Chapter 5 The Physical States of Matter

Section A Multiple Choice Questions (M.C.Qs)

Tick mark (✓) the correct answer:

01. ***Which of the following gas diffuses fastest?***
(a) Hydrogen (b) chlorine (c) fluorine (d) helium

02. ***The vapour pressure of a liquid increase with the:***
(a) increase of pressure (b) increase of temperature
(c) increase of intermolecular forces (d) increase the polarity of molecules

03. ***The freezing point depends upon:***
(a) nature of liquid (b) pressure (c) temperature (d) volume

04. ***One atmospheric pressure is equal to:***
(a) 10325 Pascal (b) 106075 Pascal (c) 10523 Pascal (d) 101325 Pascal

05. ***Which of the following does not affect the boiling point?***
(a) Intermolecular forces (b) External pressure
(c) Initial temperature of liquid (d) Nature of liquid

06. ***The mobility of liquids is lesser than:***
(a) solids (b) gases
(c) plasma (d) Bose Einstein condensate

07. ***Which of the following have a sharp melting point in solids?***
(a) Plastic (b) Rubber (c) Glass (d) Diamond

08. ***Which of the following are the lightest form of matter?***
(a) Solid (b) Liquid (c) Gases (d) Plasma

09. ***The liquid molecules leave the surface of the liquid in the evaporation process because :***
(a) energy is low (b) energy is moderate
(c) energy is high (d) None of these

10. ***The density of gases increases when its:***
(a) pressure increased (b) temperature increased
(c) volume increased (d) None of these

11. ***Anything which has mass and occupies space is the definition of:***
(a) matter (b) atom (c) space (d) mass

12. ***A gas has no fixed:***
(a) mass (b) weight (c) volume (d) density

13. ***It can easily be compressed and expanded.***
(a) Liquid (b) Gas (c) Solid (d) Plasma

14. ***Liquid has no fixed:***
(a) mass *(b)* weight *(c)* volume *(d)* shape

15. ***The different physical states of matter are due to:***
(a) arrangement of molecules *(b)* intermolecular forces
(c) Both 'a' & 'b' *(d)* None of them

16. **The gaseous state molecules are lying away from one another, this assumption was proposed by:**
(a) Boltzmann *(b)* Maxwell *(c)* Kelvin *(d)* All of them

17. ***Spontaneous mixing of molecules by random motion and collision to form a homogenous mixture is called:***
(a) Diffusion *(b)* Effusion *(c)* Mobility *(d)* Compressibility

18. ***Gases are rapidly diffusible and depend upon the:***
(a) the atomic mass of the gases *(b)* molecular mass of the gases
(c) the density of the gases *(d)* temperature of the gases

19. ***It is the movement of particles from an area of high concentration to one of low concentration.***
(a) Diffusion *(b)* Effusion *(c)* Mobility *(d)* Compressibility

20. ***The rate of diffusion does not depend upon:***
(a) temperature *(b)* viscosity of the medium
(c) volume *(d)* the size & mass of the particles

21. ***This is NOT an example of diffusion.***
(a) You can smell perfume *(b)* Garbage stinks
(c) Smoke in the air *(d)* Leakage of air through a tyre pinhole

22. ***It is escaping of gas molecules through a tiny hole into space with lesser pressure.***
(a) Diffusion *(b)* Effusion *(c)* Mobility *(d)* Compressibility

23. ***Effusion depends upon:***
(a) molecular masses of gases *(b)* viscosity of the medium
(c) the size & mass of the particles *(d)* temperature

24. ***Which of the following gas effuses rapidly?***
(a) Hydrogen *(b)* Chlorine *(c)* Fluorine *(d)* Helium

25. ***It is an example of effusion.***
(a) You can smell perfume *(b)* Garbage stinks
(c) Leakage of helium through gas balloons *(d)* Smoke in the air

26. ***The force exerted by gaseous particles per unit area is called:***
(a) viscosity *(b)* density *(c)* rigidity *(d)* gas pressure

27. ***Pressure = :***
(a) Force x Area *(b)* $\frac{Force}{Area}$ *(c)* $\frac{Area}{Force}$ *(d)* $\frac{Force \times Area}{2}$

28. ***S.I. unit of pressure is:***
(a) Nm^2 *(b)* Nm^{-2} *(c)* N^{2m} *(d)* N^{-2m}

29. ***It is used to measure the atmospheric pressure.***
(a) Barometer *(b)* Manometer *(c)* Lactometer *(d)* Ammeter

30. ***The capacity of something to be flattened or reduced in size by pressure is called:***
(a) density *(b)* mobility *(c)* effusion *(d)* compressibility

31. ***The gases are highly compressible due to:***
(*a*) the size & mass of the particles (*b*) molecular masses of gases
(*c*) larger spaces between their molecules (*d*) density of gases

32. ***It is degree of compactness or closeness of a molecules.***
(*a*) Mobility (*b*) Density (*c*) Effusion (*d*) Diffusion

33. ***Gases have:***
(*a*) low density (*b*) moderate density (*c*) high density (*d*) zero density

34. ***Gas density is expressed in:***
(*a*) Nm^2 (*b*) kelvin (*c*) pascal (*d*) grams per dm^3

35. ***At constant temperature, the volume of a given mass of a gas is inversely proportional to its:***
(*a*) density (*b*) weight (*c*) pressure (*d*) viscosity

36. ***At constant temperature, according to Boyle's law the volume of a given mass of a gas:***
(*a*) decreases with the increase of pressure (*b*) decreases with the decrease of pressure
(*c*) decreases with the increase of density (*d*) decreases with the decrease of density

37. ***Mathematical representation of Boyle's Law is:***
(*a*) $\frac{P}{V} = K$ (*b*) $PV = K$ (*c*) $\frac{V}{T} = K$ (*d*) $VT = K$

38. ***The average distance that a gas particle travels between successive collisions with other gas particles is called:***
(*a*) average path (*b*) independent path (*c*) free path (*d*) mean free path

39. ***1 atm =:***
(*a*) 760 mm of Hg (*b*) 780 torr (*c*) 103325 pascal (*d*) All of these

40. ***If the pressure is kept constant, the volume of a given mass of a gas is:***
(*a*) directly proportional to atmospheric pressure
(*b*) inversely proportional to atmospheric pressure
(*c*) directly proportional to the absolute temperature
(*d*) inversely proportional to the absolute temperature

41. ***Mathematical representation of Charles's Law is:***
(*a*) $\frac{P}{V} = K$ (*b*) $PV = K$ (*c*) $\frac{V}{T} = K$ (*d*) $VT = K$

42. ***Zero of absolute temperature scale or Kelvin scale is equal to:***
(*a*) 273°C (*b*) −273°C (*c*) 273°F (*d*) −273°F

43. ***At absolute zero (-273°C), an ideal gas would have:***
(*a*) zero volume (*b*) minimum volume (*c*) maximum volume (*d*) None of these

44. ***273 kelvin is equal to:***
(*a*) - 273 Celsius (*b*) 273 Celsius (*c*) 100 Celsius (*d*) zero Celsius

45. ***Which one is correct?***
(*a*) (T)°C = (T) K + 273 (*b*) (T)°C = (T) K - 273 (*c*) (T)°C = - 273 -(T) K (*d*) None of them

46. ***The boiling point of liquids depends on the:***
(*a*) temperature in Celsius (*b*) temperature in kelvin
(*c*) external atmospheric pressure (*d*) volume of the liquid

47. ***Evaporation is directly proportional to the:***
(*a*) volume of the liquid (*b*) temperature
(*c*) pressure (*d*) density

48. *The evaporation is considered as:*
(a) cooling process (b) heating process (c) reversible process (d) convertible process

