Chapter 5

PHYSICAL STATES OF MATTER

CONCEPTUAL LINKAGE

Before reading this chapter, the student must know the,

- Matter and its states
- Intermolecular attraction
- Simple mathematics methods

TIME ALLOCATION

Teaching periods = 14

Assessment periods = 03

Weightage = 13%

LEARNING OUTCOMES

After reading this chapter, the Student will be able to describe the:

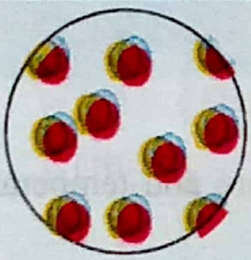
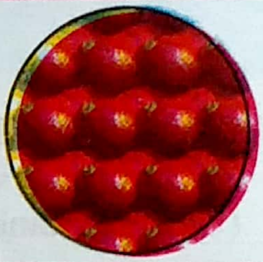
- Effect on the volume of a gas by a change in the pressure and temperature. (Understanding)
- Compare the physical states of matter with regard to intermolecular forces present between them. (Analyzing)
- Account for pressure-volume change in gases using Boyle's Law. (Analyzing)
- Account for temperature-volume change in gases using Charle's Law. (Analyzing)
- Explain the basic properties of gases. (Understanding)
- Explain the basic properties of liquids. (Understanding)
- Describe physical properties of solids. (Understanding)
- Explain the effects of temperature and external pressure on vapour pressure and boiling point. (Analyzing)
- Differentiate between amorphous and crystalline solids. (Analyzing)
- Explain the allotropic forms of solids. (Understanding)

5.0 Introduction

Every thing which has a mass and occupy space is called matter. The universe is made up of two entities, matter and the energy. Here in this chapter we will discuss matter and its types in details. Matter exists in four different states, i.e. Gas, Liquid, Solid and Plasma. The plasma state is actually a mixture of gaseous state and ions. Many scientists do not take it as a separate state, moreover in our planet we normally do not notice this plasma, that is why it is not discussed along with other states. Most of the universe is made up of the plasma, as most matter is scattered in stars (or sun).

Following table 5.1 shows the comparison of other three states of matter.

COMPARISON BETWEEN DIFFERENT STATES OF MATTER

GASES	LIQUIDS	SOLIDS
		
It is the form of matter which do not have definite shape nor definite volume.	They do not have definite shape, but volume is definite.	Both shape and volume are definite
Molecules lie far apart from each other	Molecules lie little close to each together	Molecules are very close to each other.
Molecules are free to move.	Molecules can move in a limited way.	Molecules have only oscillatory movement at their own place.
K.E of molecules is highest	K.E is intermediate.	K.E is lowest.
Intermolecular forces are very weak.	Intermolecular force are fairly stronger.	This force is very strong.
Molecular arrangement is irregular.	Molecular arrangement is some what regular	Molecules are highly arranged.

COMPARISON BETWEEN DIFFERENT STATES OF MATTER

GASES	LIQUIDS	SOLIDS
Molecules can be compressed easily.	Molecular can be compressed up to a few degree.	Molecular can not be compressed.
Rate of diffusion is very high.	Rate of diffusion is lower than gases.	No diffusion.

Table 5.1: Comparison of various stats of matter

5.1 The Gaseous State

The gaseous state, as described earlier is the simplest state of matter, having following general properties.

5.1.1 Typical Properties

In gases the molecules are far apart from each other due to weak intermolecular forces .(Figure 5.1)

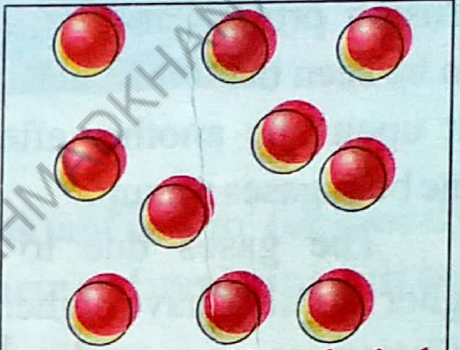


Figure 5.1: Hypothetical Model of Gases

The gas molecules spread in all available space, i.e they do not have a volume of their own, but the volume of the container where they are kept is counted as their volume.

Usually the gases are colourless and so they are invisible, but some gases have colour too, and they can be seen, e.g. the Cl_2 gas is yellowish green and the NO_2 gas is reddish brown are shown in figure 5.2.

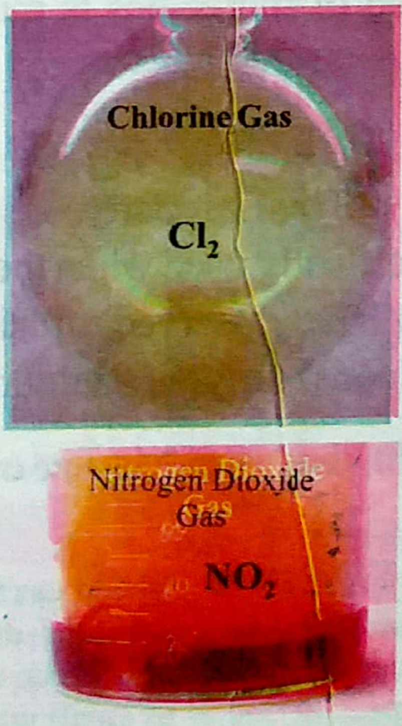


Figure 5.2 Coloured gases

In the gaseous state of matter, the kinetic energy (K.E) of the molecules is highest,(as you have observed many times in the steam which is the gaseous state of water), this is due to the high velocity of gas molecules than compared in liquid or solid states.

Some of these general characters are discussed in detail here in below:

5.1.2 Diffusion

An important character of gases is the high rate of diffusion. Diffusion is defined as the mixing of gas molecules into each other.

You have observed diffusion process of gases many times in your routine life, e.g. when a perfume is sprayed in a room, it readily spreads across the room, and even it leaks out of the room.

The figure 5.3 shows defusion process in two gases, it can be seen that when both jars are put upon one another after some time both gases mixup.

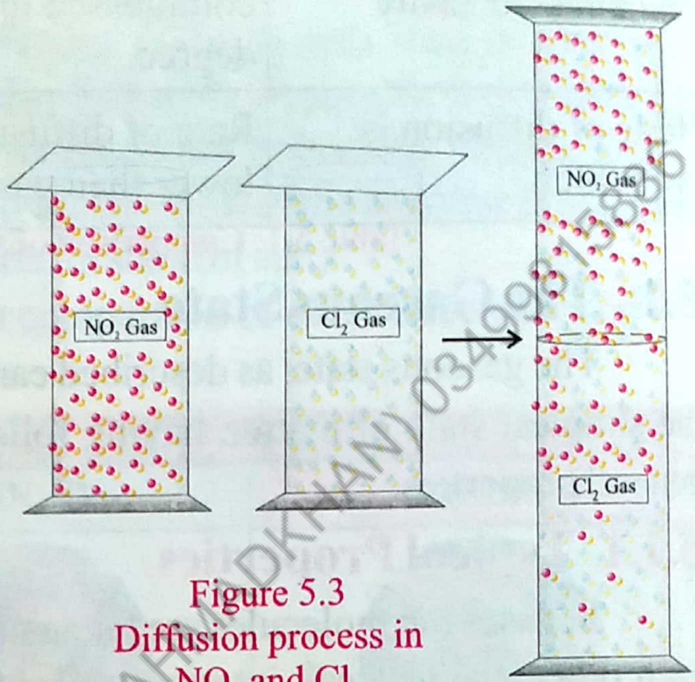


Figure 5.3
Diffusion process in NO_2 and Cl_2

The gases due to having higher mobility have higher rate of diffusion, as compared to liquids which have slower rate of diffusion. The diffusion is dependent upon the temperature, because at high temperature the speed of molecules is more so the rate of diffusion is also more at higher temperature.

