UNIT 7

Properties of Matter

Section A

Multiple Choice Questions (M.C.Qs)

Tick mark (✓) the correct answer:

01. *An object with particles close together and vibrating describes a_____.*
(a) gas (b) liquid (c) solid (d) All three

02. *A burning candle is an example of _____ state of matter.*
(a) Gas (b) Liquid (c) Solid (d) All three

03. *During which process a gas becomes a liquid_____.*
(a) melting (b) freezing (c) condensing (d) boiling

04. *A solid can _____*
(a) have a fixed shape (b) be easily compressed
(c) take a shape of container (d) have freely moving molecules

05. *According to kinetic molecular theory, the pressure exerted by a gas is caused by the _____*
(a) bombardment of the gas molecules on the walls of the container.
(b) collision between gas molecules.
(c) large distances between gas molecules.
(d) random motion of the gas molecules.

06. *If a gas is heated in a sealed cylinder, then_____ increases*
(a) the pressure inside the container (b) average kinetic energy of the particles
(c) the temperature of the gas (d) All of them

07. *A gas in a container of fixed volume is heated. What happens to the molecules of the gas?*
(a) They collide less frequently (b) They expand.
(c) They move faster (d) They move further apart

08. *In a liquid, some energetic molecules break free from the surface even when the liquid is too cold for bubbles to form. What is the name of this process?*
(a) boiling (b) condensation (c) convection (d) evaporation

09. *What happens to the molecules of a gas when the gas changes into a liquid?*
(a) They move closer and lose energy. (b) They move closer and gain energy.
(c) They move apart and lose energy. (b) They move apart and gain energy

10. *A substance has a melting point of –17°C and a boiling point of 117°C. In which state does the substance exist at –10°C and 110°C?*

	At –10°C	At 110°C
(a)	Solid	liquid
(b)	solid	gas
(c)	liquid	liquid
(d)	liquid	gas

PHYSICS NOTES FOR CLASS 9TH (FOR SINDH)

11. *States of matter are:*
(a) two (b) three (c) five (d) six

12. *Liquid state of matter has:*
(a) fixed shape & fixed volume (b) not fixed shape and fixed volume
(c) not fixed shape & not fixed volume (d) All of them

13. *Which states of matter are incompressible?*
(a) Solid & Liquid (b) Solid & Gas (c) Liquid & Gas (d) Solid, Liquid & Gas

14. *Which state of matter has low density?*
(a) Solid (b) Liquid (c) Gas (d) None of these

15. *It can change the state of matter.*
(a) Addition of certain amount of energy (b) Removal of certain amount of energy
(c) Both 'a' & 'b' (d) None of them

16. *The term 'Boiling' means:*
(a) conversion from solid to liquid (b) conversion from liquid to gas
(c) conversion from gas to liquid (d) conversion from solid to gas

17. *Evaporation is process by which a liquid becomes a gas at temperature:*
(a) at 100°C (b) equal to the boiling point of the liquid
(c) above the boiling point of the liquid (d) below boiling point of the liquid

18. *Drying of wet clothes and drying of wet floor are the examples of:*
(a) freezing (b) melting (c) condensation (d) evaporation

19. *Conversion of matter between three states involves:*
(a) physical changes (b) chemical changes
(c) Both 'a' & 'b' (d) None of them

20. *Matter is made up of tiny particles called:*
(a) atoms (b) molecules (c) ions (d) cells

21. *In 1827, the evidence of molecular motion first discovered by:*
(a) Newton (b) Einstein (c) Robert Brown (d) Kepler

22. *A group of atoms is called:*
(a) element (b) molecule (c) ion (d) cell

23. *The molecules of the following state of matter are usually arranged in a regular pattern called lattice:*
(a) Solids (b) Liquids (c) Gases (d) All of them

24. *Which state of matter has the highest densities?*
(a) Solids (b) Liquids (c) Gases (d) All of them

25. *In which state of matter, molecules are found in clusters?*
(a) Solids (b) Liquids (c) Gases (d) None of them

26. *In which state of matter, particles are very far apart?*
(a) Solids (b) Liquids (c) Gases (d) All of them

27. *It is responsible for the different states of matter as well as for the physical properties.*
(a) Force between the molecules (b) Energy of the molecules
(c) Size of the molecules (d) Shape of the molecules

PHYSICS NOTES FOR CLASS 9TH (FOR SINDH)

28. *According to the Kinetic molecular model, if the molecules have large kinetic energy then:*

(a) the forces of attraction between them are very strong
(b) the forces of attraction between them are moderate
(c) the forces of attraction between them are less strong
(d) there will be no (negligible) forces of attraction between them

29. *Boiling and melting points of gases are:*

(a) very low *(b)* low *(c)* high *(d)* very high

30. *The molecules of which state of matter have extremely lowest energies?*

(a) Gases *(b)* Liquids *(c)* Solids *(d)* Gases & Liquids

31. *It has lowest boiling and melting points as compared to other substances.*

(a) Hydrogen *(b)* Helium *(c)* Mercury *(d)* Oxygen

32. *It is the only metal that is not solid at room temperature.*

(a) Tungsten *(b)* Helium *(c)* Mercury *(d)* Copper

33. *A gas molecule moves in a straight line. It changes its direction only when*