49. *Neither definite shape nor volume is the property of:*
(a) solid (b) gas (c) liquid (d) None of them

50. *The process in which molecules escape from the surface of a liquid is called:*
(a) effusion (b) evaporation (c) boiling (d) melting

51. *A gas posseses neither definite shape nor definite:*
(a) volume (b) power (c) energy (d) density

52. *The intermediate state between solid and gas is:*
(a) plasma (b) liquid
(c) Bose Einstein condensate (d) All of them

53. *If the surface area is greater than rate of evaporation is:*
(a) zero (b) moderate (c) lower (d) higher

54. *The rate of evaporation increases with:*
(a) less intermolecular forces (b) strong intermolecular forces
(c) Both 'a' & 'b' (d) None of these

55. *Vapour pressure depends on:*
(a) nature of liquid (b) size of molecules (c) temperatue (d) All of them

56. *The temperature at which vapour pressure of a liquid become equal to atmospheric pressure is called:*
(a) evaporation of the liquid (b) boiling point of the liquid
(c) melting point of the liquid (d) freezing point of the liquid

57. *The boiling point is directly proportional to:*
(a) temperature (b) density
(c) atmospheric pressure (d) volume

58. *The temperature at which the vapour pressure of a liquid state becomes equal to the vapour pressure of its solid state is known as:*
(a) evaporation of the liquid (b) boiling point of the liquid
(c) melting point of the liquid (d) freezing point of the liquid

59. *At this temperature liquid and solid coexist in dynamic equilibrium.*
(a) evaporation of the liquid (b) boiling point of the liquid
(c) melting point of the liquid (d) freezing point of the liquid

60. *The energy that molecules have is:*
(a) potential energy (b) kinetic energy (c) atomic energy (d) molecular energy

61. *The liquids diffuse less rapidly than:*
(a) solids (b) gases
(c) plasma (d) Bose Einstein condensate

62. *Density can be expressed as D =:*
(a) $\frac{\text{mass}}{\text{volume}}$ (b) $\frac{\text{volume}}{\text{mass}}$ (c) $\frac{\text{mass}}{2(\text{volume})}$ (d) mass × volume

63. *If we increase temperature, the density of a liquid will:*
(a) become zero (b) decrease (c) increase (d) None of these

64. *The solids in which molecules are arranged in definite three dimensional geometrical pattern ares called:*
(a) powder (b) dense solids (c) amorphous solids (d) crystalline solids

65. ***The solids in which molecules are not arranged in geometrical pattern are called:***
(a) powder (b) dense solids (c) amorphous solids (d) crystalline solids

66. ***Which one of these is NOT an amorphous solid?***
(a) Sodium Chloride (b) Glass (c) Rubber (d) Plastic

67. ***Which one of these is a crystalline solid?***
(a) Glass (b) Diamond (c) Rubber (d) Plastic

68. ***The existence of an element in more than one crystalline forms is known as:***
(a) cosmogenic (b) radioactivity (c) allotropy (d) isotope

69. ***Diamond and graphite are the allotropic form of:***
(a) sodium (b) gold (c) Sulphur (d) carbon

70. ***In this form, the carbon atoms are bonded together in spheres, cylinders or egg-shaped formations.***
(a) Diamond (b) Graphite (c) Graphane (d) Fullerenes

71. ***English scientist William Crookes identify the fourth states of matter known as:***
(a) gas (b) liquid
(c) plasma (d) Bose Einestein condensate

72. ***It is plasma naturally.***
(a) Lightning (b) Lava formation (c) Center of the earth (d) All of these

73. ***It is super-hot and super excited atoms:***
(a) Plasma (b) Bose Einestein condensate
(c) Both 'a' & 'b' (d) None of these

74. ***Atoms are super unexcited and super cold in:***
(a) Plasma (b) Bose Einestein condensate
(c) Both 'a' & 'b' (d) None of these

Answers

01.	(a)	11.	(a)	21.	(d)	31.	(c)	41.	(c)	51.	(a)	61.	(c)	71.	(c)
02.	(b)	12.	(c)	22.	(b)	32.	(b)	42.	(b)	52.	(b)	62.	(a)	72.	(a)
03.	(c)	13.	(b)	23.	(a)	33.	(a)	43.	(a)	53.	(d)	63.	(b)	73.	(a)
04.	(d)	14.	(d)	24.	(a)	34.	(d)	44.	(d)	54.	(a)	64.	(d)	74.	(b)
05.	(c)	15.	(c)	25.	(c)	35.	(c)	45.	(b)	55.	(d)	65.	(c)		
06.	(b)	16.	(d)	26.	(d)	36.	(a)	46.	(c)	56.	(b)	66.	(a)		
07.	(d)	17.	(a)	27.	(b)	37.	(b)	47.	(b)	57.	(c)	67.	(b)		
08.	(d)	18.	(b)	28.	(b)	38.	(d)	48.	(a)	58.	(d)	68.	(c)		
09.	(c)	19.	(a)	29.	(a)	39.	(a)	49.	(b)	59.	(d)	69.	(d)		
10.	(d)	20.	(c)	30.	(d)	40.	(c)	50.	(b)	60.	(b)	70.	(d)		

Section B&C — Short & Detailed Answer Questions

Q.1 Define matter and its states.

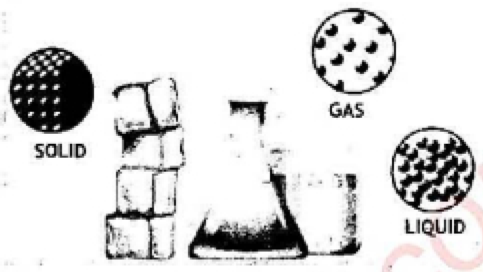
Ans: ***Matter:*** As we know that matter is the physical material of the universe. It is defined as anything which has mass and occupies space.

States of Matter: These states differ in some observable properties.

(i) ***Gas:*** A gas has no fixed volume and shape; it can easily be compressed and expanded.

(ii) ***Liquid:*** A liquid state has no fixed shape but has fixed volume it cannot be compressed easily.

(iii) **Solid:** A solid has a definite shape and volume, it cannot be compressed easily. In addition to the above three states, there are two more states of matter named plasma state and Bose-Einstein condensate. The different physical states of matter are due to the arrangement of molecules and intermolecular forces.



Q.2 *Describe the characteristics of the gaseous state.*

Ans: ***Characteristics of Gaseous State:*** The gaseous state molecules are lying away from one another, this assumption was proposed by Boltzmann, Maxwell, Kelvin. They explain the behaviour of gases according to their kinetic molecular theory. Gaseous state shows the following characteristics.

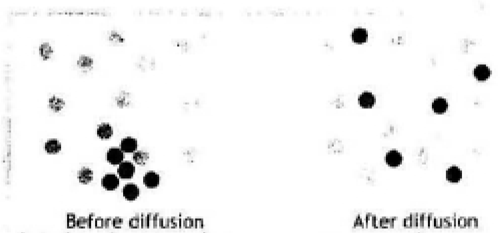
- *(i)* The molecules in gases are widely separated from each other.
- *(ii)* The molecules have negligible volume.
- *(iii)* The gas molecules are in constant random motion.
- *(iv)* The gas molecules move in a straight line until they collide with each other or the wall of the container.
- *(v)* On collision molecules do not lose energy because they are elastic in nature.
- *(vi)* Pressure produced when molecules collide with the wall of the container.
- *(vii)* There are attractive and repulsive forces between molecules.