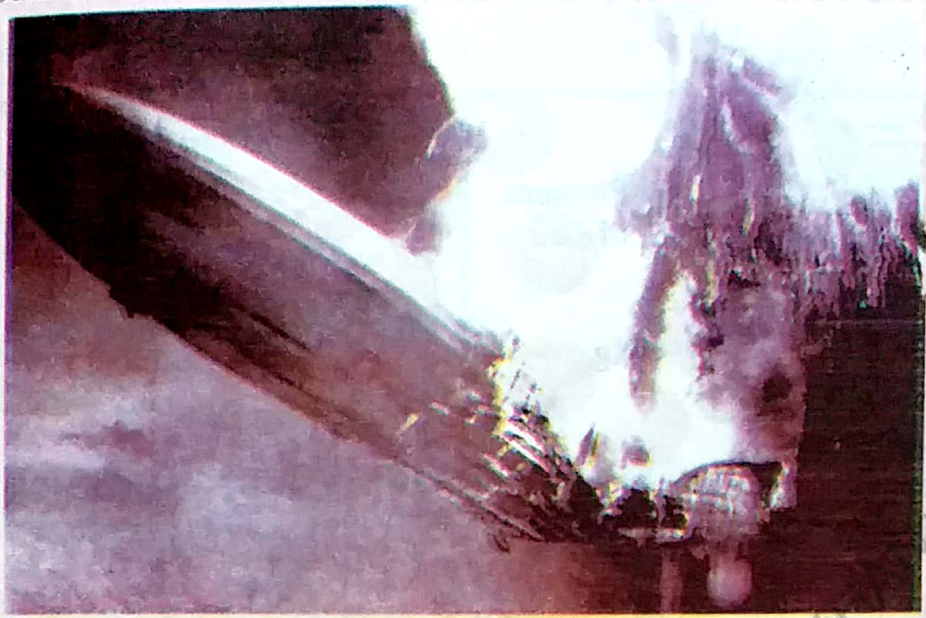
5.1.3 Effusion

This property is similar to diffusion, but the term effusion is specifically used when the gas escapes through small pores of molecular size. You have observed effusion while playing with the hydrogen balloons (gas balloons) in your childhood, when these gas filled balloons are kept over night, they shrink in size overnight.

Interesting Information

Hydrogen is the lightest gas and is also smallest in molecular size as compared to other gases. It is a best fuel which does not produces any harmful products.
once hydrogen gas has been used extensively for filling traveling air balloons and in air ships, but due to its small molecular size it leaks out from molecular sized holes in the containers and this has resulted in accidents many times, a famous air crash which is believed by such incident occurred in 1937 at New Jersey, killing all 36 persons aboard.

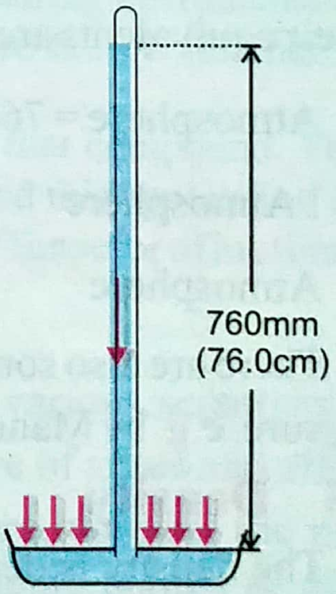
This accident stop the use of such air ships for traveling and now a days helium or hot air is filled in air balloons.



5.1.4 Pressure

Pressure is defined as the force per unit area. Its unit is N/m^2 (or Pascal) in S.I system. The commonly used units are atmosphere and mmHg or torri cell.

Like liquids and solids gases also exert pressure, and you may have noticed this pressure many times in your life e.g. while comparing the mass of an empty and filled home gas cylinder and you may have also noticed this pressure while filling air tyres and tubes using pump.



P_{atm} = Height of "Hg" column in glass tube

Figure 5.4
Simple Barometer

We are living in an atmosphere of air around us and this is obvious that if a little quantity of gas present in the gas cylinder exerts pressure than this air around us must also exert pressure on us much more than the gas of cylinder.

Air which is the mixture of gases also exerts pressure.

The atmospheric pressure is determined by a simple barometer; (figure 5.4) which is a graduated glass tube closed from one end and is

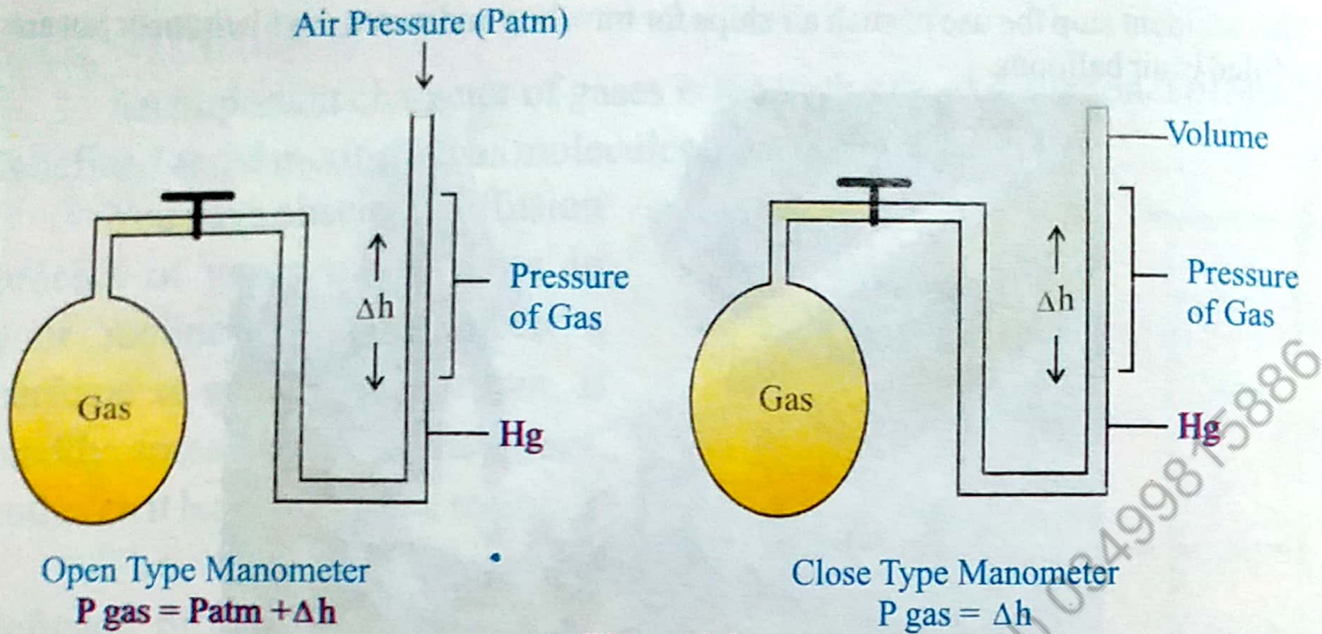


Figure 5.5

filled with mercury (Hg), when inverted in a mercury container the level of (Hg) falls up to the certain height. The height of mercury (Hg) retained in the tube indicates atmospheric pressure, this apparatus was designed by an Italian scientist Torricelly.