(a) it collides with another gas molecule
(b) with the walls of its container
(c) Both 'a' & 'b'
(d) None of these

34. *If we compress a gas, its pressure:*

(a) becomes zero *(b)* remains the same
(c) decreases *(d)* increases

35. *If a gas is compressed to half of its original volume, its pressure will be:*

(a) zero *(b)* remains the same
(c) doubled *(d)* becomes half

36. *If we decrease the pressure of a gas, the volume of the will be:*

(a) becomes zero *(b)* remains the same
(c) decreases *(d)* increases

37. *It is determined by the average translational kinetic energy of molecules of a gas.*

(a) Temperature *(b)* Pressure *(c)* Density *(d)* Volume

38. *Boyle's Law can be represented as:*

(a) $P \propto \frac{1}{V}$ *(b)* $V \propto \frac{1}{P}$
(c) Both 'a' & 'b' *(d)* None of these

Answers

1.	(c)	2.	(d)	3.	(c)	4.	(a)	5.	(a)	6.	(d)	7.	(c)
8.	(d)	9.	(a)	10.	(a)	11.	(b)	12.	(b)	13.	(a)	14.	(c)
15.	(c)	16.	(b)	17.	(d)	18.	(d)	19.	(a)	20.	(a)	21.	(c)
22.	(b)	23.	(a)	24.	(a)	25.	(b)	26.	(c)	27.	(a)	28.	(d)
29.	(a)	30.	(c)	31.	(b)	32.	(c)	33.	(c)	34.	(d)	35.	(c)
36.	(d)	37.	(a)	38.	(c)								

PHYSICS NOTES FOR CLASS 9TH (FOR SINDH)

Section B & C Short & Detailed Answer Questions

Introduction

A balloon kept under sunlight shattered, why? Why a hot coffee or tea in a cup became cold as time passes? Clothes dry up quickly under sunlight? Honey is thicker than water, why?
Why do water and milk or other liquids boil at a different temperature? Why do water and milk take the shapes of the container in which they are poured? Have you ever think that when you sit at your chair or bed, their foams compresses but their wooden frame do not?
After studying this unit you will be able to find the answers to such questions and other similar questions and develop clear concepts.

Q.1 *Define matter.*

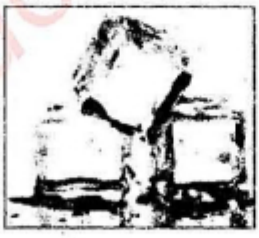
Ans: Anything which occupies space and having mass is called matter.

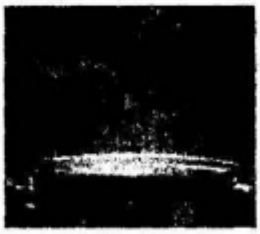
Q.2 *How many states of matter are there?*

Ans: There are three states of matter. These states are solid, liquid and gas. All the material objects around us belong to any one of these states.

Q.3 *Water is the best example of three states of matter. Explain.*

Ans: In nature, water exists in all three states of matter.
The solid-state of water is ice.
Ice exists in many forms like ice cubes, snow, glaciers and icebergs.
The liquid state is water itself.
Water is found in oceans, rivers and underground deposits.
The gaseous state of water is steam.
The "white smoke" that we see in the figure is a small cloud formed by water vapours in the air, above the cup.





Q.4 *Describe the properties of three states of matter in terms of their shapes, volume, density and compressibility.*

Ans: These states have different properties which are listed in the following table:

State of Matter	Shape	Volume	Density	Compressibility
Solid	Fixed	Fixed	High	Incompressible
Liquid	Not Fixed	Fixed	High	Incompressible
Gas	Not Fixed	Not Fixed	Low	Compressible

Q.5 How can a matter change its state?

Ans: The addition or removal of a certain amount of energy can change the state of a matter. Conversion of matter between three states involves physical changes and not chemical changes.

Q.6 In terms of changes in the state of matter, define melting, boiling, condensing, freezing and evaporation.

Ans: The terms for changes in the state of matter are:

Melting: conversion from solid to liquid.
Boiling: conversion from liquid to gas
Condensing: conversion from gas to liquid.
Freezing: conversion from liquid to solid.
Evaporation: conversion from liquid to gas.

More Information:

Water is different from other substances because it is less dense in its solid state (ice) than its liquid state (water)

Q.7 Define evaporation.

Ans: ***Evaporation:*** Evaporation is a process by which a liquid becomes a gas at a temperature below boiling point.
Drying wet clothes and drying wet floors etc. are examples of evaporation.
Evaporation is different from boiling.

More Information:

Why do liquids and gases take the shapes of their containers while solids have definite shapes? Why do different substances boil and melt at a different temperatures? Why can gases be compressed easily while solids and liquids cannot?
The answers to the above and such other questions can be obtained by considering the arrangements of the particles in these states and how these particles are able to move about. This is explained by the kinetic molecular theory of matter.

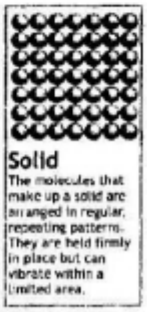
Q.8 Describe the Kinetic Molecular Model or Theory of matter.