Q.3 *Name the properties of gases.*

Ans: The kinetic molecular theory explains the behavior of gases such as:
(i) diffusion, (ii) effusion, (iii) pressure, (iv) compressibility, (v) mobility, and (vi) density

Q.4 *Define and explain the diffusion of gases with examples.*

Ans: ***Diffusion:*** Diffusion is defined as the spontaneous mixing of molecules by random motion and collision to form a homogenous mixture. Gases are rapidly diffusible and depend upon the molecular mass of the gases. Lighter gases diffuse rapidly than heavier gases. As H_2 diffuses four times more than O_2.



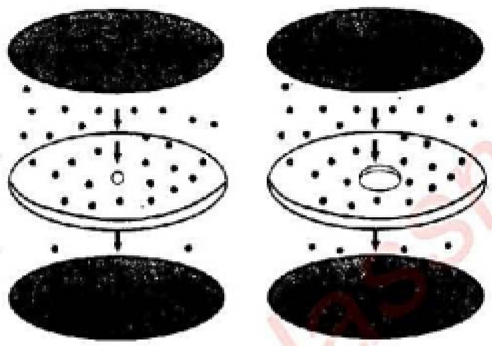
Gharam's Law of diffusion

Diffusion is the movement of particles from an area of high concentration to one of low concentration.
The rate of this movement depends upon:
(i) temperature, (ii) viscosity of the medium, and (iii) the size mass of the particles.
Diffusion results in the gradual mixing of materials, and eventually, it forms a homogeneous mixture.

Examples:
(i) We can smell perfume because it diffuses into the air and makes its way into our nose.
(ii) Smoke diffuses into the air.
(iii) Flower smell or garbage stink or body odour.

Q.5 *What is the effusion of gases? Give its examples.*

Ans: ***Effusion:*** The effusion is escaping gas molecules through a tiny hole into space with lesser pressure. Effusion depends upon the molecular masses of gases. Lighter gases effuse rapidly than heavier gases. For the process of effusion, the diameter of the hole must be smaller than the molecule's mean free path.

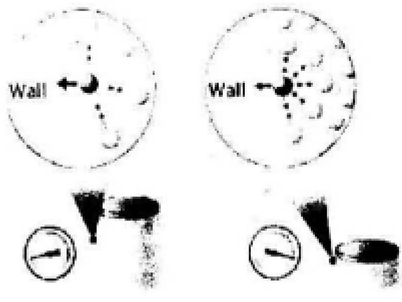


Examples: *(i)* Leakage of air through a tyre pinhole.
(ii) Leakage of helium through gas balloons.

Q.6 *Define mean free path.*

Ans: ***Mean Free Path:*** Mean Free Path is the average distance that a gas particle travels between successive collisions with other gas particles.

Q.7 *Define pressure. Give it expression and unit.*



(a) Low pressure **(b) High pressure**

Ans: ***Pressure:*** The force exerted by gaseous particles per unit area is called gas pressure. It can be expressed mathematically as.

Pressure = Force/Area or $P = F/A = N/m^2$

Unit: The S.I unit of force is Newton (N) and the unit of area is m^2, hence pressure has an S.I unit of Nm^2. It is also known as Pascal (Pa). 1 Pascal = 1 Nm^{-2}.

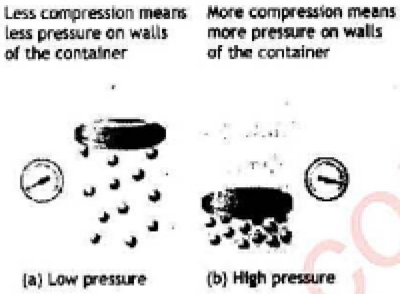
The molecules of gases are in continuous motion, but the pressure is developed by the collisions of molecules of gas with the walls of the container. A barometer is used to measure the atmospheric pressure and a manometer is used to measure the pressure and in the laboratory.

Q.8 *What is atmospheric pressure?*

Ans: ***Atmospheric Pressure:*** It is the pressure exerted by the atmosphere at sea level. It is defined as the pressure exerted by a mercury column of 760 mm height at sea level.

1 atm = 760 mm of Hg = 760 torr
1 atm = 101325 pascal

Q.9 Describe the compressibility of gases.



Ans: ***Compressibility:*** The capacity of something to be flattened or reduced in size by pressure is called compressibility. The gases are highly compressible due to the larger spaces between their molecules. When gases are compressed, the molecules come closer to one another and occupy less volume as compared to the volume of uncompressed state.

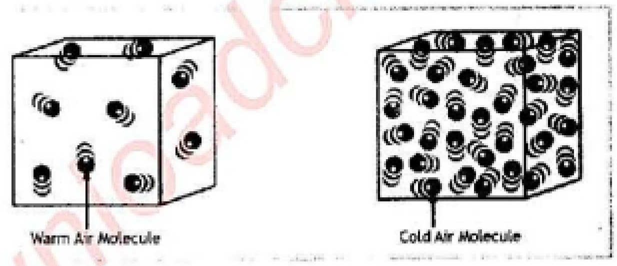
Q.10 Define mobility of gases.

Ans: ***Mobility of Gases:*** The ability to move freely is known as mobility. As the gas molecules are in continuous motion, they can move fast due to high kinetic energy. The molecules move freely in the empty space. This mobility is responsible to produce a homogenous mixture of gases.

Q.11 Define density. What do you know about the density of gases?

Ans: ***Density:*** The density is the degree of compactness or closeness of molecules.

The Density of Gases: Gases have low density because of light mass and more volume occupied by the gas molecules. Gas density is expressed in grams per dm^3. Gases are less denser than liquid. The density of gases can be increased by cooling.



Density of Gases

Density Different Gases

Gas	Chemical formula	Density Kg/m³
Oxygen	O_2	1.407
Chlorine	Cl_2	3.120
Carbon dioxide	CO_2	1.935
Hydrogen	H_2	0.088
Nitrogen	N_2	1.232
Helium	He	0.176

Q.12 Explain that effusion depends on mean free path?

Ans: Not only do gaseous particles move with high kinetic energy, but their small size enables them to move through small openings as well; this process is known as effusion. For effusion to occur, the hole's diameter must be smaller than the molecules' mean free path (the average distance that a gas particle travels between successive collisions with other gas particles). The opening of the hole must be smaller than the mean free path because otherwise, the gas could move back and forth through the hole. Therefore, effusion depends on the mean free path.

Q.13 State and explain Boyle's law.

Ans: **Boyle's Law:** In 1662 Robert Boyle proposed gaseous law about the relationship between volume and pressure of a gas at a constant temperature.

Statement: Boyles law states that "The volume of a given mass of a gas is inversely proportional to its pressure, at constant temperature" .

Mathematical Representation of Boyle's Law: According to Boyle's law the volume (V) of a given mass of a gas decreases with the increase of pressure (P) at a constant temperature.

$V \propto 1/P$ or $V = K/P$ where K = is the constart

$PV = K$

The product of pressure and volume of a gas at constant temperature is always constant where K is the same as the amount of given gas. Therefore the product of pressure and volume of a fixed mass of a gas is constant at a constant temperature.

