CHAPTER: 7
PROPERTIES OF MATTER

Kinetic Molecular Model of Matter:-

The kinetic molecular model of matter has three important features.

1. Matter is made up of small particles. These particles are called molecules.
2. The molecules of the matter remain in continuous motion.
3. The molecules of the matter attracts each other.

Density:-

The mass per unit volume of a body is called density.

Formula:-

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Unit:-

The unit of density is kg/m^3 or $kg\ m^{-3}$.

Page No. 148 Example No. 7.1

The mass of stone is 500g. Find its density?

Mass = m = 500g

Volume = v = $200cm^3$

Density = R = ?

We know

$$\text{Density} = \frac{\text{Mass}}{\text{volume}}$$

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

$$e = \frac{500\ g}{200\ cm^3}$$

$$e = \frac{2.5\ g}{cm}$$

Pressure:-

The force acting normally per unit area on the surface of a body is called pressure.

Formula:-

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$P = \frac{F}{A}$$

Quantity:-

Pressure is a scalar quantity.

Unit:-

The S.I unit of pressure is $\frac{N}{m^2}$ or Nm^{-2}.

Also the unit of pressure is Pascal.

Atmospheric Pressure:-

The earth is surrounded by a cover of air. This air cover is called atmosphere and the pressure of this atmosphere is called atmospheric pressure. Atmospheric pressure acts in all directions.

Measuring Atmospheric Pressure:-

At sea level the kpa atmospheric pressure is about 101.300. The instrument that measures atmospheric pressure is called baro meter.

As we go up then atmospheric pressure decreased. At a height of 30 km the atmospheric pressure becomes only 1000 pa.

The atmospheric pressure also indicates the change in weather. On a hot day the atmospheric pressure becomes low. And on a cold day the atmospheric pressure increases.

Pressure in Liquids:-

Question

Prove that P = pgh

We know that liquids exerts pressure and the pressure of a liquid acts in all directions.

Consider a surface of area 'A' in a liquid at a depth 'h'. The force acting on this surface will be equal to weight of the liquid. If 'm' is the mass and 'l' is the density of liquid then

$$\text{Density} = \frac{\text{Mass}}{\text{volume}}$$

Then

$$\text{Mass} = \text{Density} \times \text{volume}$$

$$m = l \times v \longrightarrow (1)$$

Here

$$\text{Volume} = \text{Area} \times \text{Height}$$

$$v = A \times h \text{ put in (1)}$$

$$m = l \times A \times h$$

We know

$$\text{Pressure} = \frac{\text{force}}{\text{Area}}$$

$$P = \frac{F}{A}$$

Here F = Weight

$$W = mg$$

So

$$P = \frac{mg}{A}$$

Putting value from 'm'

$$P = \frac{(lah)}{A} g$$

$$P = \frac{l\cancel{A}h}{\cancel{A}} g$$

$$P = lhg$$

$$\boxed{P = lhg}$$

Pascal's Law

Statement:-

Pressure applied at any point of a liquid enclosed in a container is transmitted without loss to all other parts of the liquid.

Application of Pascal's Law:-

Ist Application:-

Hydraulic Press:-

Hydraulic press is a machine which works on pascal's law consist of two cylinder's of different cross-sectional area. The area of large cylinder is 'A' and the area of smaller cylinder is 'a'. Both cylinder's are joined with the help of a pipe. An object of weight 'W' is placed over the cylinder of area 'A'. A force F1 is applied on the piston of area 'a' due to this force the pressure on the liquid will be

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$P = \frac{F_1}{}$$

a

This pressure is transmitted through the liquid and act on the piston of area 'A'. As a result a force 'f_2' is given by

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$P = \frac{F_2}{A}$$

$$\frac{F_2}{F_1} = \frac{PA}{a}$$

Since A > a

Therefore $F_2 > F_1$

This result shows that a small force applied on the smaller piston results into a large force acts on the larger piston. Hydraulic press works on the same way.