Ans: ***Kinetic Molecular Model/Theory of Matter:*** Kinetic molecular theory of matter explains how particles are able to move about in three states of matter. It also explains the arrangements of the particles in these states.
Atoms: Matter is made up of tiny particles called atoms.
Molecules: A group of atoms is called a molecule. These molecules are always in continuous random motion. The evidence of molecular motion is Brownian motion.
According to this model, particles are in continuous motion. Thus an alternative name for the model is "The particle model of matter".
The kinetic molecular theory explains the physical properties of solids, liquids and gases by considering the position and motion of molecules.

Q.9 Write down the properties of solids.

Ans: ***Properties of Solids:*** The particles in solids have the following features:

(i) The molecular are closely packed together and occupy minimum space.
(ii) The molecules are usually arranged in a regular pattern called a lattice.
(iii) There are a large number of particles per unit volume. That is why solid have the highest densities.



Solid
The molecules that make up a solid are arranged in regular, repeating patterns. They are held firmly in place but can vibrate within a limited area.

The movements of particles in solids have the following features:

(i) The forces of attraction between particles are very strong.

(ii) The particles are not able to change position.

(iii) The particles vibrate about fixed positions thus are not entirely stationary. This explains why solids have fixed shapes and volume.

Q.10 *Write down the properties of liquids.*

Ans: ***Properties of Liquids:*** The particles in a liquid have the following features:

(i) The molecules are slightly further apart as compared to that of solids.

(ii) The molecules occur in clusters.

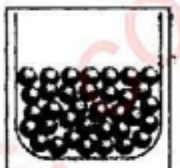
(iii) There is slightly less number of particles per unit volume compared to solids. This is why liquids have relatively high densities.

The movements of particles in liquids have the following features:

(i) The forces of attraction between particles are strong.

(ii) The particles are free to move about within the liquid.

These features explain why liquids have fixed volumes, but take the shape of the container.



Liquid
The molecules that make up a liquid flow easily around one another. They are kept from flying apart by attractive forces between them. Liquids assume the shape of their containers.

Q.11 *Write down the properties of gases.*

Ans: ***Properties of Gases:*** The particles in gases have the following features:

(i) The molecules are very far apart.

(ii) The molecules are arranged randomly and are free to move at very high speeds.

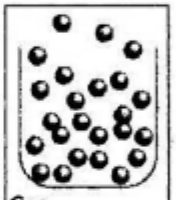
(iii) There is a small number of particles per unit volume.

The movement of particles in gases has the following features:

(i) The force of attraction between particles is negligible.

(ii) The particles are able to move freely in random directions at very high speeds.

(iii) The particles occupy any available space.



Gas
The molecules that make up a gas fly in all directions at great speeds. They are so far apart that the attractive forces between them are insignificant.

Q.12 *Define Brownian motion.*

Ans: ***Brownian Motion:*** The evidence of molecular motion was first discovered by botanist Robert Brown in 1827. He observed the irregular motion of pollen grains suspended in water and deduced that the water molecules were in constant, random motion. This irregular motion caused by water molecules is called "Brownian motion" named after the scientist.

Weblinks:
Weblink of Brownian motion
http://www.phyntau.edu

More Information:
The human body consists of all three states of matter.
- Solid in the form of organs.
- The liquid is in the form of blood.
- Gas in the form of Oxygen and carbondioxide for respiration.

Q.13 *Define lattice.*

Ans: ***Lattice:*** The molecules are usually arranged in a regular pattern called a lattice.

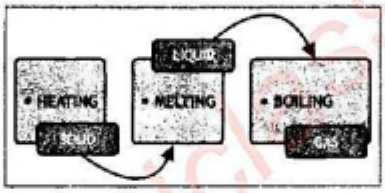
Q.14 *Why some materials are solids and liquids while others are gases at room conditions?*

Ans: Forces between the molecules are responsible for the different states of matter as well as for the physical properties. According to the Kinetic molecular model molecules of gases have large kinetic energy, as a result, there are no forces of attraction between them, as a result, molecules of gases

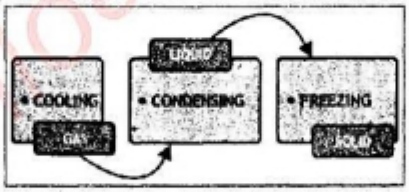
can move freely and go farther apart. This is why gases can occupy any available space and can be compressed easily. The boiling and melting points of gases are also very low because of this reason.
The molecules of liquids as compared to that of the gases have less kinetic energy hence intermolecular forces come into play. That is why the molecules of liquids are very close to each other but still free to move. Therefore liquids do not have a fixed shape but a fixed volume. The melting and boiling points of liquids are also high as compared to gases.
The molecules of solids have extremely lowest energies therefore experience strong attractive forces and cannot move freely but only have small vibrations about mean positions. This gives solid a fixed shape and volume. That is why the densities, melting and boiling points of solids are very high. As a result, we can convert water into ice, cream into ice cream, natural gas into compressed natural gas 'CNG' etc.