If $P_1V_1 = K$ then $P_2V_2 = K$

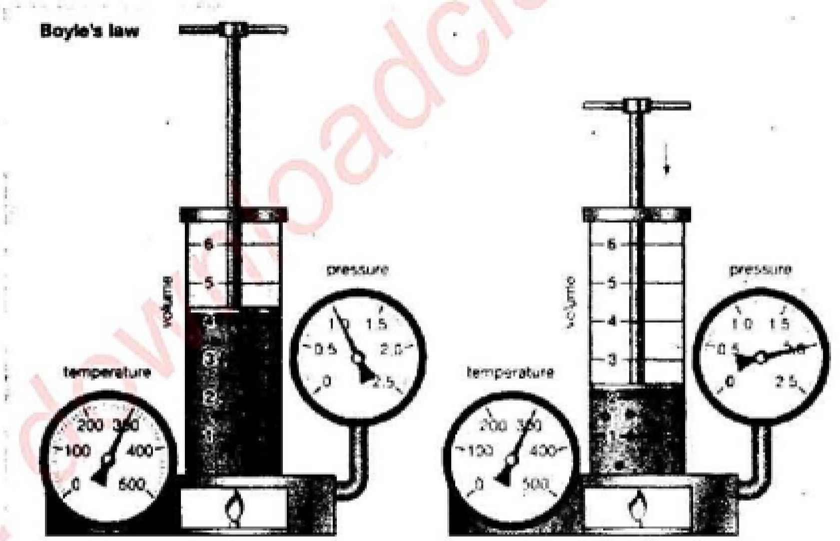
where P_1 = initial pressure P_2 = final pressure

V_1 = initial volume V_2 = final volume

As both equations have some constant therefore their variable are also equal to each other so

$$P_1V_1 = P_2V_2$$

This equation establishes a relationship between pressure and volume the relationship between volume and pressure can be well defined from the following figure.



Where the given mass of a gas at constant temperature shows an increase in volume by a decrease in pressure. On the other hand increase in pressure decreases volume. But the product of pressure and is constant in both cases. (see the following table)

Boyle's Relationship between Pressure and Volume

P (Change in pressure)		V (Change in volume)		K (Constant pressure)
1.0	x	4	=	4
2.0	x	2	=	4

Q.14 Describe Charle's law with its expression.

Ans: ***Charles's Law:*** In 1787 French scientist J. Charles proposed his law to explain the relationship between volume and temperature keeping the pressure constant.

Statement: He states that "the volume of a given mass of a gas is directly proportional to the absolute temperature if the pressure is kept constant".

Mathematical Representation of Charles's Law: According to Charle's law if the temperature of a gas is increased, its volume will also increase.

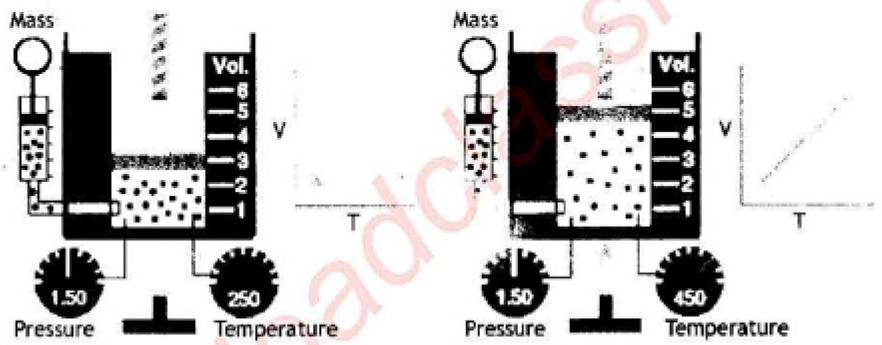
Mathematically it is represented as

$$V \propto T$$

Or $$V = KT$$

$$\frac{V}{T} = K$$

where K is proportionality constant. Then when temperature increases the volume also increases. For example, that if we double the temperature from 300 K to 600 K, at constant pressure, the volume of a fixed mass of the gas will become double (see the following figure).



If we have gas at a certain temperature (T_1) and volume (V_1). If we change the temperature (T_1) to a new value (T_2), the volume (V_1) changes to a new value (V_2). We can use Charles's law to describe both sets of conditions:

$$\frac{V_1}{T_1} = K$$

$$\frac{V_2}{T_2} = K$$

The constant, K, is the same in both cases, therefore

$$\frac{V_1}{T_1} = \frac{V_1}{T_1}$$

DO YOU KNOW?

Always convert the temperature scale from °C to K while solving problems.

K = 273 + °C

Q.15 What do you know about the absolute temperature scale?

Ans: **Absolute Temperature Scale:** Lord Kelvin introduced the absolute temperature scale or Kelvin scale. It starts from zero (0 K which is equal to –273°C). It is the temperature at which an ideal gas would have zero volume and known as absolute zero.

As Celsius and Kelvin scales have equal degree range therefore when zero Kelvin is equal to –273 Celsius and, and 273 Kelvin is equal to zero Celsius.

Conversion of Kelvin Temperature and Celsius Temperature: Conversion of Kelvin temperature and Celsius temperature is vice versa as follows:

$$(T)\,K = (T)\,^\circ C + 273$$

$$(T)\,^\circ C = (T)\,K - 273$$

Q.16 Which variables are kept constant in Boyle's law?

Ans: The constant variable in Boyle's law will only be temperature.

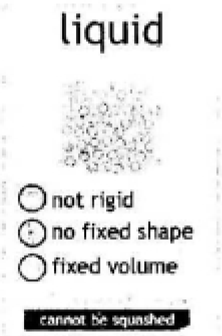
Q.17 When gas is allowed to expand, what will be the effect on its temperature?
OR Can you reduce the temperature of a gas by increasing its volume?

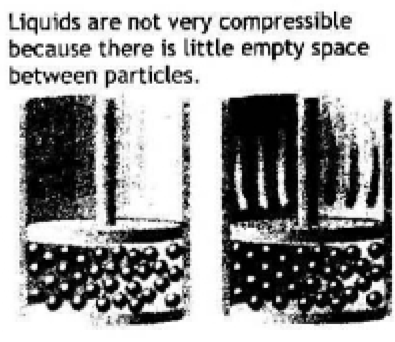
Ans: When air expands, the volume occupied by the air/gas increases, the number of molecules or atoms per unit volume decreases, thus the frequency of atomic collisions decrease (no. of times the atoms collide, thus decreasing the pressure). And the kinetic energy (heat) of all the particles is taken into account and divided by the volume to give energy density a.k.a temperature. Thus the temperature of the gas decreases as the volume increases.

Q.18 Describe the characteristics of liquids according to kinetic molecular theory.

Ans: **Characteristics of Liquids:** The liquid state is the intermediate between gaseous and solid states. According to their kinetic molecular theory liquid state shows the following characteristics.

(i) The molecules of a liquid are randomly arranged like gases.
(ii) The molecules of liquids have less kinetic energy than gases.
(iii) The molecules of liquids are fairly free to move.
(iv) The liquids have no definite shape but assume the shape of the container.
(v) The boiling point of liquids depends on the external atmospheric pressure.
(vi) The liquids are denser and not compressible like gasses.





Q.19 Name the properties of liquids.

Ans: Main properties of liquids are as follows:

(i) Evaporation *(ii)* Vapour pressure *(iii)* Boiling point *(iv)* Freezing point
(v) Diffusion *(vi)* Mobility *(vii)* Density

Q.20 Explain evaporation and describe the factors affecting evaporation.

Ans: ***Evaporation:*** The process by which a liquid changes to a gas phase is called evaporation. Evaporation is an endothermic reaction in which heat is absorbed.

For example, clothes dry under the sun due to evaporation in this process water is converted from a liquid state into vapours by acquiring from

Water (liquid) ⟶ vapour (gas)

The molecules of liquids are in continuous motion they collide with each other but all the molecules do not have the same kinetic energy. The majority of molecules have average kinetic energy and few have more than average kinetic energy. The molecules, having more than average kinetic energy overcome the attractive forces among the molecules and escape from the surface evaporation. It is directly proportional to temperature and increases with the increase in temperature.

The evaporation is also considered as a cooling process because when high kinetic energy molecules escape in the air in the form of vapour the temperature of the remaining molecules falls. To compensate for this deficiency of energy molecules absorb energy from the surrounding, due to which temperature of surrounding decreases and feel cold.

Factors Affecting Evaporation:

(i) ***Surface Area:*** Evaporation is a surface-based process. The greater the surface area greater is evaporation. For example, water left in a bowl evaporates slowly than water left in a large tub. A saucer is used to cool the tea quickly than a teacup.

