Chapter: 07

Properties of Matter

Exercise MCQs

1. In which of the following state molecules do not leave their position?

Ⓐ Solid Ⓑ Liquid Ⓒ Gas Ⓓ Plasma

2. Which of the substance is the highest one?

Ⓐ copper Ⓑ mercury Ⓒ aluminium Ⓓ lead

3. SI unit of pressure is Pascal, which is equal to:

Ⓐ 10^4 Nm^{-2} Ⓑ 1 Nm^{-2} Ⓒ 10^2 Nm^{-2} Ⓓ 10^3 Nm^{-2}

4. What should be the approximate length of a glass tube to construct a water barometer?

Ⓐ 0.5m Ⓑ 1m Ⓒ 2.5m Ⓓ 11m

5. According to Archimedes, up thrust is equal to:

Ⓐ weight of displaced liquid Ⓑ volume of displaced liquid
Ⓒ mass of displaced liquid Ⓓ none of these

6. The density of a substance can be found with the help of:

Ⓐ Pascal's law Ⓑ Hooke's law
Ⓒ Archimedes principle Ⓓ Principle of floatation

7. According to Hooke's law:

Ⓐ stress× strain = constant Ⓑ stress / strain = constant
Ⓒ strain / stress = constant Ⓓ stress = strain

Answer Key

1	Ⓐ	5	Ⓓ
2	Ⓒ	6	Ⓒ
3	Ⓑ	7	Ⓑ
4	Ⓓ		

Short Questions

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

Ans: Kinetic molecular model is used to explain three states of matter solid, liquid, and gas.

Solid:

In solids molecules are very close to one another, they possess greater attractive forces.

Liquids:

The distance between molecules is greater as compared to solids.

Gases:

In gases distance between molecules is too much.

2. What is meant by density? What is its SI unit?

Ans: Density:

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

Formula:

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

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

Unit:

The SI unit of density is kilogram per cubic metre (kgm^{-3}).

3. Does there exist a fourth state of matter? What is that?

Ans: Yes, there exists a fourth state of matter that is called **plasma.**

At very high temperature, the matter assumes the state of ions and electrons this is called plasma.

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

Ans: A Hydrometer is a device which is used to measure the density of the fluid.as the hydrometer is a glass tube with a scale marked on its stem and heavy weight in the bottom. It is partially immersed in the milk that is also a fluid, the density of which is to be measured; hence we can use a hydrometer to measure the density of milk.

5. Show that the atmosphere exerts pressure.

Ans: **Experiment:**

Boil an empty tin, half-filled with water, cap the tin. Let it cool under tap water. The tin will get crumpled as the water cool down. As the steam condenses, the pressure inside the metal tin decreases, the external atmospheric pressure that is higher, crushes the tin.

6. Define the term pressure.

Ans: **Pressure:**

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

Formula:

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

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

Units:

In SI, the unit of pressure is Newton per square metre (Nm^{-2}) or Pascal (Pa).

Physical quantity:

It is a scalar quantity.

7. It is easy to remove air from a balloon but it is very difficult to remove air from a glass bottle. Why?

Ans: It is very difficult to remove air from a glass bottle because air pressure in the bottle is less than atmospheric pressure but it is easy to remove air from a balloon due to lower external pressure.

8. Why water is not suitable to be used in a barometer?

Ans: Mercury is 13.6 times denser than water. Atmospheric pressure can hold vertical column of water about 13.6 times the height of mercury column at a place. Thus, at a sea level, the vertical height of water column would be $0.76 \times 13.6 = 10.4m$. Thus, a glass tube more than 10m long is required to make a water barometer.

9. What is a barometer?

Ans: **Barometer:**

The instrument that measures atmospheric pressure is called barometer. One of the simple barometers is mercury barometer. It consists of a glass tube 1m long closed at one end.

10. What makes a sucker pressed on a smooth wall sticks to it?

Ans: Air pressure makes the sucker pressed on a smooth wall stick to it.

