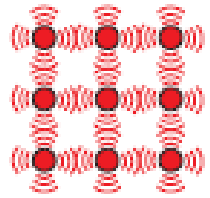
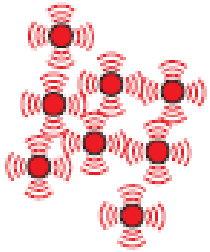
CHAPTER 2: THE PARTICULATE NATURE OF MATTER

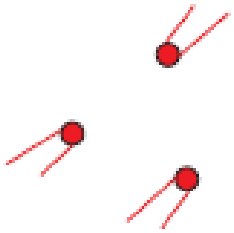
The three states of matter are *solid, liquid and gas*. The following diagram shows the arrangement of particles in :-



solid
Particles only vibrate about fixed positions. Regular structure.



liquid
Particles have some freedom and can move around each other. Collide often.



gas
Particles move freely and at random in all the space available. Collide less often than in liquid.

Figure 1.6 The arrangement of particles in solids, liquids and gases.

Qu: *Describe the forces of attraction between the particles of solid, liquid and gases.*

Qu: 1. *Describe what happens when(i) ice melts into water (ii) water boils to steam.*

2. *List down the names of 3 substances that sublimes on heating.*

Heating and cooling curves

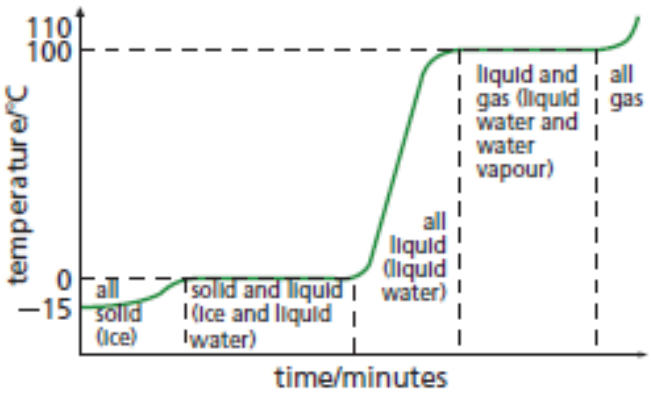


Figure 1.11 Graph of temperature against time for the change from ice at −15°C to water to steam.

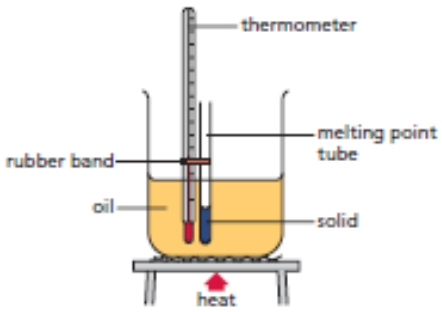


Figure 1.12 Apparatus shown here if heated slowly can be used to find the melting point of a substance such as the solid in the melting point tube.

The main points of the theory are:

- All matter is made up of tiny, moving particles, invisible to the naked eye. Different substances
- have different types of particles (atoms, molecules or ions) which have different sizes.
- The particles move all the time. The higher the temperature, the faster they move on average.
- Heavier particles move more slowly than lighter ones at a given temperature.

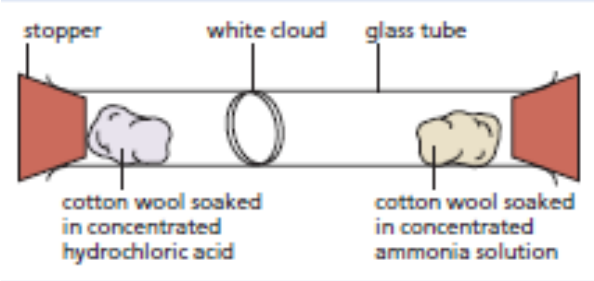
Diffusion

Diffusion is the movement of particles from a region of high concentration to that of a low concentration.

The white smoke forms closer to B. So the ammonia particles have travelled further than the hydrogen chloride particles – which means they have travelled *faster*.

The lower the mass of its particles, the faster a gas will diffuse.

The higher the temperature, the faster a gas will diffuse.



How can you tell if a substance is pure?

Chemists use some complex methods to check purity. But there is one simple method *you* can use in the lab: **you can check melting and boiling points**.

 A pure substance has a definite, sharp, melting point and boiling point. These are different for each substance. You can look them up in tables.

 When a substance contains an impurity:

– its melting point falls and its boiling point rises

– it melts and boils over a range of temperatures, not sharply.