(ii) ***Temperature:*** The rate of evaporation increases with the increase in temperature. Because temperature increases the kinetic molecular energy which overcomes the intermolecular forces and makes evaporation rapidly. For example, clothes dry quickly on a sunny day than on a cloudy day.

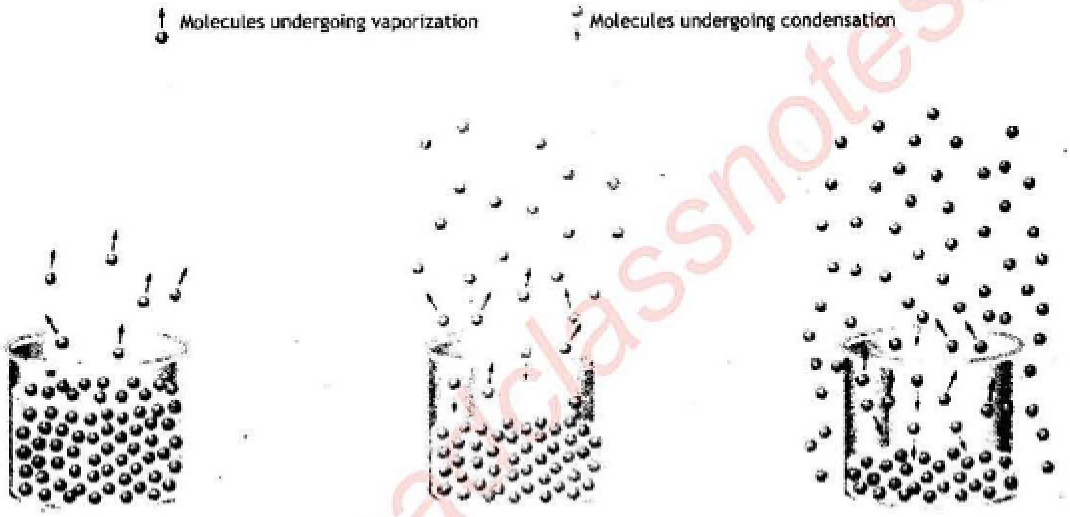
(iii) ***Intermolecular Forces:*** The rate of evaporation increases with fewer intermolecular forces. If intermolecular forces are stronger evaporation is lesser. For example, perfume has lesser intermolecular forces than water therefore it evaporates quickly.

Q.21 Define vapour pressure and describe the factors affecting vapour pressure.

Ans: ***Vapour Pressure:*** The pressure exerted by vapours in equilibrium on a pure liquid at a particular temperature is called Vapour Pressure. The equilibrium is a state when the rate of evaporation is equal to the rate of condensation but in opposite directions.

$$\text{Liquid} \underset{\text{Vaporize}}{\overset{\text{Condensation}}{\rightleftharpoons}} \text{Vapours}$$

Vapour pressure takes place in a closed system because in an open system or open surface liquid molecule evaporates and mix-up with air.



(a) Vaporization (b) Vaporization rate > condensation rate (c) Vaporization rate = condensation rate

Evaporated molecules start gathering over the liquid surface. Initially, the vapour condenses slowly to return to liquid. After sometimes condensation process increases and a stage reaches when the rate of evaporation becomes equal to the rate of condensation. At that stage the number of molecules evaporate will be equal to the number of molecules condensate (coming back) to liquid. At this point where pressure exerted by the vapour is called vapour pressure. The unit of pressure is expressed in mm of Hg, atmosphere, torr or newton.

Factors Affecting Vapour Pressure:

(i) ***Nature of Liquid:*** The vapour pressure depends upon the nature of liquids. Polar liquids have low vapour pressure than non-polar liquids at the same temperature. It is because of the strong intermolecular forces of molecules and the high boiling point in the polar liquids. For example, water (polar liquid) has less vapour pressure than alcohol (non-polar liquid).

(ii) ***Size of Molecules:*** The vapour pressure is more in small size molecules because small sized molecules evaporate easily and exert more vapour pressure. For example, hexane (C_6H_{14}) has a small size molecule as compared to decane ($C_{10}H_{22}$), due to this hexane evaporates rapidly and exert more pressure.

(iii) ***Temperature:*** The vapour pressure increases with the rise of temperature. The average kinetic energy of molecules increases with temperature which causes an increase in vapour pressure. For example, the vapour pressure of water at 0° is 4.58 mm Hg while at $100^{\circ}C$ it increases up to 760 mm Hg.

Q.22 What do you know about boiling point and factor affecting the boiling point of a liquid?

Ans: ***Boiling Point:*** The temperature at which the vapour pressure of a liquid becomes equal to atmospheric pressure is called the boiling point of the liquid. When the liquid is heated, bubbles begin to form throughout its volume. The bubbles contain vapour pressure which being lighter than the liquid rise to surface and burst. The vapour pressure in a bubble is equal to atmospheric pressure. All bubbles containing vapours will rise to the surface of the liquid and burst into the air. It appears that water is boiling. The boiling point varies with the atmospheric pressure.

Factors Affecting Boiling Point:

(i) ***Atmospheric Pressure:*** The boiling point is directly proportional to atmospheric pressure. The boiling point can be increased by increasing atmospheric pressure. For example, working of a pressure cooker.

(ii) ***Nature of Liquid:*** The boiling point depends upon the nature of liquid as polar liquids have high boiling point than non-polar liquids because polar liquids have stronger intermolecular forces than non-polar liquids. Boiling points of few liquids are given in the following table.

Boiling Points of Some Common Liquids

S.No	Liquids	Boiling (°C)
1.	Diethyl ether	34.6
2.	Ethyl alcohol	78
3.	Water	100
4.	n-octane	126
5.	Acetic acid	118
6.	Mercury	356
7.	Sulphuric acid	330
8.	Bromine	58.8

(iii) ***Intermolecular Forces:*** Intermolecular forces play a very important role in the boiling points of liquids. Substances having stronger intermolecular forces have high boiling points because such liquids attain a level of vapour pressure equal to external pressure at high temperature.

Q.23 Describe the freezing point and factors affecting the freezing point.

Ans: ***Freezing Point:*** The temperature at which the vapour pressure of a liquid state becomes equal to the vapour pressure of its solid state is known as the freezing point of a liquid. At this temperature liquid and solid coexist in dynamic equilibrium.

Factors Affecting Freezing Point: The freezing point depends upon the temperature and intermolecular forces. Molecules with stronger intermolecular forces are pulled together to form a solid at high temperature. Due to this, they show a high freezing point. Molecules with lower intermolecular forces solidify at a lower temperature.

Freezing points of few liquids are given in the following table.

Freezing Points of Some Common Liquids

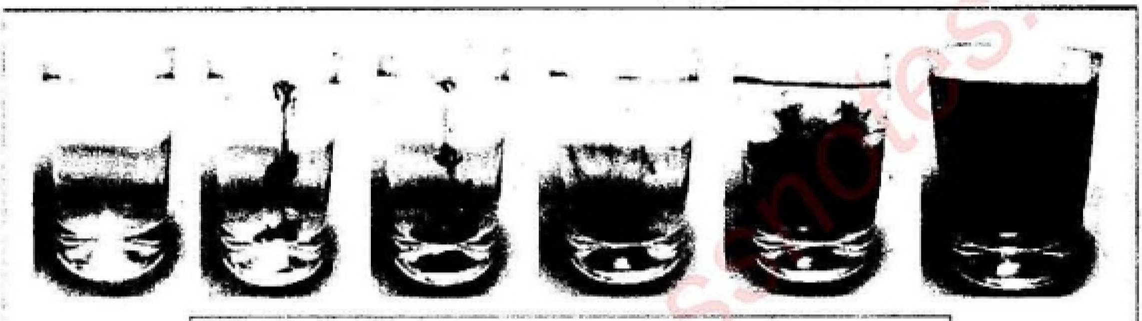
S.No	Liquids	Freezing point °C
1.	Benzene	5.12
2.	Ethyl alcohol	-114
3.	Water	0.0
4.	Acetic acid	16.6
5.	Mercury	-38.33
6.	Sulphuric acid	103
7.	Bromine	-7.2

Q.24 Explain diffusion in liquids and the factors affecting diffusion.