11. What does it mean when the atmospheric pressure at a place falls suddenly?

Ans: A sudden fall in atmospheric pressure often followed by a storm, rain, and typhoon occurs in a few hours' time that cause internal energy of air to decrease, and coldness is produced.

12. Why does the atmospheric pressure vary with height?

Ans: The density of air is not uniform in the atmosphere. It decreases continuously as we go up. Hence atmospheric pressure is also decreased.

13. What changes are expected in weather if the barometer reading shows a sudden increase?

Ans: If the barometer reading shows a sudden increase or a rapid increase in atmospheric pressure, means that it will soon be followed by a decrease in the atmospheric pressure indicating poor weather ahead.

14. Explain the working of a hydraulic press.

Ans: The hydraulic press works on the principle of Pascal's law and consists of two cylinders fitted with pistons of different cross-sectional area.

15. State Pascal's law.

Ans: Pascal's law:

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

16. What is meant by elasticity?

Ans: Elasticity:

Elasticity is the property of matter by virtue of which matter resists any force which tries to change its length, shape or volume.

17. What is up thrust? Explain the principle of floatation.

Ans: Up thrust:

The fluids (liquids) exert force in the upward direction when some object is immersed into them. This is called upward thrust.

Principle of floatation:

The weight of the fluid displaced is equal to the weight of the floating object inside the liquid. Then object will into sink and keep floating. It is called the principle of floatation.

18. State Archimedes principle.

Ans: Archimedes principle:

When an object is whole or partially immersed in a liquid, an upthrust force acts on it equal to the weight of the liquid displaced. This is known as Archimedes principle.

19. Explain how a submarine moves up the water surface and down into the water.

Ans: If the submarine is not filled with seawater then, its weight is less than the upward thrust. So that floats on the surface of seawater. But when, it is filled with water, then its weight becomes larger as compared with the upward thrust of water then it sinks into the water.

20. What is Hooke's law? What is meant by elastic limit?

Ans: Hooke's law:

The strain produced in a body by the stress applied to it is directly proportional to the stress within the elastic limit of the body is called Hooke's law.

$$\text{Stress} \propto \text{strain}$$

Elastic limit:

An elastic limit can be defined as a limit within which a body recovers its original length, volume, or shape after the deforming force is removed.

21. Why does a piece of stone sink in water but a ship with a huge weight floats?

Ans: Ships and boats float on water. It is because the weight of an equal volume of water is greater than the weight of ships and boats. Ships have less density and large volume. A stone sinks in water. It is because the weight of an equal volume of water is smaller than the weight of a stone. Stone has high density and small volume.

22. Take a rubber band. Construct a balance of your own using a rubber band. Check its accuracy by weighing various objects.

Ans: Take a rubber band, hang it with a hook. Then pointer is attached at the lower end of it with a scale in front of pointer. Different known weights are suspended one by

one at lower end of this rubber band. The pointer position on the scale is marked for each different known weight suspended. It is called the calibration of scale for weight measurement. This makes a balance for weight measurement.

Important Formulas

- $A = \pi r^2$
- Volume = $l \times w \times h$
- Area = length × width
- Young's Modulus: $Y = \frac{F L_O}{A \Delta L}$
- $\frac{\text{Volume of ice}}{\text{Volume of water}} = \frac{\text{Density of water}}{\text{Density of ice}}$
- $\rho = \frac{m}{v}$
- $\rho_{obj} = \frac{w_1}{w_1 - w_2} \times \rho_{water}$
- Pascal's law: $P_1 = P_2$

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

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

Important Values and Some Units

Values:

- Density of ice = $920 kgm^{-3}$
- Density of water = $1000 kgm^{-3}$
- Density of A1 = $2727 kgm^{-3}$
- 1m = 100cm
- $1m^4 = 10^4 cm^2$
- $1m^3 = 10^6 cm^2$
- $1m = 10^3 mm \Rightarrow 1m^2 - 10^6 mm^2$

Units:

- Area = m^2
- Density = kgm^{-3}
- Young's Modulus = Y = Nm^{-2}
- Volume = m^3
- Pressure = Pa = Nm^{-2}
- Stress = Nm^{-2}

Numerical

1. A wooden block measuring 40cm × 10cm × 5cm has a mass 850g. Find the density of wood?

Ans: Given data:

$$\text{Volume} = V = 40\text{cm} \times 10\text{cm} \times 5\text{cm}$$

$$\text{Volume} = V = 2000\text{cm}^3$$

$$F = 300\text{N}$$

To Find:

$$\text{Work} = W = ?$$

Solution:

$$W = F \times S$$

$$W = 300 \times 35$$

$$W = 10500\ \text{J}$$

Result:

Work done by the man = W = 10500 J

2. How much would be the volume of ice formed by freezing 1 liter of water?

Ans: Given data:

$$\text{Density of ice} = 920\text{kgm}^{-3}$$

$$\text{Density of water} = 1000\text{kgm}^{-3}$$

$$\text{Volume of water} = \rho_2 = 1000\text{kgm}^{-3}$$

$$\text{Volume of water} = V_2 = 1\ \text{litre}$$

To Find:

$$\text{Volume of ice} = V_1 = ?$$

Solution:

$$\frac{\text{Volume of ice}}{\text{Volume of water}} = \frac{\text{Density of water}}{\text{Density of ice}}$$

Or $$\frac{V_1}{V_2} = \frac{\rho_2}{\rho_1}$$

Or $$v_1 = \frac{\rho_2}{\rho_1} \times v_2$$

Putting the values, we have

$$V_{ice} = \frac{1000}{920} \times 1$$

$$\text{Volume of ice} = 1.09 \text{ liter}$$

Result:

Thus, the volume of following of ice is 1.09 liter.

3. Calculate the volume of the following objects:

(a) An iron sphere of mass 5kg, the density of iron is 8200kgm^{-3}

(b) 200g of lead shot having density 11300kgm^{-3}

(c) A gold bar of mass 0.2kg and ρ = 19300 kgm^{-3}

Ans: Given data:

(a) Mass of iron = m = 5kg

Density of iron = ρ = 8200kgm^{-3}

To Find:

Volume of iron = V = ?

Solution:

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

$$8200 = \frac{5}{V}$$

$$V = \frac{5}{8200}$$

$$V = 6.1 \times 10^{-4} m^3$$

Volume of iron sphere = V = $6.1 \times 10^{-4} m^3$

(b) Mass of lead = m = 200g = $\frac{200}{1000}$kg = 0.2kg

Density of lead = ρ = 11300kgm^{-3}

To Find:

Volume of lead = V = ?

Solution:

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

$$11300 = \frac{0.2}{V}$$

$$v = \frac{5}{11300}$$

$$v = 1.77 \times 10^{-5} m^3$$

Volume of iron sphere $= v = 1.77 \times 10^{-5} m^3$

(c) Mass of gold bar $= m = 200g = \frac{200}{1000} kg = 0.2kg$

Density of gold bar $= \rho = 19300 kgm^{-3}$

To Find:

Volume of gold bar $= V = ?$

Solution:

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

$$19300 = \frac{0.2}{V}$$

$$v = \frac{5}{19300}$$

$$v = 1.04 \times 10^{-5} m^3$$

Volume of gold bar $= v = 1.04 \times 10^{-5} m^3$

4. The density of air is 1.3 kgm^{-3}. Find the mass of air in a room measuring $8m \times 5m \times 4m$.

Ans: Given data:

Density of air $= \rho = 1.3 kgm^{-3}$

Volume $= V = 8m \times 5m \times 4m$

Volume $= V = 160 m^3$

To Find:

Mass of air $= m = ?$

Solution:

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

$$1.3 = \frac{m}{160}$$

$$m = 1.3 \times 160$$

$$\mathbf{m = 208kg}$$

Result:

Mass of air = m = 208kg

5. A student presses her palm by her thumb with a force of 75N. How much would be the pressure under his thumb having contact area 1.5cm²?

