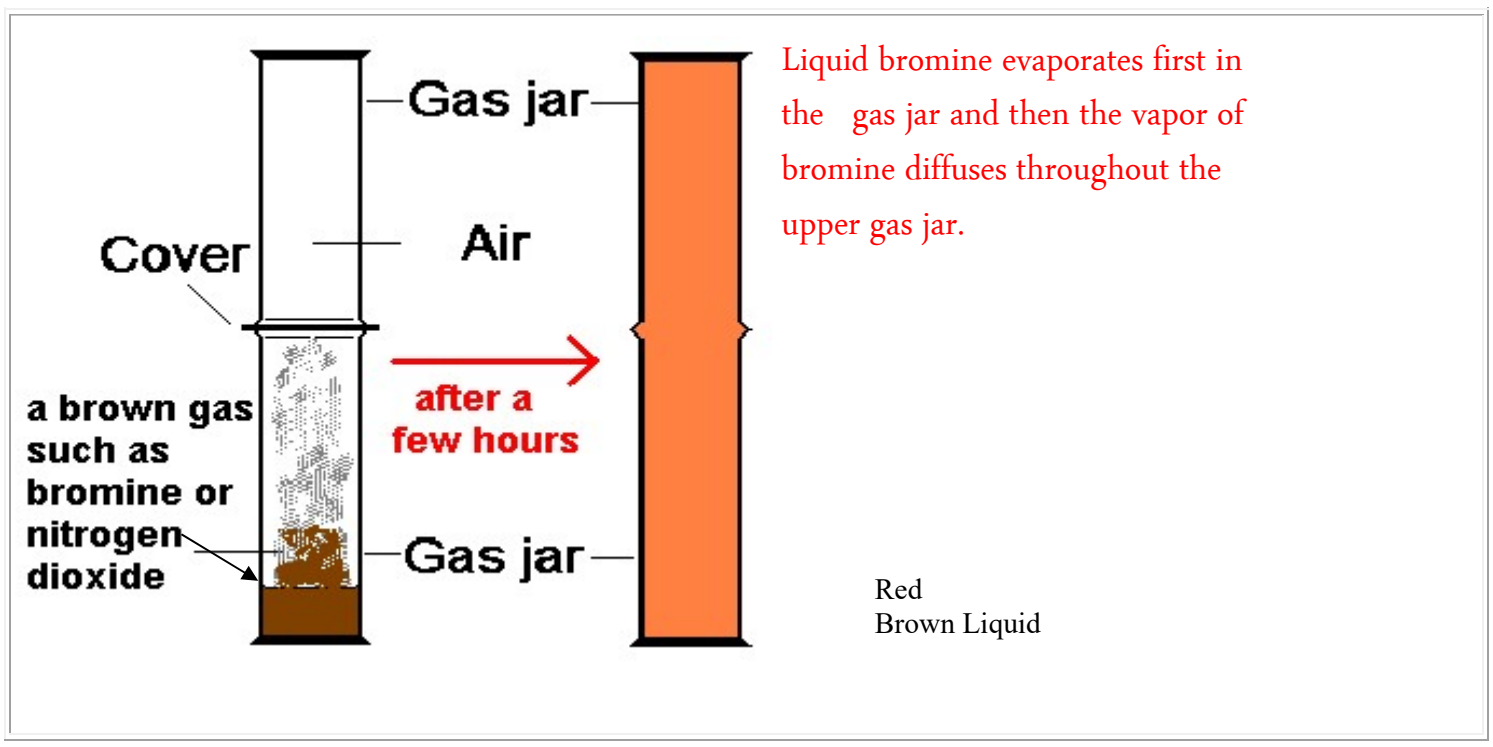
Sublimation: Certain substances (e.g. ammonium chloride, solid carbondioxide, iodine etc.) do not melt when they are heated but change directly from solid to a gas.
When the gases are cooled they return directly to their solid state.