 The more impurity there is:

– the bigger the change in melting and boiling points

– the wider the temperature range over which melting and boiling occur.

ATOMIC STRUCTURE

Atoms: Atoms are the smallest particles of matter, that we cannot break down further by chemical means.

Element: An element is a substance that contains only one kind of atoms.

Compounds: Compounds are pure substances which are formed when two or more elements chemically combine together.

Qu: *Draw a similar diagram to illustrate the following reaction:-*

$N_2 + 3H_2 \longrightarrow 2NH_3$

hydrogen + oxygen → water

Hydrogen a pure element	Oxygen a pure element	Hydrogen and oxygen mixed together	Water a pure compound formed from hydrogen burning in oxygen

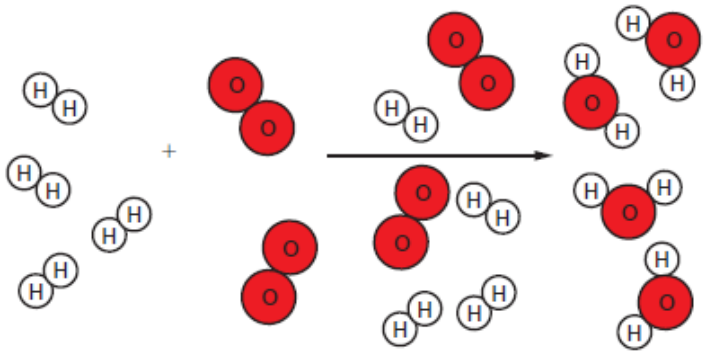


Figure 2.6 The element hydrogen reacts with the element oxygen to produce the compound water.

Mixtures and Compounds

Mixture	Compound
It contains two or more substances	It is a single substance
The composition can vary	The composition is always the same
No chemical change takes place when a mixture is formed	When the new substance is formed it involves chemical change
The properties are those of the individual elements/compounds	The properties are very different to those of the component elements
The components may be separated quite easily by physical means	The components can only be separated by one or more chemical reactions

Research: *Find out the substances present in (i) Javel (ii) Soap (iii) Paint (iv) cement (v) glass*

Qu: *Work out the questions in the space below:-*

6 The table below shows the melting points, boiling points and densities of substances **A** to **D**.

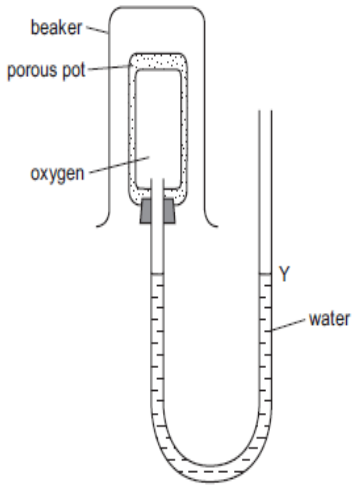
Substance	Melting point/°C	Boiling point/°C	Density/g cm^{-3}
A	1110	2606	9.1
B	−266	−252	0.07
C	40	94	1.6
D	−14	60	0.9

a Which substance is a gas at room temperature?
b Which substance is a liquid at room temperature?
c Which substances are solids at room temperature?
d Which substance is most likely to be a metal?
e Which substance will be a liquid at −260 °C?
f What is the melting point of the least dense non-metal?
g Which substances are gases at 72 °C?

7 a How many atoms of the different elements are there in the formulae of the compounds given below?
(i) nitric acid, HNO_3
(ii) methane, CH_4
(iii) copper nitrate, $Cu(NO_3)_2$
(iv) ethanoic acid, CH_3COOH
(v) sugar, $C_{12}H_{22}O_{11}$
(vi) phenol, C_6H_5OH
(vii) ammonium sulfate, $(NH_4)_2SO_4$

b Balance the following equations:
(i) $Zn(s) + O_2(g) \rightarrow ZnO(s)$
(ii) $Fe(s) + Cl_2(g) \rightarrow FeCl_3(s)$
(iii) $Li(s) + O_2(g) \rightarrow Li_2O(s)$
(iv) $H_2(g) + O_2(g) \rightarrow H_2O(g)$
(v) $Mg(s) + CO_2(g) \rightarrow MgO(s) + C(s)$

The diagram shows a diffusion experiment.



Which gas, when present in the beaker over the porous pot, will cause the water level at Y to rise?

A carbon dioxide, CO_2
B chlorine, Cl_2
C methane, CH_4
D nitrogen dioxide, NO_2