Ans: **Diffusion:** The diffusion is spreading out of the liquid molecules throughout the vessel. The liquids diffuse less rapidly than gases.

As the molecule of liquid are in a cluster and bounded with strong intermolecular binding forces. The liquid molecules are in continuous motion. They move from high concentration to low concentration and mix up with molecules of others liquids from a homogenous mixture.

For example, when few drops of ink are dropped in a water-filled flask, the molecules move around and after a while spread into the whole flask, thus diffusion takes place as shown in the following figure.



An Ink Drop Gradually Dissolves into a Glass of Water by DIFFUSION

Factors Affecting Diffusion:

(i) **Inter-Molecular Forces:** Liquids have weaker intermolecular forces than solids due to this diffuses faster than solid but less rapidly than gases.

(ii) **Size of Molecules:** Diffusion depends upon the size of molecules the small size of molecules diffuses rapidly than bigger ones. For example, diffusion is slow in water than in alcohol.

(iii) **Shape of Molecules:** Molecules with irregular shape diffuses slowly while regular-shaped molecules diffuse faster because they can easily slip over and move faster.

(iv) **Temperature:** Diffusion increases by increasing temperature because at high temperature intermolecular forces becomes weak due to the high kinetic energy of the molecules.

Q.25 Describe the mobility of liquids and factors affecting them.

Ans: **Mobility of Liquids:** Mobility is the ability to move freely. The molecules in a liquid move freely, due to free movement they can adjust their shape in a container. Due to this reason, liquids can flow.

Factors Affecting Mobility:

(i) **Temperature:** Mobility increases by increasing the temperature. When temperature increases in a liquid movement of molecules increases accordingly.

(ii) **Inter-molecular Forces:** Mobility increases by the decrease in intermolecular forces. The liquids which have strong intermolecular forces show less mobility of molecules.

Q.26 Define and explain the density of liquids and factors affecting the density of liquids.

Ans: **Density of Liquids:** The density of a liquid is defined as mass per unit volume. Liquids are denser than gases due to closely packed molecules and negligible intermolecular spaces. As the closely packed molecules of liquids have strong intermolecular forces they cannot expand freely and shows definite volume which makes liquids denser than gases.

Mathematically, it can be expressed as $D = \frac{M}{V}$

Factors Affecting Density:

(i) ***Temperature:*** Liquids are less affected by the temperature as by increasing temperature liquids increase their volume which decreases density. Different densities of water at different temperature is given in the following table.

Densities of water at different temperature

T(°C)	Density (g/cm³)
0	0.99984
30	0.99565
60	0.98320
90	0.96535

(ii) ***Pressure:*** Liquids are slightly affected by pressure. An increase in pressure on liquids increases the density, but liquids are not readily compressed due to this density change is negligible.

Q.27 *[illegible]ibrium state involved in the vapour pressure of liquids in a closed system?*

Ans: Let us take an example of water. With any body of water, water molecules are always both evaporating and condensing. The vapour pressure of water is the pressure at which the gas phase is in equilibrium with the liquid phase. The high surface tension of water (water "sticks" to itself, so it doesn't "want to" evaporate) means water has a low vapour pressure.

Vapour pressure is constant when there is an equilibrium of water molecules moving between the liquid phase and the gaseous phase, in a closed container.

The vapour pressure of a liquid is the point at which equilibrium pressure is reached, in a closed container, between molecules leaving the liquid and going into the gaseous phase and molecules leaving the gaseous phase and entering the liquid phase. Note the mention of a "closed container". In an open container, the molecules in the gaseous phase will just fly off and equilibrium would not be reached, as many fewer gaseous molecules would be re-entering the liquid phase. Also note that at equilibrium the movement of molecules between liquid and gas does not stop, but the number of molecules in the gaseous phase stays the same—there is always movement between phases. So, at equilibrium there is a certain concentration of molecules in the gaseous phase; the pressure the gas is exerting is the vapour pressure. As for vapour pressure being higher at higher temperatures, when the temperature of a liquid is raised, the added energy in the liquid gives the molecules more energy and they have a greater ability to escape the liquid phase and go into the gaseous phase.

Q.28 *Explain how evaporation causes a cooling effect?*

Ans: See 'Short & Detailed Answer Questions' - Q.20 (Last Paragraph)

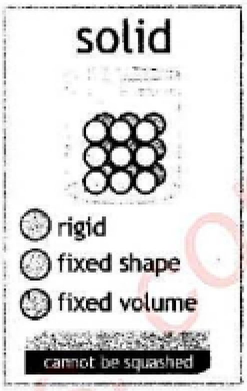
Q.29 *How boiling point of a substance is affected by atmospheric pressure?*

Ans: See 'Short & Detailed Answer Questions' - Q.22 (i)

Q.30 *Describe the characteristics of solids according to kinetic molecular theory.*

Ans: ***Solids State:*** Solids have fixed shape and volume. The molecules in solids are extremely closer to each other, without leaving space between them. According to kinetic molecular theory, solid-state shows the following characteristics:

(i) The molecules in solids are closely packed due to stronger forces of attraction.
(ii) The molecules are unable to move freely as they have little space between them.
(iii) The molecules can vibrate and rotate in their fixed position.
(iv) Solids have a definite shape and definite volume.
(v) Pure solids have a sharp melting point.



Q.31 *Name some properties of solids.*

Ans: Properties of solids are:
(i) melting point *(ii)* rigidity *(iii)* density

Q.32 *Define melting point of solids.*

Ans: ***Melting Point:*** The temperature at which a solid starts melting and coexist in equilibrium with the liquid state is called the melting point. When the temperature is raised the kinetic energy of molecules increases. When continuous heat is supplied to the solid, molecules leave their fixed position and become mobile, at this stage solid starts melting.
The melting points of different solids are given in the following table.

Melting points of solids

S.No	Solids	Melting point °C
1.	Sugar	185
2.	Chocolate	36
3.	Mercury	-38.33
4.	Sodium chloride	801
5.	Water	0

Q.33 *Define rigidity.*

Ans: ***Rigidity:*** The molecular arrangement of solids is closely packed due to this solids are not mobile. They exhibit a vibration at fixed positions. Therefore solids are rigid in their structure.

Q.34 *Define the density of solids.*

Ans: ***Density of Solids:*** The solids are typically denser than a liquid or a gas. Molecules in solid are more tightly packed together because of the greater intermolecular forces. Due to this reason, solids have the highest densities among the three states of matter. Some densities are shown in the following table.

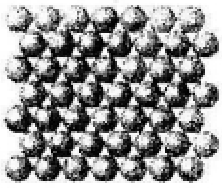
Densities of solids

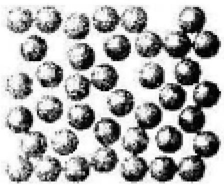
S.No	Solids	Density (g/cm^3)
1.	Aluminum	2.70
2.	Iron	7.86
3.	Gold	19.3
4.	Sodium chloride	2.16
5.	Sugar	1.59

Q.35 *Name the types of solid based on the arrangement of molecules.*

Ans: The solids are classified based on the arrangement of molecules. There are two types of solids

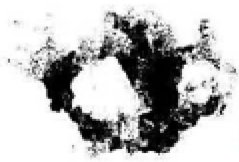
which as follows:
(i) Crystalline solids (ii) Amorphous solids


Crystalline


Amorphous

Q.36 Write few lines on crystalline solids.