There are some other units too which are used for pressure, these units and their equivalents are following:

Atmosphere = 760mm of Hg = 760Torr

1 Atmosphere = 101325 Pascal

Atmosphere = 1.01325 Bar

There are also some other methods available for accurate measurement of pressure. e.g. by Manometer, which is shown in figure 5.5.

5.1.5 Density

The density is defined as the mass per unit volume of a substance.

$$d = \frac{m}{v}$$

The density of a substance is the measure how the mass is distributed in a unit area, thus the iron has a greater mass per unit area as compared to cotton and therefore cotton has less density than iron.

You can see the difference in the densities of two substances in the given figure 5.6, as the number of particles per unit area increases the density also increases.

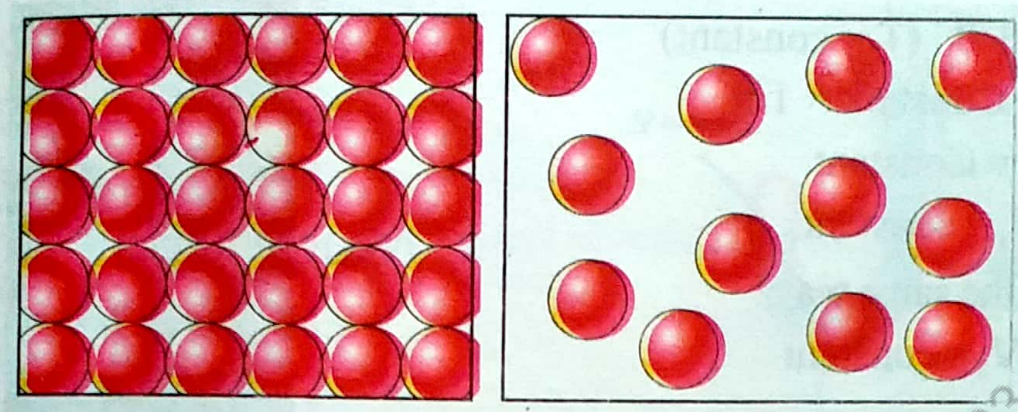


Figure 5.6 Comparison of densities

The density of a substance is dependent upon the temperature too, with the increase of temperature the density decreases.

Interesting Information

The density of a substance in gases state is least while in solid state it has the highest value (water is an exception).

The density also has a relation with the temperature, as the temperature increases density decreases, e.g., all measuring instruments of lab show a temperature (as can be seen in the figure 6.2 of volumetric flask).

Density of a compound is a characteristic of that compound. The famous Greek scientist Archimedes (287-212BC) used this application of density to find out the impurity amount in the crown of Emperor of his time.

5.2 Laws related to Gases

In order to understand the behavior of gases, various scientists have proposed laws, these laws generally explain the nature of gases and effect of variations in the conditions like temperature, pressure, volume, the rate of diffusion etc upon the gases. These laws are collectively known as the gas laws. In the following pages, these laws are described separately.

5.2.1 Boyle's Law (Volume-Pressure Law)

In 1662 Robert Boyle studied the relation between volume and pressure of a gas at a constant temperature.

According to this law the volume of given mass of a gas is inversely proportional to the pressure at constant temperature, i.e.

$$V \propto 1/P \quad (T = \text{constant})$$

$$V = \text{Constant} \times 1/P$$

or $$PV = \text{Constant}$$

$$P_1V_1 = \text{constant}$$

In the same way,

$$P_2V_2 = \text{constant}$$

So,

$$P_1V_1 = P_2V_2$$

Robert Boyle
(Ireland)
Born 1627—Died 1691

Where P_1, V_1 are initial pressure and volume while P_2 and V_2 are final pressure and volume.

This is the mathematical representation of Boyle's law.

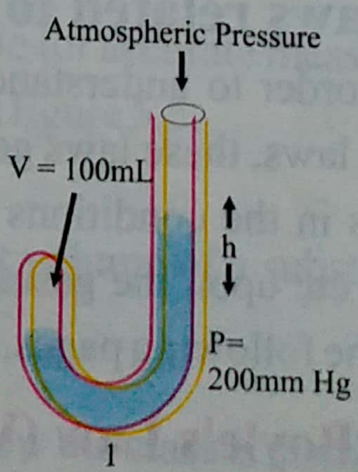
Experimental Verification

Boyle proved his law experimentally by using a "J" shaped glass tube. He observed that by doubling the height of mercury (Hg) in tube reduced half the volume of gas entrapped,

Thus $P \times V = \text{constant}$

This is visible in figure 5.7

In case 1



Volume (V_1) = 100ml

Pressure (P_1) = 200mm of Hg

According to Boyl's Law

P_1V_1 = Constant

P_1V_1 = $100 \times 200 = 20000$

In case 2

(By doubling the pressure by adding mercury, therefore)

$V_2 = 50ml$

$P_2 = 400ml\ of\ Hg$

$P_2V_2 = Constant$

$50 \times 400 = 20000$

i.e.

case 1 = case 2

or

$P_1V_1 = P_2V_2$,

Thus Boyle's law is verified.

So,

PV = Constant

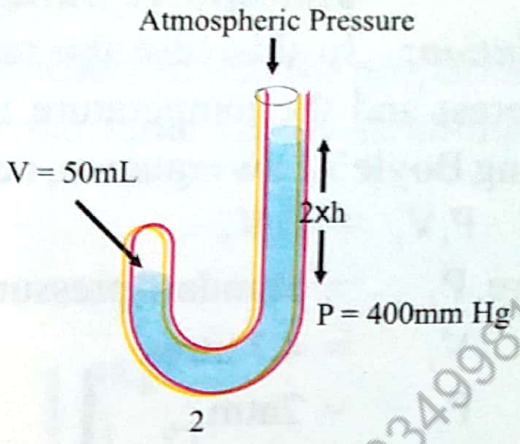


Figure 5.7: Boyle's Law experimental Verification

Boyle's Law graphical Representation

By plotting a graph between pressure and volume a curve is obtained indicating that volume decreases with the increase in pressure as shown below in figure 5.8, graph (a).