These substances are called **sublimates** and the process is called sublimation.

Diffusion:

4. Video Link: https://www.youtube.com/watch?v=Peg1yaB2bsk

Diffusion is the spontaneous movement of particles at random from an area of higher concentration to an area of lower concentration.
Diffusion occurs as the particles in a gas or liquid collide with each other.

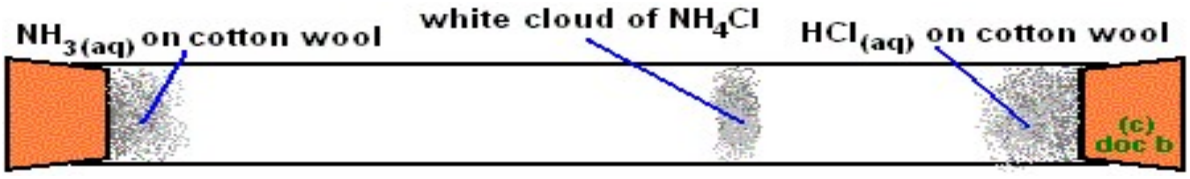


Diffusion occurs whena soluble ink is dropped in water or other liquid.
The rate of diffusion is faster wen the temperature is greater

The lighter the particles are, the faster they diffuse:

An Experiment to investigate the diffusion rate of particles with different masses:

Video Link: https://www.youtube.com/watch?v=YptxzEfXPI4



A piece of cotton wool soaked in concentrated hydrochloric acid (which gives off hydrogen chloride fume) and a piece of cotton wool soaked in concentrated ammonia solution (which gives off ammonia fume) are placed at the opposite ends of a 100 cm long glass tube.

The tube is then closed with rubber corks.
A white ring is formed in the tube after about five minutes.
The white ring is formed 34 cm away ($^1/_3$ of the tube length) from the acid end and 66 cm away ($^2/_3$ of the tube length) from the ammonia end.

The relative formula mass of HCl is 1+35.5= 36.5 which is about double than that of NH_3 (14+1x3=17).
So, ammonia moves (travels) double distance than hydrogen chloride.

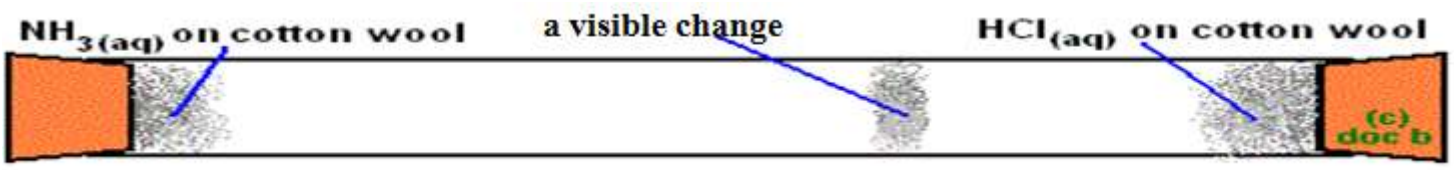
The equation of the reaction that takes place to form white fume is –

$$HCl\ (g) + NH_3\ (g) \longrightarrow NH_4Cl\ (s)$$

Ammonia particles move about twice as fast as the hydrogen chloride particles.
Lighter particles diffuse faster than heavier ones.

Comprehensive Exercise:

1. In an experiment, two plugs of cotton wool soaked respectively in concentrated aqueous ammonia and concentrated hydrochloric acid were placed at either end of a long glass tube. After a short time, a visible change was observed in the tube.



(a) **Ammonia gas** is produced at the plug of cotton wool soaked in concentrated aqueous ammonia.
(i) State the **name** of the **physical change** to produce ammonia gas from the soaked cotton wool.

.....

[1]

(ii) **Name** the **gas** produced at the plug of cotton wool soaked in concentrated hydrochloric acid.

.....