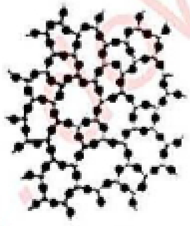
Ans: ***Crystalline Solids:*** The solids in which molecules are arranged in the definite three-dimensional geometrical pattern are called crystalline solids. The arranged molecules in solids are bounded biplane surface called faces which intersect each other at a particular angle. The melting point of crystals is sharp. Sodium chloride and diamond are common examples of crystalline solids.


Sodium Chloride


Diamond

Q.37 Define amorphous solids.

Ans: ***Amorphous Solids:*** The solids in which molecules are not arranged in the geometrical pattern are called amorphous solids. They do not have a sharp melting point. Plastic, rubber and glass are examples of amorphous solids.


Amorphous SiO_2 (Glass)


Glass


Rubber

Q.38 What is allotropy? Describe the allotropes of carbon.

Ans: ***Allotropy:*** The existence of an element in more than one crystalline forms is known as allotropy. These forms of the element are called allotropes or allotropic forms. This happens when the atoms of the element are bonded together differently. Different bonding arrangements between atoms result in different structures with different chemical and physical properties. Only some elements like sulphur, phosphorus, carbon and tin are elements that show allotropy.

Allotropes of Carbon: For example, the allotropes of carbon include:

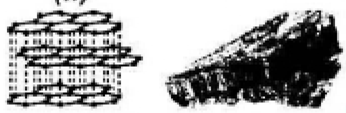
(i) Diamond, where the carbon atoms are bonded together in a four-cornered lattice arrangement.

(i)

Allotropy of Diamond

(ii) Graphite, where the carbon atoms are bonded together in sheets of a six-sided lattice.

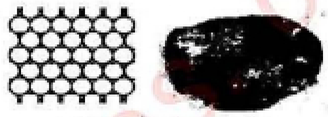
(ii)



Allotropy of Graphite

(iii) Graphane, single sheets of graphite.

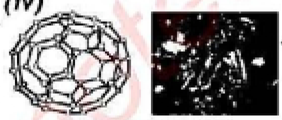
(iii)



Allotropy of Graphene

(iv) Fullerenes, where the carbon atoms are bonded together in spheres, cylinders or egg-shaped formations.

(iv)



Allotropy of Graphite

Q.39 *What do you know about the plasma state?*

Ans: ***Plasma State:*** English scientist William Crookes identify the fourth states of matter known as plasma. It was discovered by adding energy to a gas. As a result, some electrons left their atoms and formed positive and negative ions by ionization. In plasma, these charged particles react strongly to electric and magnetic fields. If plasma loses heat, the ions will re-form into a gas, emitting the energy which had caused them to ionize.

It means that plasma is a distinct state of matter containing a significant number of electrically charged particles that affect its electrical properties and behaviour.

Some examples of daily life are as follow:

(i) Lightning makes plasma naturally.
(ii) The artificial (man-made) uses of plasma include fluorescent light bulbs, neon signs.
(iii) The use of plasma display of television or computer screens.
(iv) The plasma lamps and globes are popular in children's toys and room decoration.
(v) Scientists are experimenting with plasma to make a new kind of nuclear power, called fusion, which will be much better and safer than ordinary nuclear power with less radioactive waste.

Q.40 *Describe Bose-Einstein Condensate (BEC).*

Ans: ***Bose-Einstein Condensate (BEC):*** Two scientists Satyendra Bose and Albert Einstein discovered another state of matter in 1920 but they did not have the equipment and facilities to make it happens at that time. Afterwards in 1995 two other scientists Eric Cornell and Carl Weiman also proposed another state of matter known as Bose-Einstein Condensate (BEC).

They discovered that plasma is super-hot and super excited atoms. The atoms in a Bose-Einstein condensate (BEC) are totally opposite. They are super unexcited and super cold atoms.

Let's explain condensation first. Condensation happens when several gas molecules come together and form a liquid. It all happens because of a loss of energy. Gases are excited or energetic atoms. When they lose energy, they slow down and begin to gather. They can gather into one drop.

For example, when we boil water. Water vapour in the form of steam condenses on the lid of the pot. Vapour cool and become a liquid again. We would then have a condensate.

The BEC happens at super-low temperatures. When we get a temperature near absolute zero, all molecular motion stops due to depletion of energy, and atoms begin to clump. The result of this clumping is the BEC. In common we can not see this state in observable nature, because it is very difficult to reach at very low temperature under normal lab conditions.

Q.41 *Explain the three states of matter on the basis of kinetic theory.*

Ans: The kinetic theory tells about the way particles (atoms or molecules) move about in solid, liquids and gases. The word kinetic comes from the Greek word which means "I move".

Solids:

- Solids have a definite shape and a definite volume.
- Accordingly their particles are packed closely together with strong attractive forces between them.
- They have smaller amount of energy.
- They vibrate about their fixed positions only.

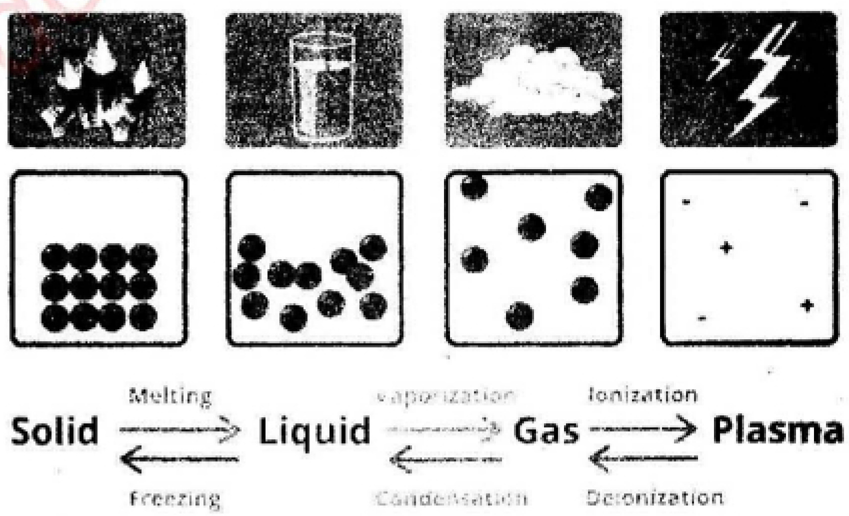
Liquids:

- Liquids do not have fixed shapes.
- They take the shape of the container in which they are kept.
- They have a definite volume.
- They are only slightly compressible and the attraction between the particles is weaker than in solids, therefore, can move freely around each other in a fixed volume.

Gases:

- Gases do not have a definite shape or a definite volume.
- Gases take whatever space is available to them. This is due to diffusion.
- The gases are compressible because the particles of a gas are spaced well apart.
- The attractive forces between the gas particles are weak.

DO YOU KNOW?



Differences

1 Differentiate between crystalline and amorphous solids.

Ans: Difference between Amorphous and Crystalline Solids

Amorphous Solids	Crystalline Solids
They don't have a definite geometrical shape.	They have characteristics of geometrical shape.
Amorphous solids do not have a particular melting point. They melt over a wide range of temperatures.	They have a sharp melting point.
Amorphous solids are isotropic.	Crystalline solids are anisotropic.
Amorphous solids are unsymmetrical.	Crystalline solids are symmetrical.
Amorphous solids do not break at fixed cleavage planes.	Crystalline solids break along a particular direction at fixed cleavage planes.