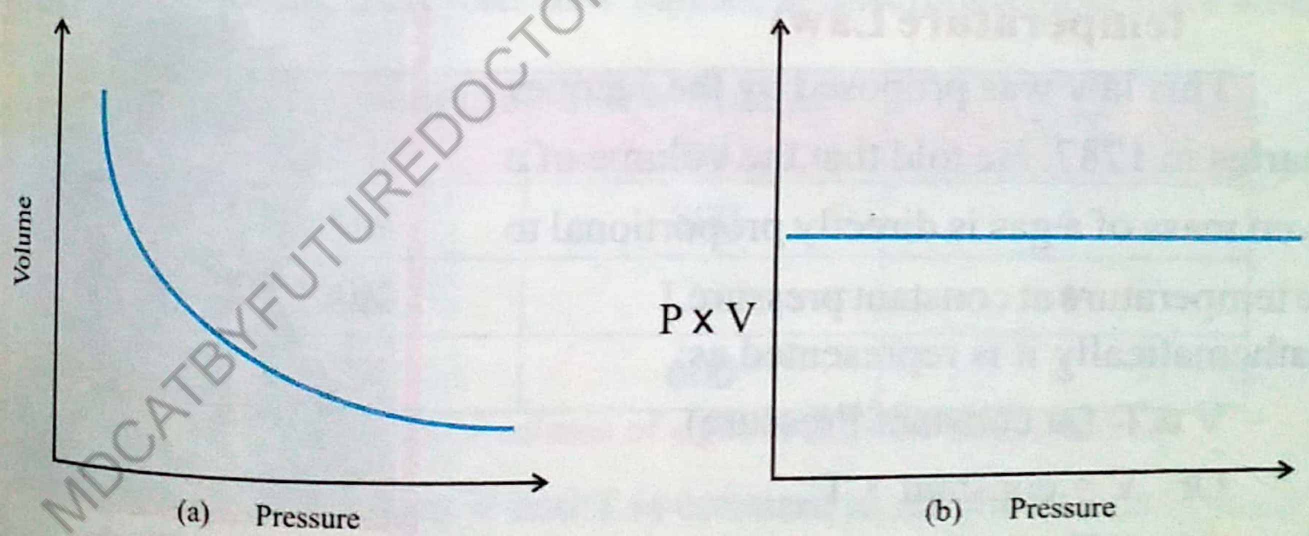


Figure 5.8: Boyle's Law Graph

If a graph is plotted between pressure and P x V, a straight line parallel to pressure axis is obtained, as shown below in figure 5.8(b).

Example 5.1: Volume of a gas at standard pressure is 4.7litres, what will be the volume of gas when the pressure is increased to 2 atmosphere while the temperature remains unchanged.

Solution: In this case the relation between volume and pressure is in interest and the temperature is constant, so this problem can be solved using Boyle's Law equation, i.e.

$P_1V_1 = P_2V_2$ (Temperature = Constant)

Here, P_1 = Standard pressure = 1atm

V_1 = 4.7 litres

P_2 = 2atm

V_2 = ?

As $P_1V_1 = P_2V_2$

So, $V_2 = \frac{P_1V_1}{P_2}$

by putting values:

$V_2 = \frac{1 \times 4.7}{2} = 2.35$ litres

So, the volume of gas at 2 atmospheric pressure will be 2.35 litres.

5.2.2 Charle's Law (volume-temperature Law)

This law was proposed by the Jacques Charles in 1787. He told that the volume of a given mass of a gas is directly proportional to the temperature at constant pressure.

Mathematically it is represented as:

$V \propto T$ (at constant Pressure)

Or $V = \text{constant} \times T$

Or $V/T = \text{constant}$

Or $V_1/T_1 = V_2/T_2$

Jacques Charles
(France)
Born 1746—Died 1823

Wehre V1, T1 are initial values of volume and temperature while V2 and T2 are final values of volume and temperature.

Experimental Verification

Charle's used a cylinder fitted with a frictionless piston, as shown in figure 5.9. He observed that the proportion of change in volume at temperature would be the same i.e. by doubling the temperature, volume of gas also doubles.

Mathematically it is represented as:

$$V/T = \text{constant}$$

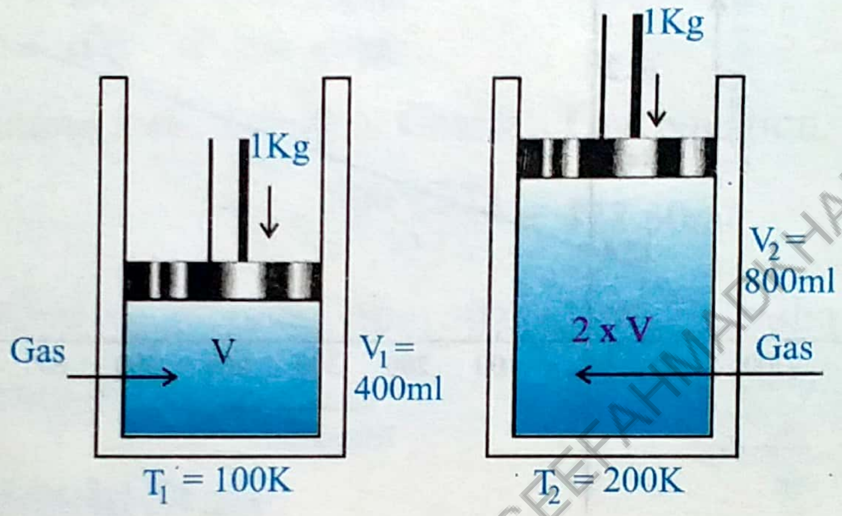


Figure 5.9: Experimental verification of Charle's Law

Consider a given mass of gas in frictionless piston of a cylinder at 100K having volume 400ml, therefore, new volume at different temperature would be:

S.No.	New Temperature (K)	New Volume (ml)	V/T
1	200K	800	4
2	300K	1200	4
3	150K	600	4

Table 5.2: The values of volume of a gas at different temperatures

Thus the ratio between V and T is constant in all conditions.

Graphical Representation

While plotting a graph between 'T' and 'V' a straight line is obtained and when this line is increased downwards it touches zero volume line at -273.15°C, which means that volume at this point is zero which is not possible, so this temperature is not achievable. From here we start a new scale in which zero or negative values are not possible. This new scale is called Kelvin scale, as shown in figure 5.10.