Q.15 ***The state of a substance can be changed either by heating or by cooling it. Explain.***

Ans: The state of a substance can be changed either by heating or by cooling it. On the other hand, when a solid substance is heated, the molecules start to vibrate more and more strongly. Eventually, the molecules vibrate more violently and intermolecular forces become weak. As a result 'material becomes a liquid, if the process of heating is continued further, then molecules have sufficient energy to overcome all of the attractive forces as a result 'substance becomes a gas'.



'When a gas is cooled, the molecules move slowly and collide with one another, may stick together and force of attraction between molecules increases. Keep cooling the gas and eventually, all of the molecules stick together to form a liquid. Further cooling will cause all the molecules to stick together to form a solid.



The table on the right shows the boiling end melting points of some pure substances: Helium has the lowest boiling and melting points as compared to other substances. It solidifies only when it is cooled and compressed. Mercury is the only metal that is not solid at room temperature.

Q.16 ***What is the name of the process in which a liquid changes into a solid?***

Ans: Freezing is a phase transition in which a liquid turns into a solid when its temperature is lowered to its freezing point.

Q.17 ***What is the name of the temperature at which a liquid changes into a solid?***

Ans: The name of the temperature at which a liquid changes into a solid is the freezing point. It is the temperature at which a liquid becomes a solid at normal atmospheric pressure.

Boiling and Melting Points of some pure Substance

Substance	Melting Point (°C)	Boiling Point (°C)
Helium	-272	-269
Oxygen	-218	-183
Nitrogen	-191	-177
Mercury	-39	257
Water	0	100
Iron	2080	3570
Diamond (Carbon)	4100	5400
Tungsten	3920	6500

Q.18 Describe the properties and behaviour of gases in the light of the kinetic theory.

Ans: ***Behaviour of Gases:*** Kinetic molecular theory clearly describes the properties and behaviour of gases. Hot air balloons are the practical application of this.

(i) The molecules in the gases have relatively large distances between them.

(ii) The molecules in the gases move about very quickly.

(iii) A gas molecule moves in a straight line.

(iv) It changes its direction only when

(a) it collides with another gas molecule or

(b) with the walls of its container. After the collision, it moves away in a new direction.

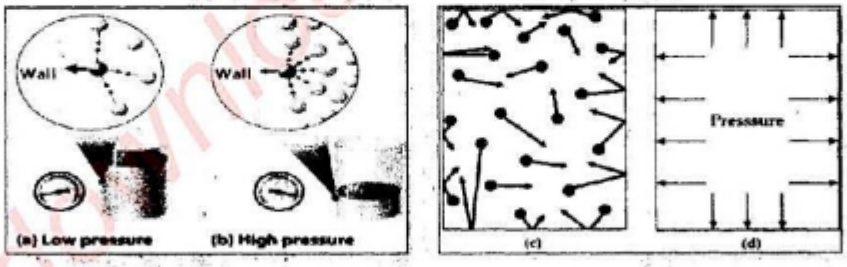
(v) Since gas molecules collide many times each second. Therefore the motion of molecules is constant and random.

The behaviour of a gas can be described completely by its pressure, volume and temperature.

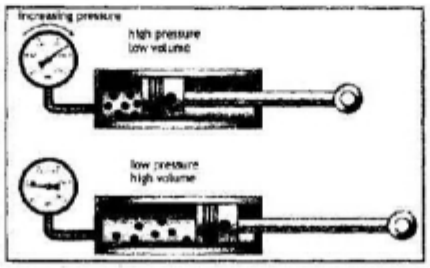
Q.19 Define pressure. Describe the pressure of gases.

Ans: ***Pressure:*** Pressure is defined as the force per unit area.

The pressure of Gases: All the gases exert pressure on the walls of their container. This pressure is the total force exerted per unit area by the gas molecules during the collision. The gas molecules exert pressure only when they collide with the walls. The number of collisions is proportional to the number of molecules. If the number of molecules is doubled, the number of collisions will also be doubled (Fig. a, b, c and d). Hence the pressure is also doubled.



Blowing up a balloon is an example of pressure. If more air is pushed into the balloon it will be inflated more because air molecules apply pressure on the rubber walls of the balloon hence it gets inflated. The pressure of a gas can also be increased by compressing it. This is done by reducing the size of the gas container. The gas molecules have been compressed into a smaller volume so they will collide more frequently with the walls of the container and creates more pressure. If the gas is compressed to half its original volume its pressure will be doubled.

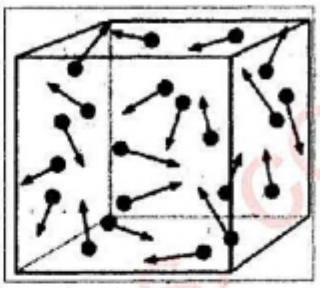


PHYSICS NOTES FOR CLASS 9TH (FOR SINDH)

Q.20 Define volume and describe the volume of a gas.

Ans: ***Volume:*** The space occupied by a substance is known as volume.

The Volume of a Gas: A gas has no definite volume because the molecules of the gas are far away from each other and can move freely at high speed. Therefore gas always takes up the shape and volume of its container.



For example, the smell of perfume quickly spreads through the room as soon you spray it at your body or clothes because the molecules move freely and randomly at high speeds throughout the room.