Page No. 153 Exercise No. 7.2

Force on smaller piston = F_1 = 100N

Cross – sectional area of smaller cylinder = a = $0.01m^2$

Cylinder = a = $0.01m^2$

Force on larger piston = F_2 = ?

Cross – sectional area of larger cylinder = A = $1m^2$

Solution:-

By pascal's law

$$\frac{F_2}{F_1} = \frac{A}{a}$$

$$\frac{F_2}{100} = \frac{1}{0.01}$$

$$F_2 = \frac{1}{0.01} \times 100$$

$$F_2 = 10000 \text{ N}$$

Second Application of Pascal's Law

Breaking System in Vehicles:-

The breaking system of cars buses and other vehicles work according to pascal's law. In these brakes when the driver pushes down the brake pedal then it exert a pressure on the oil present in the master cylinder. This pressure is transmitted through the wheels of the car. As a result of this pressure the disc stops the wheel and the car stops moving when the pressure is released from the brake pedal then the disc attached with wheel also release the wheel and the car starts moving.

Archimedes Principle

Statement:-

When an object is totally or partially immersed in a liquid then an up thrust acts on it equal to the weight of the liquid it displaces.

Explanation:-

Consider a solid cylinder of cross sectional area 'A' and height 'h' is immersed in a liquid. Let 'h_1' and 'h_2' are the height of top and bottom faces of the cylinder. The

$h_2 - h_1 =$ h.

If 'p_1' is the liquid pressure at depth 'h1' and 'p_2' is the liquid pressure at depth 'h_2'

We know that

$P = egh$

Also

$P_1 = egh_1$

And

$P_2 = egh_2$

If 'F_1' is the force exerted at the top of cylinder and 'F' is the force exerted at the bottom of cylinder.

Then we know that

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$P = \frac{F}{A}$$

$$F = PA$$

Also

$F_1 = P_1A$

And

$F_2 = P_2A$

Since 'F_1' and 'F_2' are acting on the opposite forces of the cylinder. Therefore

Net force $= F_2 - F_1$

Putting value of 'p_1' and 'p_2'

Net force $= (e,g,h_2)\ A - (egh, A)$

Taking 'ega' common

Net force = egA $[h_2 - h_1]$

Putting value of 'h_2 h_1'

Net force = egAh ⟶ (1)

We know

Volume = Area × Height

V = A × h put in (1)

Net force = egv

Net force = (ev) g ⟶ (2)

We know

Ev = mass

Ev = m put in (2)

Net force = mg

Net force = weight

This net force is called up thrust of the liquid.

So

Up thrust = weight

Density of an object:-

Archimedes principle is also used to determined the density of an object. The ratio in weights of a body with equal volume of a liquid is equal to the ratio of their densities.

Let

Density of object = D

Density of liquid = l

Weight of object = W

Weight of equal volume of liquid

= W = $w_1 - w_2$

Where

W = Weight of object immersed in liquid

Here

$$\frac{\text{Density of object}}{\text{Density of liquid}} = \frac{\text{Weight of object}}{\text{weight of equal volume of liquid}}$$

$$\frac{D}{L} = \frac{W1}{W}$$

$$D = \frac{W_1}{w} \times l$$

Putting value of 'W'

$$D = \frac{W_1}{W_1 - W_2} \times l$$

Question

How can an object floats and how can an object sinks:-

Ans. If weight of the body is greater than up thrust of liquid acting on it then an object will sink. If weight of the body is less than the up thrust of the liquid then an object will floats.

Ships and Submarines:-

Ships and boats are designed on the principle of floatation. If the total weight of a ship and passengers becomes greater than up thrust of water then the ship will sink. And if the total weight of a ship and passengers becomes less than up thrust of water then the ship will float. Therefore ships and boats are designed in such a way that their weight always becomes less than up thrust of water so that they can float easily.

Submarines

Question:-

How a submarine moves up the water surface and down in to water?