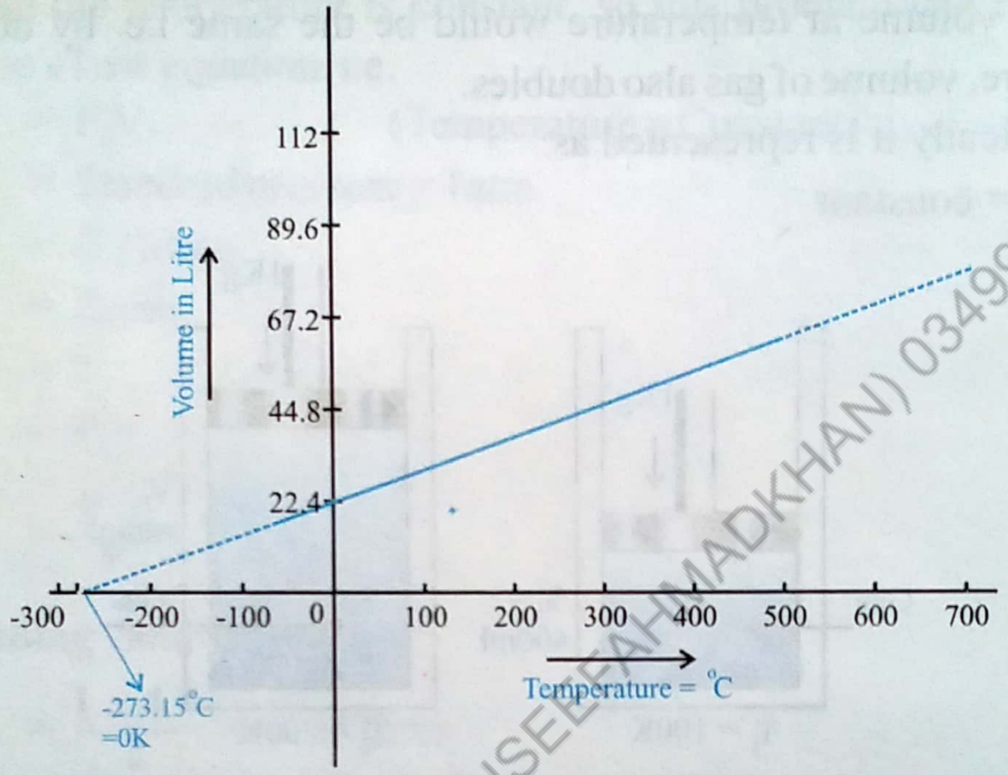


Figure 5.10: Graphical representation of Charle's Law.

The Kelvin scale of temperature is denoted by the symbol 'K', and note that no degree sign is used in this scale.

$$0K = -273^{\circ}C$$

The Kelvin scale is needed for calculations specifically, because in this scale the temperature cannot be in negative values or even zero.

Activity: 5.1

Normal human temperature is 37°C express this temperature in Kelvin scale.

In order to change centigrade value of temperature to Kelvin scale just 273 is added.

$$K = {}^{\circ}C + 273$$

Example 5.2: **The volume of a gas at 50°C and standard pressure is 500ml. If the temperature drops to 0°C at same pressure, what will be the new volume?**

Solution: In this example the pressure is constant and the relation between volume and temperature is in interest, so here Charle's Law operates, using Charle's law equation this problem can be solved easily:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \qquad \text{(Pressure = Constant)}$$

And $V_2 = \dfrac{V_1 \times T_2}{T_1}$

The given data of example is:

$V_1 = 500ml$

$T_1 = 50^{\circ}C = 323K$

$T_2 = 0^{\circ}C = 473K$

By putting these values in Charle's Law equation, we get:

$$V_2 = \frac{500 \times 273}{323} = 422.60ml$$

So, if 500ml gas is cooled from 50°C to 0°C, the volume of gas will be reduced to 422.60ml.

5.3 The Liquid State

The liquids are one of the states of matter which do not have the definite shape but have definite volume.

In the liquid state, the molecules are loosely held, have limited movement in a definite region, so this makes them having a definite volume, but the molecules can not leave the system as in the gaseous state so their volume is definite (See fig. 5.11). The molecules have lesser kinetic energy than the gases due to lesser mobility.

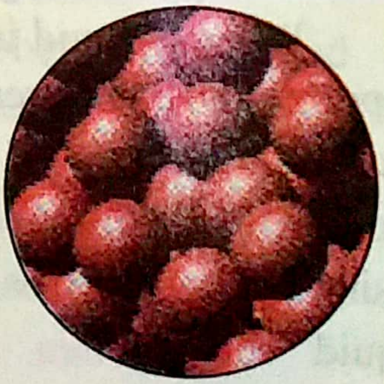


Figure 5.11: A hypothetical view of molecules in liquid state

The Liquids have stronger intermolecular forces than the gaseous state, and hence they have comparatively higher melting and boiling points.

Let's discuss some of the basic characteristic properties of liquids in a little detail.

5.3.1 Evaporation

It is the common character of liquids. It is observed that when a liquid like water or petrol is placed in an open container it vanishes away by changing into vapours. This process is called evaporation.

Evaporation is because when molecules of liquid gain energy from surroundings, when the kinetic energy of some molecules becomes enough high to break the intermolecular forces, then molecule enters into gaseous state.

Interesting Information

Due to evaporation process, the vapours from sea comes out and travel hundreds of kilometers away, cool down and fall (condense) in the form of rain or snow, thus life on planet continues.

Evaporation occurs at all temperatures, but it has a direct relation with temperature, i.e when temperature increases the rate of evaporation also increases. Moreover liquids having lower intermolecular attractions are evaporated easily.

Evaporation of a liquid is also increased when the surface area increases, that is why a china dish is used for evaporating rather than a beaker in the labs.

5.3.2 Vapour Pressure

When a liquid is placed in a closed container, some of its molecules vaporize and exert pressure on liquid. Some of these molecules condense after losing their K.E back into liquid state, when rate of evaporation and rate of condensation is equal, the pressure at this stage is called vapour pressure or equilibrium pressure.

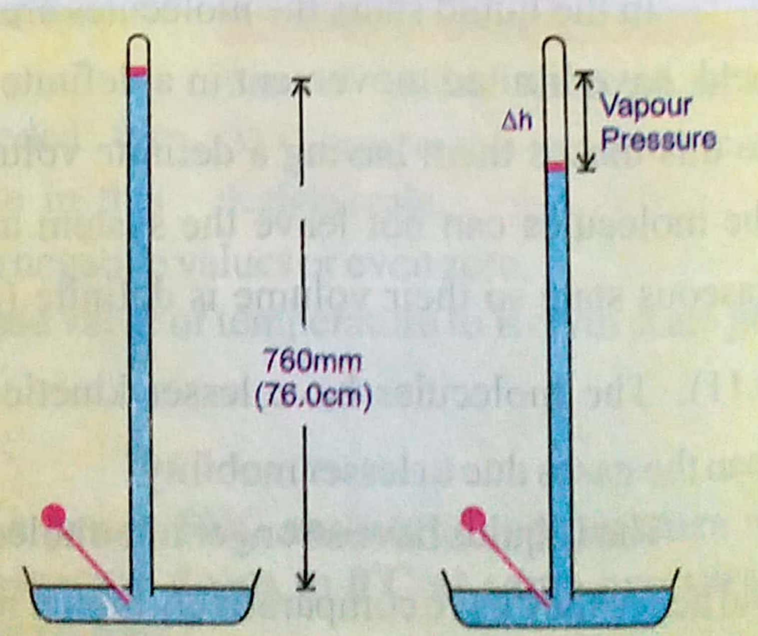


Figure 5.12: A simple mercury Barometer used for vapour pressure determination

The vapour pressure is a characteristic property of liquids but is temperature dependent, and increases with increase in temperature.

The liquids having low intermolecular forces have higher vapour pressure. Vapour pressure can be determined by using simple barometer. as shown in figure 5.12.

The liquid whose vapour pressure is to be determined is inserted by dropper at the bottom of glass tube. The change in height of column gives vapour pressure of liquid (Δh).

5.3.3 Boiling Point

The temperature at which vapour pressure of a liquid and atmospheric pressure becomes equal is called its boiling point. At this temperature the liquid's molecule vaporizes and enters into gaseous state, and its bubbles can be seen arising from bottom moving upward (Figure 5.13).