The volume of a gas can also be increased by decreasing pressure. This could be done by reducing the load on the piston of the gas container. As the gas molecules are in random motion they quickly cover the whole space and the volume increases. If the gas is compressed to half its original volume is pressure will be doubled.

Q.21 Describe the temperature of a gas. OR What is the effect of temperature on the average translational kinetic energy of molecules?

Ans: ***Temperature of a Gas:*** The temperature of a gas is determined by the average translational kinetic energy of its molecules. If a gas is heated the average translational kinetic energy of its molecules increases and the temperature of the gas rises. If a gas is cooled down the average translational kinetic energy of its molecules decreases and the temperature of the gas falls.

Q.22 Explain the pressure-volume relationship in gases. OR Describe Boyle's Law.

Ans: ***Pressure-volume relationship in gases / Boyle's Law:*** Robert Boyle, an English physicist and chemist in 1662, studied the relationship between pressure and volume of a gas.

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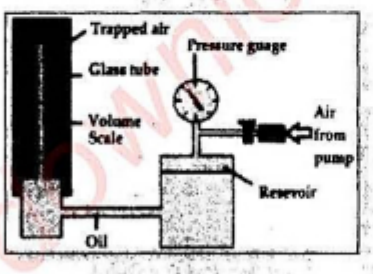
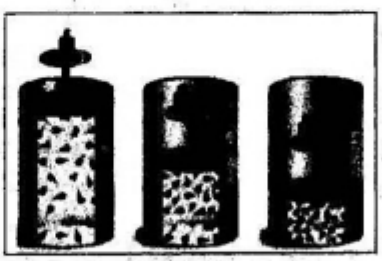


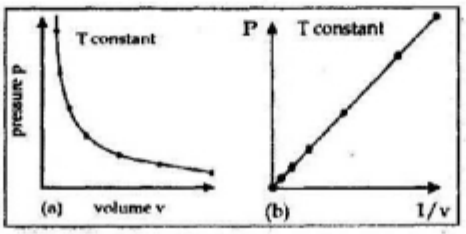


The results of a Boyles experiment as shown below:

$$I \propto \frac{1}{\quad} \quad or \quad I \propto \frac{1}{\quad}$$

(1) If the pressure of the gas is double its volume becomes half. If pressure increases by three times then the volume becomes one-third and so on.

(2) The graph between "p" and "V" between "p and 1/V" is shown below:



(3) The graph between "p" and "V" shows that if pressure increases then volume decreases and vice-versa.

(4) The graph between "p" and "1/V" shows a straight line passing through the origin.

(5) At constant temperature the product of pressure and volume is constant. i.e.

$$pV = \text{constant}$$

(6) Using the above result, at a constant temperature, we can write:

initial pressure x initial volume = final pressure x final volume

$$p_1V_1 = p_2V_2$$

Thus Robert Boyle concluded his law known as "Boyle's Law" which states that:

Statement of Boyle's Law: The volume of a fixed mass of a gas is inversely proportional to its pressure, provided its temperature remains constant.

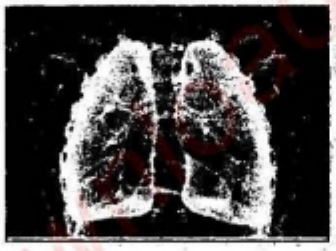
More Information:

An important feature of the equation $p_1V_1 = p_2V_2$ is that it does not matter what units we use for p and V, as long as we use the same unit for both values of p (for example Pa, kPa or atmosphere etc.), and the same units for both values of V (for example m^3, dm^3 etc.)

Q.23 *Write down the application of Boyle's Law.*

Ans: ***Applications of (p-V) relationship of gas / Boyle's Law:*** Some applications of pressure-volume (p-V) relationship of a gas i.e. Boyle's Law is given below:

Aerosols, such as spray paints, use Boyle's Law in their working mechanism.



When we breathe, our diaphragm moves downward, increasing the volume of the lungs. This causes the pressure inside the lungs to be less than the outside pressure so air rushes in.

More Information:

When gas is compressed, volume decreases and the pressure increases.

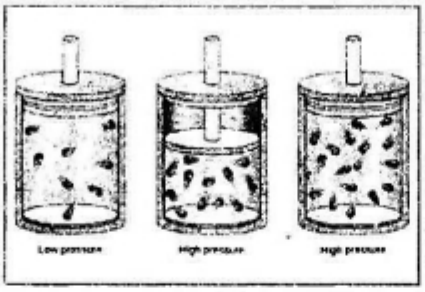
A bicycle pump is a good example of Boyle's law.

As the volume of the air trapped in the pump is reduced, its pressure goes up, and the air is forced into the tire.

When fluids are drawn into a syringe, the volume inside the syringe is increased, the pressure decreases on the inside. The pressure on the outside of the syringe is greater, therefore fluids are forced into the syringe.

Q.24 ***Draw diagrams of the molecules in a gas to explain the effect of pressure change on its volume.***

Ans:



Q.25 ***What is meant by the subscripts 1 and 2 in the equation, $p_1V_1 = p_2V_2$?***

Ans: In the above equation, subscript 1 means initial pressure and volume and subscript 2 means final pressure and volume.

