STRUCTURED QUESTIONS

KINETIC MOLECULAR MODEL OF MATTER

1. a) "The particles are free to move within the material, has a fixed volume but takes up the shape of its container", which state of matter is being described here?
   b) Write a similar description of the particles that make up a solid.
   c) Write down any two properties of a solid.

ANS:

a) Particles are free to move is not a solid. Fixed volume is not a gas. Takes the shape of the container is the characteristic of a liquid .

b) Particles in a solid are closely packed together , vibrate in place , and cannot move freely . Solids have a fixed shape and fixed volume .

c) The two properties of a solid are given as
   1 Solids have a fixed shape .
   2 Solids have a fixed volume .

2. a) Why the kinetic model of matter is called kinetic?
   b) In which state of matter the molecules are widely separated?
   c) In which state of matter the molecules are most closely packed?
   d) In which state of matter molecules can move freely at high speed?

ANS:

a) The kinetic model explains matter in terms of motion of particles . "Kinetic" comes from movement —the particles of matter are always in motion , whether vibrating, sliding past each other, or moving freely. That's why the kinetic model of matter is called kinetic

b) Molecules are widely separated in a gas

c) Molecules are **very close together** in a **solid** , so solids have a **fixed shape and volume**

d) Molecules move freely and quickly in a gas. The Liquids move freely too, but not as fast as gases

3. a) By using kinetic molecular theory explain why we can walk through air, swim through water but can not walk through a solid wall.
b) In which state of matter do the molecules have minimum kinetic energy?
c) Which state of matter is highly incompressible?

ANS:

a) We can understand why we can walk through air, swim through water, but cannot pass through a solid wall by thinking about how particles behave in different states of matter. In gases, like the air around us, the particles are very far apart and move freely, That is why we can easily move through air without feeling resistance. In liquids, such as water, the particles are closer together than in gases but they are not fixed in place; they can slide past each other. This is why we can push our hands or swim through water. In **solid,** Particles are **tightly packed and vibrate only in place,** leaving **no space to pass through.** we **cannot walk through a solid wall.**

b) The kinetic energy of particles also depends on how much they move. In solids, particles vibrate only slightly in their fixed positions, so their kinetic energy is the lowest compared to liquids and gases.

c)

- Incompressibility means the volume cannot be easily reduced
- Solids and liquids are closely packed , but liquids can flow to fill a container, so slightly compressible under high pressure
- Solids are the most incompressible , because particles are tightly packed and fixed
  .

FORCES AND KINETIC THEORY

4. A sample of a gas is in a sealed test tube is cooled. Describe what happens to:
a) The size of the molecules.
b) The speed at which molecules move.
c) The number of the molecules.
d) The pressure inside the tube.
e) The state of the gas.

ANS:

a) The size of the molecules **does not change significantly** .
Reason: Molecules themselves are rigid structures; cooling affects their motion, not their actual dimensions. Even at very low temperatures, the molecules remain essentially the same size.

b) The speed of the molecules **decreases** .
Reason:
Temperature is a measure of the average kinetic energy of molecules. Lowering the temperature reduces kinetic energy, so molecules move more slowly.

c) The number of molecules **remains the same** .

Reason:

The test tube is sealed, so no molecules can enter or leave. Cooling does not create or destroy molecules.

d) The pressure **decreases** .

Reason:

Gas pressure is due to molecules colliding with the walls of the container. Slower-moving molecules (from cooling) hit the walls less forcefully and less frequently, reducing pressure.

e) The gas remains a gas initially , but if cooled enough, it may condense into a liquid .

Reason:

Cooling reduces kinetic energy. At sufficiently low temperatures, the attractive forces between molecules can dominate, leading to condensation and changes into gas.

5. An inflated car tyre is considered to have a constant volume, regardless of any changes in temperature or pressure. Use the kinetic molecular theory of gases to answer the following:

a) How does air in the tyre exert a pressure on the walls of the tyre?

b) Why is the pressure the same at all points on the inside wall of the tyre?

c) More air is pumped into the tyre while the temperature is kept constant until there are twice as many molecules as before. Explain
why you would expect the pressure to be doubled.

ANS:

a) According to the kinetic molecular theory, air molecules are in constant random motion. As they move, they collide with the inside walls of the tyre. The total force from the huge number of molecular collisions per unit area produces the **pressure** on the tyre wall.

b) The air molecules move randomly in all directions and spread out to fill the whole tyre. Since the gas is uniform throughout the tyre, the number of molecules hitting each equal area of the wall per second is the same on average. Therefore, the force per unit area is the same everywhere, so the pressure is the same at all points on the inside wall.

c) If twice as many molecules are pumped into the same tyre volume, there will be twice as many molecules colliding with the walls each second. Since each molecule has the same average kinetic energy and produces the same average effect per collision, the total force on the walls doubles.

$$P \, \alpha \, N$$

where N is the number of molecules. Therefore, if the number of molecules is doubled, the pressure is doubled.

6. Describe the following:
a) What happens to the motion of the molecules of a gas when it cools down?
b) What happens to the motion of a liquid when it cools down?

ANS:

a) When a gas cools, its molecules have **less kinetic energy** , so they move **more slowly on average** . They collide with each other and with the container walls **less energetically** .

b) When a liquid cools, its molecules also have **less kinetic energy** . They still move around each other, but they move **more slowly** and become less able to slide past one another. If cooled enough, the liquid may **freeze** , and the molecules then only **vibrate about fixed positions** in a solid structure.

GASES AND KINETIC THEORY

7. The pressure on 9cm^3 of oxygen gas is doubled at a fixed temperature. What will its volume become?

ANS:

DATA

$P_1 = 9\ cm^3$

$V_1 = V$

$V_2 = 2V$

$P_2 = ?$

SOLUTIONS

$$P_1 V_1 = P_2 V_2$$

$$(9)(V) = P_2 (2V)$$

$$9 = P_2\ x\ 2$$

$$\frac{9}{2} = P_2$$

$$4.5\ cm^3 = P_2$$

8. A container holds 30m^3 of air at a pressure of 150000Pa. If the volume changed to 10m^3 by decreasing load on the piston. What will the pressure of the gas become? Assume that its temperature remains constant.

DATA

$V_1 = 30\ m^3$

$P_1 = 150000\ Pa$

$V_2 = 10\ m^3$

$P_2 = ?$

SOLUTIONS

$$P_1 V_1 = P_2 V_2$$

$$(150000)(30) = P_2 (10)$$

$$450000 = P_2$$

9. Air at atmospheric pressure of 760 mm of Hg is trapped inside a container available with a moveable piston. When the piston is pulled out slowly so that the volume is increased from 100 dm^3 to 150 dm^3, the temperature remaining constant.
What will be the pressure of the air becomes?

DATA

P_1 = 760 mm

V_1 = 100 m^3

V_2 = 150 m^3

P_2 = ?

SOLUTIONS

$$P_1 V_1 = P_2 V_2$$

$$(760)(100) = P_2 (150)$$

$$\frac{76000}{150} = P_2$$

$$506.7\ mm\ Hg = P_2$$