Ans: Given data:

$$\text{Force} = F = 75N$$

$$\text{Area} = A = 1.5cm^2 = \frac{1.5}{(100)^2} = 1.5 \times 10^{-4}\ m^2$$

To Find:

$$\text{Pressure} = P = ?$$

Solution:

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

$$P = \frac{75}{1.5 \times 10^{-4}}$$

$$P = 5 \times 10^5\ Nm^{-2}$$

6. The head of a pin is a square of side 10mm. Find the pressure on it due to the force of 20N.

Ans: Given data:

$$\text{Side of square} = L = 10mm$$

$$\text{Area of square} = A = L \times L = 10 \times 10 = 100mm^2$$

$$\text{Area of square} = A = 1 \times 10^{-4}\ m^2$$

$$\text{Force} = F = 20N$$

To Find:

$$\text{Pressure} = P = ?$$

Solution:

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

$$P = \frac{20}{1 \times 10^{-4}}$$

$$P = 20 \times 10^4\ Nm^2$$

$$\mathbf{P = 2 \times 10^5\ Nm^{-2}}$$

7. A uniform rectangular block of wood 20cm × 7.5cm ×7.5cm and of mass 1000g stands on a horizontal surface with its longest edge vertical. Find

(i) The pressure exerted by the block on the surface

(ii) Density of the wood.

Ans: Given data:

$$\text{Area of block} = A = 7.5 \times 7.5 = 56.25\text{cm}^2$$

$$\text{Area of block} = A = 56.25 \times 10^{-4}\ \text{m}^2$$

$$\text{Mass of block} = m = 1000\text{g} = 1\text{kg}$$

$$\text{Volume} = V = 20\text{cm} \times 7.5\text{cm} \times 7.5\ \text{cm} = 1125\text{cm}^3$$

$$\text{Volume} = V = 1125 \times 10^{-6}\ \text{m}^3$$

$$g = 9.8\text{ms}^{-2}$$

To Find:

$$\text{Pressure} = P = ?$$

$$\text{Density} = \rho = ?$$

Solution:

(i) $$P = \frac{F}{A} = \frac{mg}{A}$$

$$P = \frac{1 \times 10}{56.25 \times 10^{-4}}$$

$$\mathbf{P = 1778\ Nm^{-2}}$$

(ii) $$\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{m}{V}$$

$$\text{Density} = \rho = \frac{1}{1125 \times 10^{-6}}$$

$$\rho = \frac{10^6}{1125}$$

$$\boldsymbol{\rho = 889\text{kgm}^{-3}}$$

8. A cube of glass of 5cm side and mass 306g has a cavity inside it. If the density of glass is 2.55gcm^{-3}. Find the volume of the cavity.

Ans: Given data:

$$\text{Original volume of glass} = V = 5\text{cm} \times 5\text{cm} \times 5\text{cm} = 125\text{cm}^3$$

$$V = 125 \times 10^{-6}\ \text{m}^3 = 1.25 \times 10^{-4}\ \text{m}^3$$

$$\text{Mass of cube} = 306\text{g} = 0.306\text{kg} = 3.06 \times 10^{-1}\text{kg}$$

To Find:

$$\text{Volume of cavity} = V = ?$$

Solution:

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

$$\text{Volume of cavity} = \frac{3.06 \times 10^{-1}}{2.55 \times 10^{3}}$$

$$\text{Volume of cavity} = 1.20 \times 10^{-4}\ m^3$$

$$\text{Volume of cavity} = \text{Volume without cavity} - \text{Volume with cavity}$$

$$\text{Volume of cavity} = 1.25 \times 10^{-4} - 1.20 \times 10^{-4}$$

$$\text{Volume of cavity} = 0.05 \times 10^{-4}\ m^3$$

$$\text{Volume of cavity} = 5 \times 10^{-6}\ m^3 \quad \text{or} \quad 5\ cm^3$$

9. An object has a weight 18N in the air. Its weight is found to be 11.4N, when immersed in water. Calculate its density. Can you guess the material of the object?