Ans. A submarine can travel over as well as under water. It works on the principle of flotation. In a submarine there are tanks which can be filled with water. When these tanks are filled with water then weight of submarine becomes greater than up thrust of water therefore it goes down into the water. But when the water from the tanks is pumped out then weight of submarine becomes less than up thrust of water therefore submarine moves up the water.

Elasticity:-

The property of a body to restore its original size and shape is called elasticity.

Stress:-

The force acting on unit area at the surface of a body is called stress.

Unit:-

The unit of stress is newton per square metre ($\frac{N}{m^2}$ or Nm^{-2})

Strain:-

A stress can change the length valume or shape of a body. The fractional change in length, volume or shape of a body is called strain.

The fractional change in length is called tensil strain.

Formula:-

$$\text{Tensile Strain} = \frac{\text{Change in length}}{\text{Original length}}$$

Unit:-

Strain has no unit.

Hooke's Law:-

Within the elastic limit the strain produced in a body is directly proportional to the applied stress.

$$\text{Stress} \propto \text{Strain}$$

$$\text{Stress} = (\text{constant}) \text{ strain}$$

$\frac{\text{Stress}}{\text{Strain}}$ = Constant

Young's Modulus:-

The ratio of stress to the tensile strain is a constant. This constant is called young's modulus.

$$\text{Young Modulus} = \frac{\text{Stress}}{\text{Tension Strain}} \longrightarrow (1)$$

We know

$$\text{Stress} = \frac{\text{force}}{\text{Area}} = \frac{F}{A}$$

And

$$\text{Tensile Strain} = \frac{\text{Change in Length}}{\text{Original Length}} = \frac{\triangle L}{L}$$

$$Y = \frac{F}{A} \times \frac{L}{\triangle L}$$

$$Y = \frac{F \times L}{A \times \triangle L}$$

Page No. 165 Question No. 7.2

How kinetic molecular model of matter is helpful in differentiating various states of matter?

Ans. According to kinetic molecular model of matter all the matter is made up of small particles. These particles are called molecules. These molecules remain in continuous motion.

There are large empty spaces between the molecules of the gases. But in case of liquids the distance between the molecules is not very large. In case of solids the molecules are closely packed together.

Page No. 164 Question No. 7.3

Does there exists a fourth state of matters? What is it?

Ans. Yes, fourth state of matter exists and it is called plasma. It is also called ionic state. Because at very high temperature when atoms collide with the molecules of the gas. Then atoms lose their electrons and become positive ions. This collection of positive ions at very high temperature is called plasma.

Sun and stars exist in plasma state.

Question No. 7.4

What is meant by density. What is its S.I unit?

Ans. The mass per unit volume of a body is called density.

Formula:-

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

Unit:-

The S.I unit of density is kilograme per cubic metre ($\frac{kg}{m^3}$ or kgm^{-3})

Question No. 7.5

Can we use a hydrometer to measure the density of milk?

Ans. No hydrometer cannot be used to measure density of milk. Because hydrometer is a device which can be used to measure the concentration of acid in a battery whereas lactometer is a device which can be used to measure density of milk.

Question No. 7.6

Define the term Pressure?

Ans. The force acting normally per unit area on the surface of a body is called pressure.

Formula:-

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

Unit:-

The S.I unit of pressure is newton per square metre ($\frac{N}{m^2}$ or Nm^{-2}) the unit of pressure is also pascal.

Question No. 7.7

Show that atmosphere exerts pressure?

Ans. In the atmosphere of earth there are number of gases, water vapours and dust particles. The force of gravity on these particles. As a result every object inside the atmosphere experience a pressure. This pressure acts in all directions.

Question No. 7.8

It is easy to fill air in a balloon but it is very difficult to remove air from a glass bottle, why?

Ans. By applying pressure the air can be entered in a balloon easily. This is because the atmospheric pressure help us to enter air in a balloon. But it is difficult to remove air from a glass bottle because the pressure of air inside the glass bottle and atmospheric pressure are equal.