Scientific Reasons

01. ***Explain why?***

(i) Solids have the highest densities.

Ans: There are a large number of particles per unit volume. That is why solids have the highest densities.

(ii) Solids have fixed shapes and volume.

Ans: The particles vibrate about fixed positions thus are not entirely stationary. This explains why solids have fixed shapes and volume.

(iii) Liquids have relatively high densities.

Ans: There is slightly less number of particles per unit volume compared to solids. This is why liquids have relatively high densities.

(iv) Liquids have fixed volumes, but take the shape of the container

Ans: The forces of attraction between particles are strong and the particles are free to move about within the liquid. These features explain why liquids have fixed volumes, but take the shape of the container.

02. ***Why dose a gas has neither a fixed shape nor a fixed volume ?***

Ans: The molecules of a gas keep moving very fast in all directions. They are far from one another. Thus the cohesive forces are insignificant and the gases do not have a fixed shape or a fixed volume. They occupy all the space available to them.

03. ***Its is easy to compress air as compared to water. Why ?***

Ans: In gases the molecules are far apart from each other. There are a lot of empty spaces between gas molecules. As air is a mixture gases so it can be compressed quite easily . Whereas water is a liquid and its molecules are closer then air. Liquid are incompressible. That is why it is easy to compressed air as compared to water

04. ***Why does Tungsten melts at a much higher temperature than iron?***

Ans: Tungsten melts at a much higher temperature than iron because of its heaviness and covalent bond between the atoms. It is well known that elements with a higher atomic mass have higher melting points. For Tungsten there is the added indication that some of its valence electrons (the 5d electrons) are making covalent bonds between neighbouring atoms in the crystal structure. In general, the greater the number of valence electrons, the stronger is the resultant bonding. Tungsten has the maximum number of unpaired electrons and therefore, it is one of the very hard metals and has maximum enthalpies of atomization. So tungsten has a very melting point.

05. ***Why did the smell of perfume quickly spread through the room.***

Ans: The smell of perfume quickly spreads through the room as soon we spray it at our body or clothes because the molecules move freely and randomly at high speeds throughout the room.

06. ***Why the kinetic model of matter is called kinetic?***

Ans: Any matter that is moving has energy just because it's moving. The energy of moving matter is called kinetic energy. Scientists think that the particles of all matter are in constant motion. In other words, the particles of matter have kinetic energy. The theory that all matter consists of constantly moving particles is called the kinetic theory of matter or Kinetic model of matter.

07. ***By using kinetic molecular theory explain why we can walk through air, swim through Water but cannot walk through a solid wall.***

Ans: According to kinetic molecular theory, there is no or little space between the particles of solids as compared to liquids and gases. The forces of attraction between these particles are so strong that we cannot pass through solid objects, such as walls.

Difference

01. ***What is the difference between evaporation and boiling?***

Ans: Difference Between Evaporation and Boiling

	Evaporation	***Boiling***
01	Evaporation can occur at any temperature.	Boiling always occurs at a fixed temperature.
02	In this process, no bubbles are formed.	Bubbles are formed as a result of the liquid.
03	It takes place only on the surface of the liquid.	It takes place throughout the liquid.
04	The temperature of the liquid body decreases when evaporation takes place.	In contrast, the temperature remains constant in this process.
05	Evaporation continues as long as the air above the surface of liquid remains unsaturated.	It takes place until the internal temperature of the liquid is equal to the external temperature of the surroundings.
06	Sunlight or surrounding temperature is the major source to initialize evaporation.	To initialize this process, a heat energy source is supplied to the liquid.

02. ***What is the difference between the three states of matter in terms of the spacing between the molecules?***

Ans: ***Molecules in a:***

- gas are well separated with no regular arrangement.
- liquid are close together with no regular arrangement.
- solid are tightly packed, usually in a regular pattern.

Section D — Numerical

Worked Examples of the Textbook

01. ***A cylinder contains 60cm³ of air at a pressure of 140kPa. What will its volume be if the pressure on it is increased to 420kPa?***

Solution:

Step 1: Write the known quantities and point out quantities to be found.

$p_1 = 140\ kPa \quad V_1 = 60\ cm^3 \quad p_2 = 420\ kPa \quad V_2 = ?$

Step 2: Write the formula and rearrange if necessary.

$$p_1V_1 = p_2V_2$$

$$V_2 = \frac{p_1V_1}{p_2}$$

Step 3: Put the value in the formula and calculate.

$$V_2 = \frac{140kPa \times 60cm^3}{420kPa} = \boxed{20\ cm^3}$$

The new volume is $20cm^3$.

02. ***Air at a pressure of 1.0 x 10⁵ Pa is contained in a cylinder fitted with a piston. The air is now compressed by pushing the piston so that the same mass of air now occupies one-fifth of the original volume without any change in temperature. Calculate the pressure of the air.***

Solution:

Step 1: Write the known quantities and point out quantities to be found.