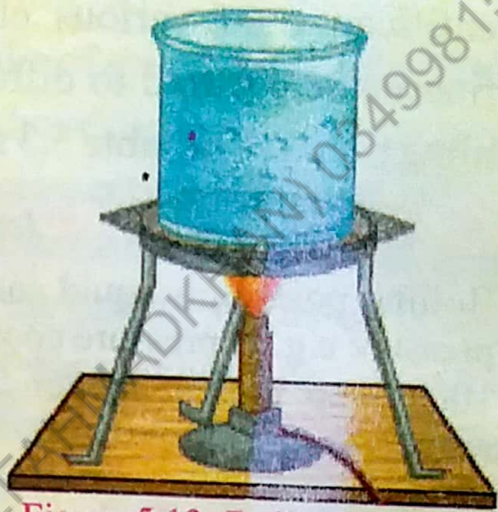


Figure 5.13: Boiling process in a liquid

The boiling point of a liquid depends upon the atmospheric pressure. If this pressure decreases boiling point also decreases and vice versa.

The following graph shows relation between atmospheric pressure and vapour pressure of different liquids at changing temperatures.

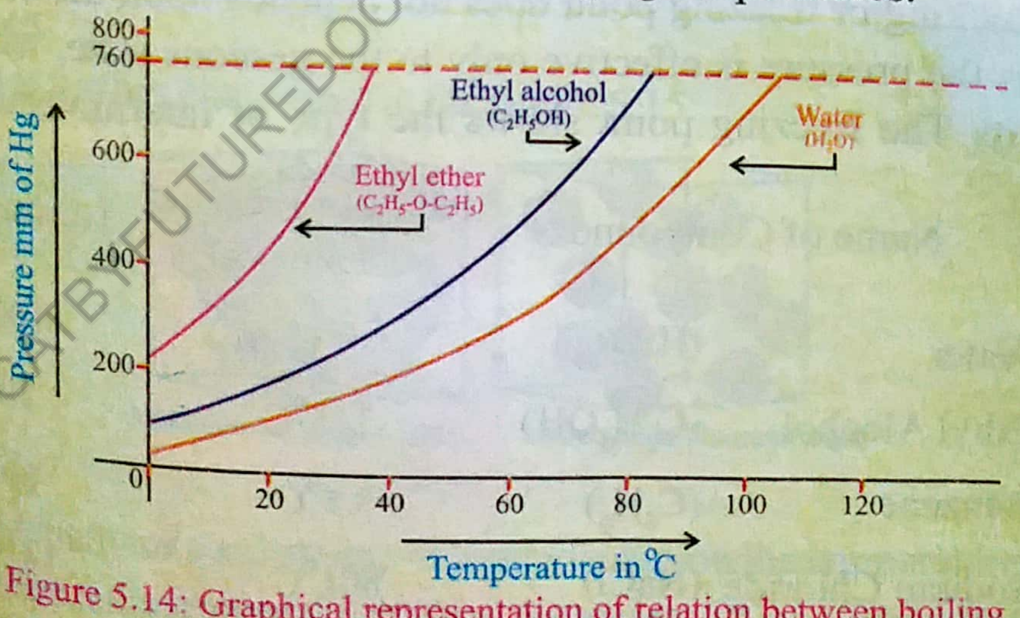


Figure 5.14: Graphical representation of relation between boiling point and atmospheric pressure.

Interesting Information

When the boiling point of a liquid is achieved then further heating does not increase the temperature but only vaporizes the liquid. Amount of heat required to vaporize one mole of a liquid at its boiling point is called molar heat of vaporization, and is characteristic for each liquid e.g. for water it has a value of 40.7KJ/mole.

The boiling point has wide applications of separating mixtures and identification of various chemical compounds e.g. the petroleum in oil refineries is purified to different constituents on the basis of their different boiling points. The table 5.3 shows boiling points of some common liquids.

Interesting Information

Boiling point of a liquid can be decreased or increased by changing external pressure e.g. in pressure cookers boiling point of water is increased above than 100°C and thus at higher temperature cooking time of meat and pulses is reduced.

5.3.4 Freezing Point

The freezing point of a liquid is the temperature at which a liquid freezes to solid state. The freezing point is same as that of the melting point of solid to a liquid. The melting or freezing point is a characteristic property for a compound, e.g. the water has value for both of these "0°C". Unlike the boiling point, the melting or freezing point does not depends upon the atmospheric pressure, as the pressure is effective only to the gaseous state, which is not present here. The freezing point shows the type of intermolecular forces

S/No.	Name of Compound		Melting or Freezing Point	Boiling Point
1	Water	(H_2O)	0°C	100°C
2	Ethyl Alcohol	(C_2H_5OH)	-115°C	78°C
3	Benzene	(C_6H_6)	5.5°C	80°C
4	Sodium Chloride	(NaCl)	801°C	1413°C

Table 5.3: Some common compounds and their melting and boiling points

present in the compound. For the compounds that have stronger intermolecular forces have high values of freezing points as compared to the compounds that have weaker intermolecular forces and have low freezing points.

Table 5.3 shows freezing points of some common compounds along with their boiling points.

5.3.5 Diffusion in Liquids

The diffusion is a property of liquids just like of gases, this refers to the mixing of molecules with one another. The gases have higher mobility and so their rate of diffusion is also higher. Liquids have slower rate of diffusion.

The diffusion is dependent upon the temperature, because at high temperature the speed of molecules is more so the rate of diffusion is also more. The diffusion is easily observed in a glass of water, when a drop of ink is placed in it, and the process when observed at different temperatures can also shows the effect of temperature upon the diffusion.

5.3.6 Density of Liquids

The density which we defined as the mass per unit volume of a substance is also a prominent character of liquids.

The liquids have more density as compared to the gaseous state, which is because of the close distribution of molecules of liquids as compared to the gaseous state.

This is further elaborated in the figure 5.15.

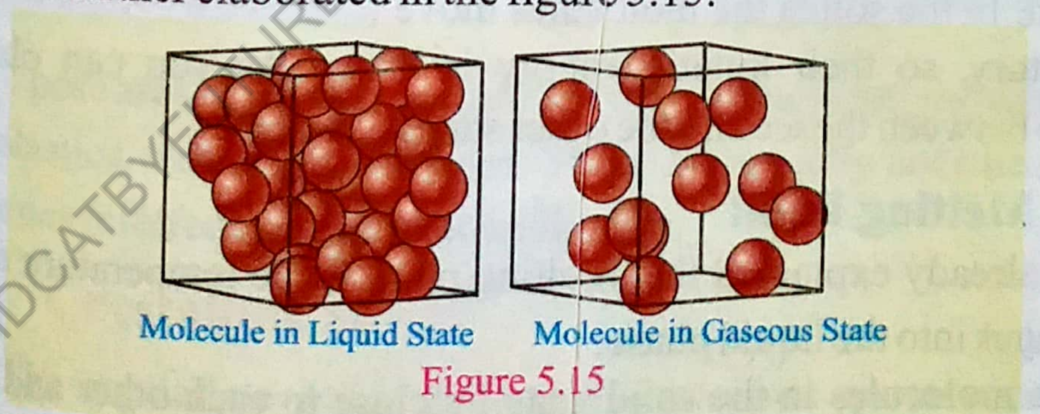


Figure 5.15

The density of a substance is dependent upon the temperature too, with the increase of temperature the density decreases. This is shown by following table 5.2 which shows the density values of water at different temperatures.