[1]

(iii) **Name** the process by which the gases move through the tube to each other is **diffusion**.

Why do the particles diffuse?

.....

[1]

(b) The relative speeds of the gases are measured and compared based on the **visible change** in the tube.
(i) State the **<u>appearance</u>** of the **visible change** in the tube.

.....

[1]

(ii) Give the formula of the **chemical substance** responsible for the **visible change**.

.....

[1]

(iii) **Explain** why the **visible change** appears near the end of Hydrochloric acid.

.....

.....

.....

[2]

(c) Diffusion also occurs in liquid.
If a drop of **brown bromine** is placed in water, the colour of the water turns orange in **two minutes**.
Suggest a way, other than stirring, how to make the colour of water to change in **one minute**?

.....

[1]

(d) A student repeated the experiment for investigating diffusion rate in the glass tube with different chemical substances **X** and **Y**.
When **X** and **Y** meet together they produce a visible change as like in the first experiment.

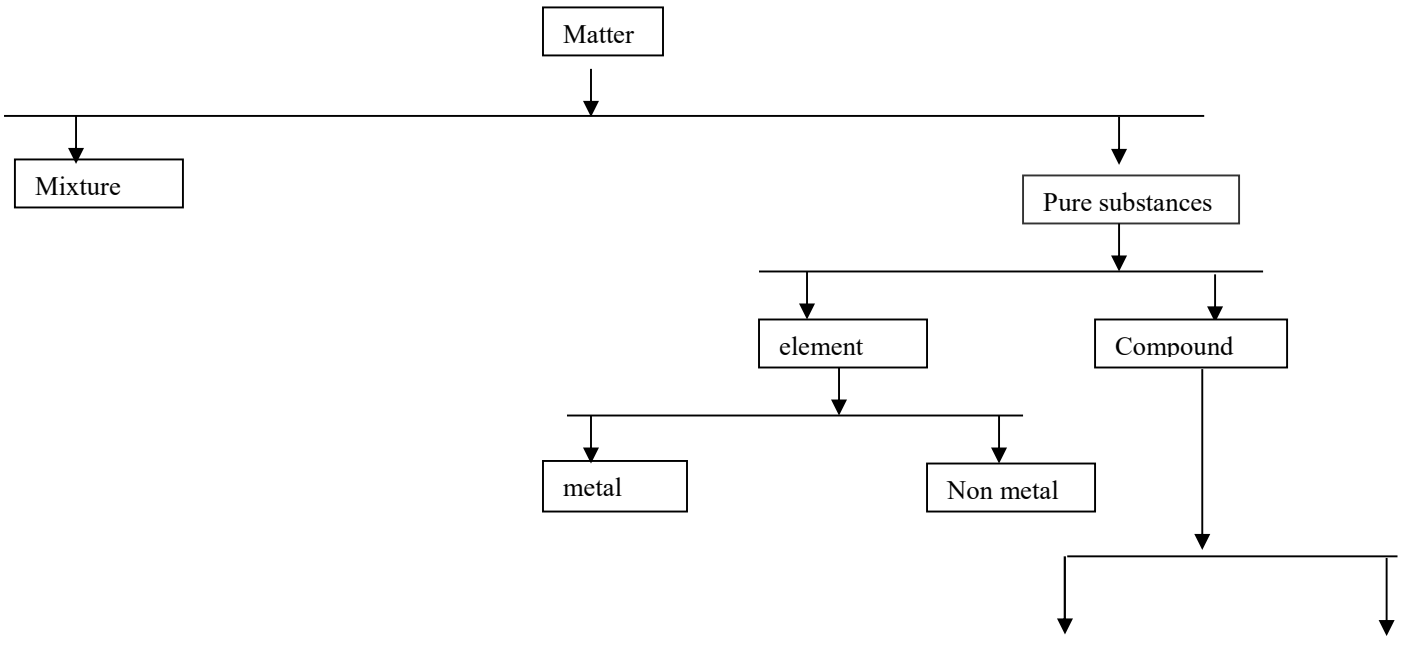
X and **Y** have equal mass. **Draw** to indicate the position in the tube where they would meet.