$p_1 = 1.0 \times 10^5\ Pa \quad V_1 = V_1\ cm^3 \quad V_2 = \frac{1}{5} V_1\ cm^3 \quad p_2 = ?$

Step 2: Write the formula and rearrange if necessary.

$$p_1V_1 = p_2V_2$$

$$p_2 = \frac{p_1V_1}{V_2} = \frac{p_1V_1}{\frac{1}{5}V_1}$$

Step 3: Put the value in the formula and calculate.

$$p_2 = \frac{1.0x10^3\ Pa \times V_1\ cm^3}{\frac{1}{5}V_1 cm^3} = 5.0 \times 10^5\ Pa$$

So, the final pressure is now 5.0×10^5 Pa.

PHYSICS NOTES FOR CLASS 9TH (FOR SINDH)

Solved Numerical

(01.) ***The pressure on 9cm³ of oxygen gas is doubled at a fixed temperature. What will its volume become?***

Solution:

Data: $p_1 = p_1$ $V_1 = 9cm^3$ $p_2 = 2p_1$ $V_2 = ?$

Working Formula: $p_1V_1 = p_2V_2$

Calculation: $p_1(9) = (2p_1)V_2$

$$V_2 = \frac{9p_1}{2p_1} = \frac{9}{2} = \boxed{4.5\ cm^3}$$ Ans.

(02.) ***A container holds 30m³ of air at a pressure of 150000 Pa. If the volume changed to 10m³ by decreasing load on the piston, what will the pressure of the gas become? Assume that its temperature remains constant.***

Solution:

Data: $p_1 = 150000\ Pa$ $V_1 = 30\ m^3$ $V_2 = 10\ m^3$ $p_2 = ?$

Working Formula: $p_1V_1 = p_2V_2$

Calculation: $(150000)(30) = p_2(10)$

$4500000 = 10p_2$

$$p_2 = \frac{4500000}{10} = \boxed{450000\ m^3}$$ Ans.

(03.) ***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 100dm³ to 150dm³, the temperature remains constant. What will be the pressure of the air becomes?***

Solution:

Data: $p_1 = 760\ mm$ $V_1 = 100dm^3$ $V_2 = 150\ m^3$ $p_2 = ?$

Working Formula: $p_1V_1 = p_2V_2$

Calculation: $(760)(100) = p_2(150)$

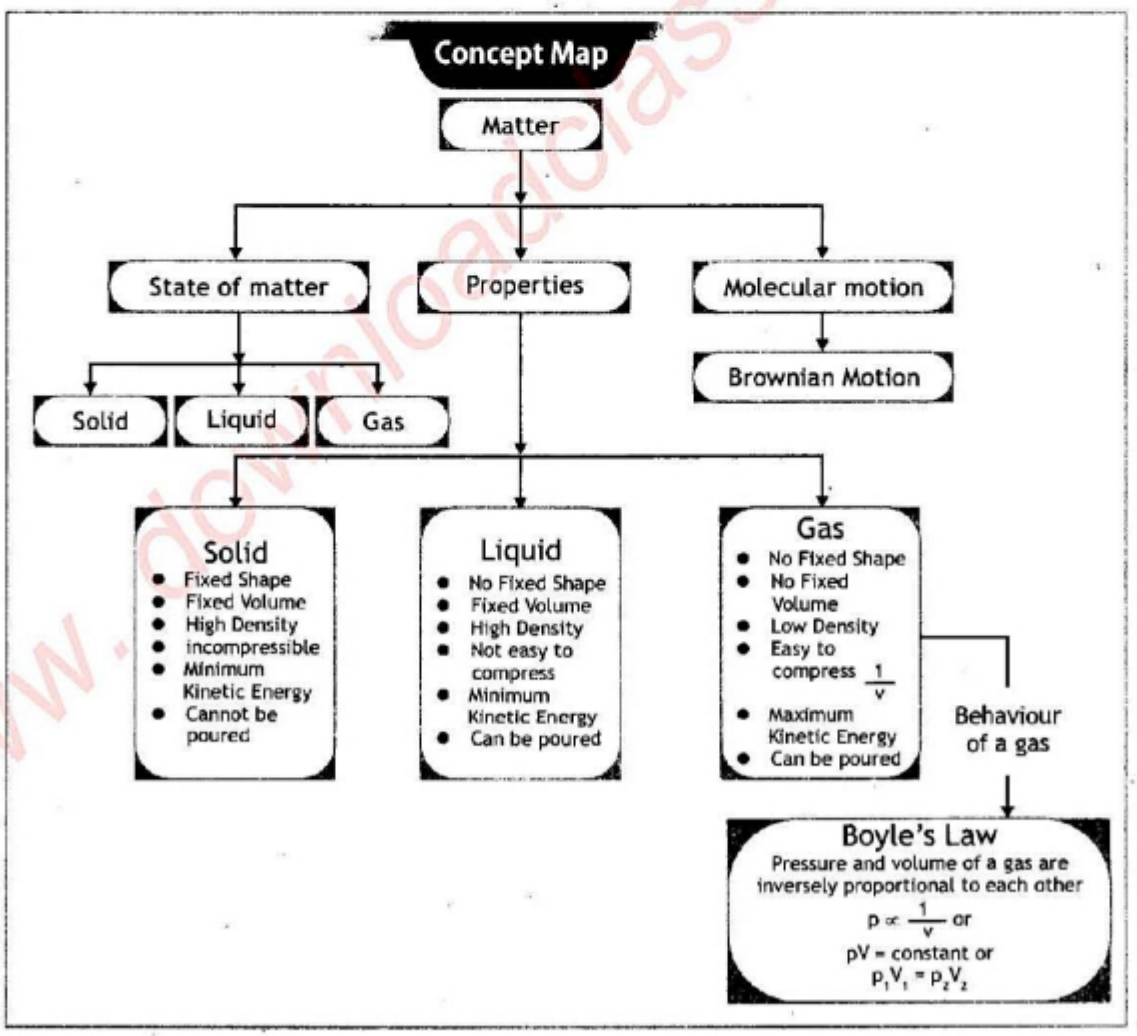
$76000 = 150p_2$

$$p_2 = \frac{76000}{150} = \boxed{506.66dm^3}$$ Ans.

PHYSICS NOTES FOR CLASS 9TH (FOR SINDH)

Summary

- Matter exists in three states: solid, liquid and gas.
- The state of a matter can be changed by adding or removing a certain amount of energy.
- The kinetic molecular theory is based upon the arrangement and movement of molecules in a substance.
- The kinetic molecular theory suggests that the molecules in a substance are always in continuous random motion.
- When molecules are close to each other, the attractive forces between them become strong.
- The change in force between molecules causes the change of state.
- Boyle's law describes the pressure-volume relationship of a gas.
- The pressure and volume of a gas are inversely proportional to each other.
- Mathematically $p_1V_1 = p_2V_2$



End of Unit Questions Solution

SECTION - A: MULTIPLE CHOICE QUESTIONS

Tick Mark (✓) the correct answer:
See "Multiple Choice Questions (M.C.Qs)" - (1) to (10)

SECTION - B: STRUCTURED QUESTIONS

Kinetic Molecular Model of Matter

01. *(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)* Liquids

(b) The particles are closely packed together and usually arranged in a regular pattern called a lattice. The forces of attraction between particles are very strong. The particles are not able to change position. Therefore, solids have fixed shapes and volumes.

(c) See 'Short & Detailed Answer Questions" – Q.9

02. *(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)* See 'Scientific Reasons' – Q.6 *(b)* Gas *(c)* Solid *(d)* Gas

03. *(a)* ***By using kinetic molecular theory explains why we can walk through air, swim through water but cannot 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)* See 'Scientific Reasons' – Q.7 *(b)* Solid *(c)* Solid

Forces and Kinetic Theory

04. ***A sample of a gas in a sealed test tube is cooled. Describe what happens to***

(a)	The size of the molecules.	*Ans:*	No effect
(b)	The speed at which molecules move.	*Ans:*	Decreases
(c)	The number of the molecules.	*Ans:*	Remains the same
(d)	The pressure inside the tube.	*Ans:*	Decreases
(e)	The state of the gas.	*Ans:*	At a very low temperature, it becomes liquid.

05. ***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 pressure on the walls of the tyre?***

Ans: For the car to move there has to be friction between the tyre and the road. Otherwise, the car will go nowhere. Hence a moving car has to do work against this friction. This work results in the transfer of energy to the tyres as heat.

If we consider the tyre to have a volume that is fixed (an approximation as the rubber provides some flexibility in volume) then the pressure law states that "for a fixed mass at constant volume, the pressure is directly proportional to the temperature (in Kelvin)." Hence the increase in temperature will result in an increase in pressure.

In molecular terms, molecules in the tyre collide with the tyre wall resulting in a force, and therefore, pressure on the tyre wall. The increase in temperature increases the kinetic energy, and hence the speed, of the air molecules in the tyre. The increased speed of the molecules will increase the number of collisions per second with the tyre wall. This in turn results in an increased force and therefore increased pressure on the tyre wall.

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

Ans: The kinetic energy of a gas inside of an enclosed space suggests that the gas particles can move anywhere within that space because of their "Random Motion." Due to this, there is an equal chance of an amount of gas being in all areas of the tyre; suggesting that the pressure is all equal too.

(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 doubled.

Ans: The temperature is kept constant and more air is pumped into the tyre until there are twice as many molecules as before. All these molecules collide with each other and against the tyre walls, which means the pressure will be doubled.

06. Describe the following:

(a) What happens to the motion of the molecules of a gas when it cools down?

Ans: If a gas is cooled down, its molecules lose heat; they lose energy and slow down. They move closer to other gas molecules. If we keep cooling down the gas, its particles will eventually stop moving about so fast and form a liquid. This is called condensation.

(b) What happens to the motion of a liquid when it cools down?

Ans: If a liquid is cooled down, its molecules lose heat; they lose energy and slow down. They move closer to other liquid molecules. If we keep cooling down the liquid, the molecules in a liquid stop moving about and settle into a stable arrangement, forming a solid. This is called freezing.

Gases and Kinetic Theory

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

Ans: See "Solved Numerical" – Q.1

02. A container holds $30m^3$ of air at a pressure of 150000 Pa. 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.

Ans: See "Solved Numerical" – Q.2

03. 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 $100dm^3$ to $150cm^3$, the temperature remains constant. What will be the pressure of the air becomes?

Ans: See "Solved Numerical" – Q.3