SNo.	Temperature °C	Fahrenheit °F	Density (g/cm³)
1	0.0	32.0	0.9998
2	4.0	39.2	0.9999
3	15.0	59.0	0.9991
4	20.0	68.0	0.9982
5	25.0	77.0	0.9980
6	37.0	98.6	0.9933
7	100	212.0	0.9583

Table 5.2: Density values of water at varying temperatures

5.4 The Solid State

The state of matter that has definite shape and definite volume is called the solid state. Some typical properties of solids are given below.

5.4.1 Typical Properties

The solids are the form of matter having a definite shape and volume. In solids the particles lie very close to each other and have very high intermolecular forces, due to which they cannot change their location so both the shape and the volume here remains unchanged. In the solids the molecules move just vibratory, so their kinetic energy is least. (As you can observe the difference between the ice and the other states of water).

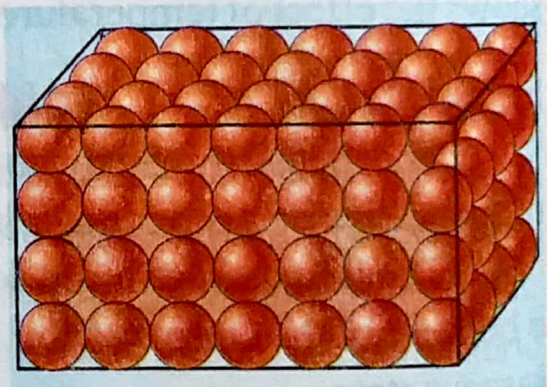


Figure 5.16: A hypothetical view of molecules in solid state

5.4.1.1 Melting Point

As already explained that melting point is the temperature at which a solid changes into the liquid phase.

The molecules in the solid state lie close to each other and thus they have high values of intermolecular attractions, therefore it becomes hard to separate them as compared to the liquids. Thus they have high and sharp melting points.

5.4.1.2 Rigidity

In the solid state, the molecules lie in close association to each other, so deformity in their structure is not easy, that is why they are rigid.

5.4.1.3 Density

The density in the solid phase is also highest because the constituting particles lie very close to each other and more mass is concentrated as compared to the liquid and the gaseous states.

5.5 Types Of Solids

The solids are further classified into two main sub types; these are discussed in the next sections.

5.5.1 Amorphous Solids

The word amorphous has its origin from two parts where 'A' stands for without and morph for shape, thus amorphous means without shape.

Figure 5.17 some amorphous solids

These are the solids which do not have a characteristic shape, e.g Glass, some plastics, wax and gem stones. These are actually not true solids and are sometimes referred as **super cooled liquids**.

5.5.2 Crystalline Solids

The crystalline solids have a characteristic geometrical shape. The crystalline solids are actually the true solids. The crystals have all characters by which a solid is recognized, e.g. the rigidity, elasticity, sharp melting point etc.

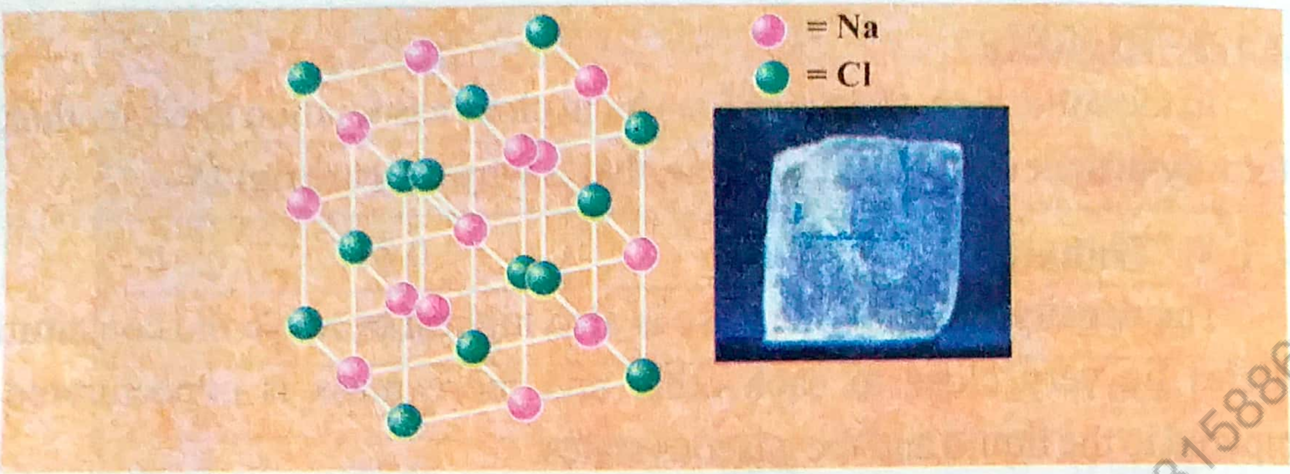


Figure 5.18: The NaCl crystal

5.6 Allotropy

The word allotropy has been derived from two parts, where allos stands for other and tropy (from tropos) means forms, thus allotropy means other forms.