Ans: Given data:

Weight of object in air $= w_1 = 18N$

Weight of object in water $= w_2 = 11.4N$

Density of air $= \rho_w = 1000 kgm^{-3}$

Gravitational acceleration $= g = 10 ms^{-2}$

Weight of equal volume of water $= w = 18N - 11.4N = 6.6N$

To Find:

Density of material $= D_m = ?$

Density of material $= ?$

Solution:

As we know that;

$$\frac{D}{\rho} = \frac{m_1}{w}$$

By putting the value, we have

$$\frac{D}{1000} = \frac{18}{6.6}$$

$$D = \frac{18}{6.6} \times 1000$$

$$D = \frac{18000}{6.6}$$

$$D = 2727 Kgm^{-3}$$

Result:

Density of material = D_m = 2727Kgm^{-3}

As we know that density of aluminum is approximately equal to the density found in the numerical. So, the material is aluminum.

10. A solid block of wood of density 0.6gcm^{-3} weighs 3.06N in air. Determine

(a) Volume of the block

(b) The volume of the block immersed when placed freely in a liquid of density 0.9gcm^{-3}?

Ans: Given data:

Density of wood = 0.6gcm^3

Weight of wood in air = w_1 = 3.06N

Weight of wood in air = w_1 = mg

$$m = \frac{3.06}{10}$$

$$m = 0.306kg$$

$$m = 306g$$

To Find:

Volume of block = V_1 = ?

Volume when immersed in liquid = V_2 = ?

Solution:

Density of liquid = ρ = 10.9gcm^{-3}

(a) $$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$0.6 = \frac{306}{V_1}$$

$$V_1 = \frac{306}{0.6}$$

$$V_1 = 510cm^3$$

Volume of block = V_1 = 510cm^3

(b) $$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$0.9 = \frac{306}{V_2}$$

$$V_2 = \frac{306}{0.9}$$

Volume in water $= V_2 = 340cm^3$

11. The diameter of the piston of a hydraulic press is 30cm. How much force is required to lift a car weighing 20000N on its piston if the diameter of the piston of the pump is 3cm?

Ans: Given data:

Weight on small piston $= W = F_1 = 20000N$

Diameter of large piston $= D = 30cm$

Radius of large piston $R = \frac{D}{2} = \frac{30}{2} = 15cm = 0.15m$

Area of large piston $= A = \pi R^2$

Area of large piston $= A = 3.14 \times (0.15)^2$

Diameter of small piston $= d = 3cm$

Radius of small piston $= r = \frac{\beta}{2} = 1.5cm = 0.015m$

Area of small piston $= a = \pi r^2 = 3.14 \times (0.015)^2$

Area of small piston $= a = 0.000706m$

To Find:

Force on small piston $= F_2 = ?$

Solution:

$$P = P$$

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

$$\frac{20000}{\pi R^2} = \frac{F_2}{\pi r^2}$$

$$\frac{20000}{0.0706} = \frac{F_2}{(0.000706)}$$

$$\mathbf{F_2 = 200N}$$

12. A steel wire of cross–sectional area $2 \times 10^{-5}m^2$ is stretched through 2mm by a force of 4000N. Find the Young's modulus of the wire. The length of the wire is 2m.

Ans: Given data:

Cross-sectional area of wire $= A = 2 \times 10^{-5}m$

Length of wire $= L_o = 2m$

Force $= F = 4000N$

Increase in length $= \Delta L = 2mm = 2 \times 10^{-3}m$

To Find:

Young's modulus $= Y = ?$

Solution:

$$Y = \frac{FL_o}{A\Delta L}$$

$$Y = \frac{4000 \times 2}{2 \times 10^{-5} \times 2 \times 10^{-3}}$$

$$Y = \frac{4000}{2 \times 10^{-8}}$$

$$Y = \frac{4 \times 10^{3} \times 10^{6}}{2}$$

$$\mathbf{Y = 2 \times 10^{11} Nm^{-2}}$$