[2]

<u>Total 10 marks for the TEST</u>

Matter:

Classification of matter: Depending on components and compositions, matters are classified as follows-



Mixture: The existence of two or more substances together (at any ratio) with their independent properties is called mixture.

Pure substance: A substance is considered to be pure when no other substance is mixed with it.
A pure substance always shows particular **melting and boiling points** at atmospheric pressure.
For example, pure water boils at exactly 100^0 C at atmospheric pressure, but impure water will boil at different temperature.

Elements: The substances which consist of only one type of atoms are called elements.
Example- Oxygen, Diamond etc.

Compounds: The substances which consist of more than one types of atoms/elements held together **chemically** are known as compounds.
Water consists of hydrogen and oxygen **bonded chemically**. So it is a compound.

The differences between compounds and mixtures are –

Properties	Compounds	Mixtures
Composition	Always consist of same elements in the same composition.	Composition of the constituents varies.
Separation	Can only be separated into elements by chemical means.	Can be separated by physical means.
Bonding	Different elements are chemically bonded (strongly).	Different constituents in a mixture are not chemically bonded.
Properties	Compounds have different properties from their elements.	Have similar properties with their constituents.

Comprehensive Question: Q1. This Question is about the following chemical substances.

A CO_2 B O_2 C N_2 and H_2 D NaCl (aq)

Answer in terms of the letters.

(i) Which of the substances is an element?

(ii) Which of the substances are mixture?

(iii) Which of the substances is a solution?

(iv) Which of the substances is a pure compound?

(v) Which of the substances consists of elements, which are chemically bonded?

(vi) Which of the substances can be separated into their constituents by physical means?

(vii) Which of the substances has entirely different chemical properties from its constituents?

Comprehensive Question Worksheet:

Name of the studen..... Section : .....

1. Copy the words below to answer the following questions. [you are given some unnecessary words]

move about decreases very strong kinetic energy increases solid melting point gas moving about strong Very weak.

The particles in a solid are in fixed positions. They cannot.....and just vibrate without changing their positions. The attractive force among the particles is..... .

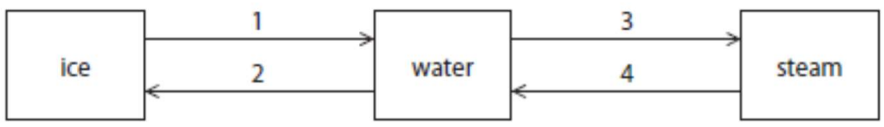
When heated, the vibration of the particles..... and at their..... the particles fall apart to produce a liquid and the particles start ..... . If heating is continued, the particles keep gaining ..... , which increases their movement.

At the boiling point, the particles lose their attractive force completely and the liquid turns into a .....

Total 7 marks for the question 1

2.The compound with the formula H_2O can exist in three states of matter. The names ofthese three states are shown in the boxes.

The numbers 1, 2, 3 and 4 represent changes of state.



(a) The particles of H_2O are arranged differently in each state.

(i) In which state are the particles furthest apart? ..... (1)

(ii) In which state do the particles have the least energy? ..... (1)

(iii) In which state are the particles arranged in a regular pattern? ..... (1)

(b) (i) Change of state 1 is called (1)

A boiling **B** condensing **C** freezing **D** melting

(ii) Change of state 4 is called (1)

A boiling **B** condensing **C** freezing **D** melting

(c) The term sublimation is also used for a change of state.

Sublimation is the change of state from (1)

A solid to liquid **B** liquid to gas **C** gas to liquid **D** solid to gas

(d) Heat energy is released when steam changes to water.

(i) Write an equation, including state symbols, for the change of state from steam to water. (1)

(Total for Question 2 = 7 marks)