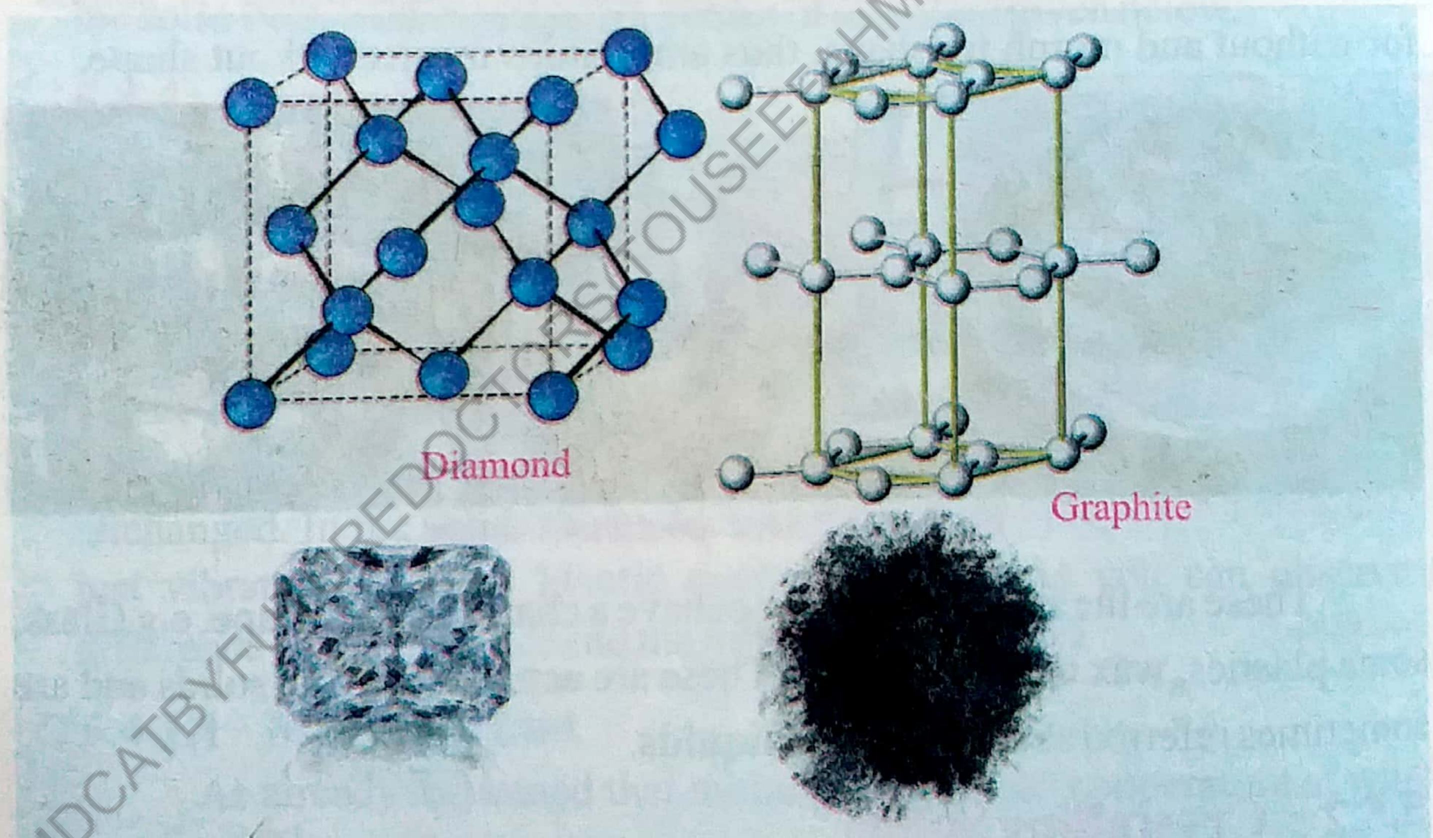


Figure 5.19 Allotropic forms of Carbon with their molecular structures.

The Allotropic forms are the different forms of an element, which have although the same chemical properties, but different structures. For example the famous diamond and graphite are the allotropic forms of carbon.

Other Examples of allotropic forms:

i) Oxygen

- Oxygen O_2 - colourless
- Ozone O_3 - blue

ii) Sulfur

- Plastic (amorphous) sulfur - polymeric solid
- Rhombic sulfur - large crystals composed of S_8 molecules
- Monoclinic sulfur - fine needle-like crystals

iii) Phosphorous

- Red Phosphorous (Polymeric solid)
- White Phosphoric (Crystalline solid)

SUMMARY OF THE CHAPTER

- The matter exists in 4 different states, the gaseous state, liquid state, solid state, and the plasma state.
- Generally we deal with the first 3 states of matter, the plasma is not considered as the true state by some scientists, as this state is not stable in earth on normal conditions.
- Gases are the simplest state of matter and are defined as the state of matter having neither definite shape nor definite volume.
- Gases have highest mobility, and kinetic energy is also highest.
- Gases diffuse easily and can be compressed by pressure.
- In order to explain the relation between the volume, pressure and temperature, various gas laws have been presented.
- According to Boyle's law, the volume of a gas is inversely proportional to the pressure at constant temperature.
- The Charle's law states that volume of a gas is directly proportional to the temperature at constant pressure.
- Liquids are the state of matter having definite volume but indefinite shape.
- Liquids also have the ability of diffusion, but with lesser extent to the gases.
- Solids are the state of matter having definite volume and definite shape.
- In solids the particles are held strongly and show only vibratory movement, so diffusion in solids is not possible.
- The solid can be divided into two categories, the Amorphous solids and the Crystalline solids.
- Different types of an element are called Allotropic forms. Allotropic forms have same composition but different structures.

EXERCISE

Q1. Fill in the blanks with appropriate words.

i) Matter in the universe exists in .... states.

ii) 1 atmosphere pressure is equal to .... mmHg .

iii) The volume of a gas is .... related with temperature.

iv) The liquids have .... volume and variable ....

v) The relation between the density and the temperature is ....

vi) Mixing of gas molecules is called ....

vii) Boyle's law states that volume of a gas is .... related to the pressure.

viii) Solids state of matter has .... density, as compared to liquid and gaseous states.

ix) Same element with different shapes are called ....

x) In Kelvin scale of temperature 300°C is equal to ....

Q2. Choose the correct answer.

i) The form of matter which does not have definite shape and volume is called:
(a) liquid (b) gas (c) solid (d) plasma

ii) Gases can be liquefied by:
(a) simple physical methods (b) simple chemical methods
(c) by using both physical and chemical methods
(d) no physical and chemical method can be used

iii) Manometer is used for the determination of:
(a) pressure (b) volume (c) length (d) area

iv) The vapour pressure can be determined by using:
(a) manometer (b) barometer
(c) both manometer and barometer
(d) neither manometer nor barometer

v) The different forms of an element are called:
(a) isotopes (b) free radicals
(c) molecules (d) allotropes

Q3. Answer the following questions in short.

i) If you take equal volumes of N_2 and CO_2 in different containers, which sample will expect to have more density?

ii) Compare different states of matter.

iii) Why we can't see most of the gases? Name 3 gases which are visible for us.

iv) Compare diffusion and effusion processes in gases.

v) Explain the term pressure of gases, also describe its units?

vi) Why we use Kelvin scale in solving gas laws problem?

vii) Can you explain why wet skin under the fan feels cool?

viii) Differentiate between rates of diffusion among gases and liquids with examples?

ix) Why solids have higher melting points than liquids?

x) According to their shape what types of solids are found in nature?

Q4. Answer the following questions with reasoning.

i) Why pressure of a gas sealed in a container when temperature is increased?

ii) Explain in light of KMT what would happen with respect pressure when more quantity of a gas is added to container of gas?

iii) Arrange the gases Cl_2, H_2, NH_3 in order of increasing speed of their molecules at 25°C .

iv) What would you expect to happen in respect of volume when a balloon filled with air is placed in the freezer of a refrigerator?

v) Name 3 methods by which the volume of a gas can be decreased.

Q5. How can you differentiate between the various forms of matter?

Q6. Derive a relation to show that volume and pressure have indirect relation?

Q7. Discuss the importance of Charle's law?

Q8. Define the term Allotropy? How the allotropes of oxygen effect our life?

Q9. What are the various types of solids? Give daily life examples to differentiate?

Q10. An ideal gas is kept in a cylinder of moveable piston of mass 1kg, has a volume of 500cc at the temperature of $25^{\circ}C$,. If the temperature rises to $40^{\circ}C$, what will be the new volume of the gas?

Q11. Suppose a gas is kept in a cylinder of volume 3litres and a pressure of 2 atmospheres, if the gas is shifted into a new cylinder of volume 5 litres. What will be the new pressure if the temperature remains constant?

Q12. Compare the physical states of matter with regard to intermolecular forces present between them.

Q13. Differentiate between the amorphous and crystalline solids with examples?

Q14. Compare the different physical states of matter with regards to their typical characteristics.