2 Differentiate between Solid & Liquids:

Ans. **Solid & Liquids**

S. No	Solids	Liquids
1.	The molecules are close together.	The molecules are not close together.
2.	The molecules do not leave their mean position	The molecules leave their mean position.
3.	They are not compressible.	They are little compressible.
4.	They have definite shapes.	They do not have definite shapes.

3 Differentiate between Liquids & Gasses:

Ans. **Liquids & Gasses**

S. No	Liquids	Gases
1.	The molecules are a little apart from each other.	The molecules are very far apart from each other.
2.	The molecules keep moving in a limited space.	The molecules keep moving in all directions.
3.	They are slightly compressible.	They are very compressible.
4.	They have no fixed shape but they have a fixed volume.	They have neither a fixed shape nor a fixed volume.

4 **Differentiate between Boiling & Evaporation:**

Ans. **Boiling & Evaporation**

S. No	Boiling	Evaporation
1.	It takes place at a fixed temperature.	It takes place at all temperatures.
2.	It takes place throughout the liquid.	It takes place only from the surface.
3.	Boiling causes hotness.	Evaporation causes coolness.

Reasons

1. ***Why gases diffuse rapidly? Explain.***

Ans: Gases diffuse rapidly because:

(i) the force of attraction between their particles is very low or negligible,
(ii) the kinetic energy of the particles is very high, and
(iii) there are vast spaces between the particles.

Due to these reasons, the molecules of a gas move at a faster rate, hence making the diffusion rate faster.

2. ***Why density of gases increases on cooling?***

Ans: Gases are made up of tiny particles in random and straight-line motion. They move rapidly and continuously and make collisions with each other and the walls.

When a gas is cooled, its molecules move more slowly and take up less space.

The density of a gas can be termed as a number of molecules per unit volume of the material. With the decrease in temperature, the number of molecules the gas contains per unit volume of it increases. So the density of the gas increases with a decrease in temperature or on cooling.

3. ***Why an increase in temperature causes an increase in the process of evaporation?***

Ans: See 'Short & Detailed Answer Questions' - Q.20

4. ***Why the rate of diffusion in liquids is less than in gases?***

Ans: In gases, molecules are very loosely packed and they will move randomly. In liquids, molecules are loosely packed, the molecules can move slightly. In solids, molecules are tightly packed, the molecules cannot move.

For diffusion, the molecules should move from one place to other. This can only happen when the molecules are loosely packed. So the rate of diffusion of gases is more than liquid and solid.

Rate of diffusion of gases > liquids > solids.

5. ***Gases are compressible whereas solid and liquids are not compressible.***

Ans: There are large intermolecular spaces in gases so they can be compressed. However, in solids and liquids there are not large intermolecular spaces. Hence they can not be compressed.

6. **Liquids change into vapour on heating.**

Ans: On heating, kinetic energy of the molecules increases and the molecules of the liquid overcome the attractive forces holding them together and they leave the surface of water as vapour.

7. ***Solids have definite shapes and volumes.***

Ans: Solids have definite shapes and volumes and their molecules are closely packed with each other and they can not leave their position, so solids have definite shapes and volumes.

8. ***Gases have neither fixed shapes nor fixed volumes***

Ans: In gases, the molecules move very fast in all directions and they are very far apart from each other. The cohesive forces between these molecules are insignificant so they do not have a fixed volume or shape.

9. ***It is easy to compress air than water.***

Ans: In water, the molecules are close together and in air the molecules are at large distances, so the air can be compressed easily.

Section D Numericals:

Solved Examples of the Textbook

Example 5.1: The pressure of a sample gas is 3 atm and the volume is 5 litres. If the pressure is reduced to 2 atm, what will be the new volume?

Data: V_1 = 5 liter P_1 = 3 atm

P_2 = 2 atm V_2 = ?

Solution: $P_1V_1 = P_2V_2$

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

$$V_2 = \frac{3 \times 5}{2} = \frac{15}{2}$$

V_2 = 7.5

The volume will be 7.5 litres. The volume is increased by decreasing the pressure.

Example 5.2: The 700 cm³ of a gas is enclosed in a container under a pressure of 650 mm of Hg. If the volume is reduced to 350 cm³, what will be the pressure then?

Data: $V_1 = 700cm^3$ P_1 = 650mm

$V_2 = 350cm^3$ P_2 = ?

Solution: $P_1V_1 = P_2V_2$

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

By putting the values P_2 = 630 × 700/350 = 1300 mm of Hg

Thus pressure is increased by decreasing volume.

Example 5.3: A 600 ml sample of gas is heated from 27°C to 77°C at constant pressure. What is the final volume?

Data: T_1 = 27°C = 27 + 273 K = 300 K

T_1 = 77°C = 77 + 273 K = 350 K

V_1 = 600ml

Solution: By using the equation

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

or

$$V_2 = \frac{V_1 T_2}{T_1}$$

By putting the values in the equation

$$V_2 = \frac{600 \times 350}{300}$$

$$V_2 = 700 \text{ ml}$$

The volume will become 700 ml, which shows an increase in volume with raising the temperature.

Example 5.4: A sample of Hydrogen gas has a volume of 350 cm^3 at 40°C. If gas is allowed to expand up to 700 cm^3 at constant pressure. Find out its final temperature?

Data: $T_1 = 40°C = 40 + 273 K = 313 K$

$V_1 = 350 cm^3$ $V_2 = 700 cm^3$ $T_2 = ?$

Solution: By using Charle's law equation:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

or

$$T_2 = \frac{V_2 T_1}{V_1}$$

By putting the values

$$T_2 = \frac{700 \times 313}{350}$$

$$T_2 = 626 K$$

The expansion in volume is due to an increase in temperature.

Solved Numericals

1. *Convert the following units :*

(a) **100°C to K** *(b)* **150°C to K** **(c) 780K to °C** **(d) 170 K to °C**

Solution:

(a) **Data:** T°C = 100°C T (K) = ?

Calculation: We know that (T) K = (T) C + 273

Therefore, = 100 + 273 = **373 K** Ans.

(b) **Data:** T°C = 150°C T (K) = ?

Calculation: We know that (T) K = (T)°C + 273

Therefore, = 150 + 273 = **423 K** Ans.

(c) **Data:** T (K) = 780 K T°C = ?

Calculation: We know that (T)°C = (T) K - 273

Therefore, = 780 - 273 = **507°C** Ans.

(c) **Data:** T (K) = 170 K T°C = ?

Calculation: We know that (T)°C = (T) K - 273

Therefore, = 170 - 273 = **-103°C** Ans.

2. It is desired to increase the volume of a fixed amount of gas from 90.5 to 120 cm^3 while holding the pressure constant. What would be the final temperature if the initial temperature is 33°C.

Solution:

Data: T_1 = 33°C = 33 + 273 K = 306 K

V_1 = 90.5 cm^3 V_2 = 120 cm^3 T_2 = ?

Calculation: By using Charles' law equation:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

or $$T_2 = \frac{V_2 T_1}{V_1}$$

By putting the values

$$T_2 = \frac{120 \times 306}{90.5} = \frac{36720}{90.5}$$

$$T_2 = 405.74 \text{ K}$$

or (T)°C = (T) K – 273

= 405.74 – 273 = **132.74°C Ans.**

3. A 78ml sample of gas is heated from 35°C to 80°C at constant pressure. What is the final volume?

Solution:

Data: T_1 = 35°C = 27 + 273 K = 308 K

T_1 = 80°C = 77 + 273 K = 353 K

V_1 = 78 ml

Calculation: By using the equation

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

or $$V_2 = \frac{V_1 T_2}{T_1}$$

By putting the values in the equation

$$V_2 = \frac{78 \times 353}{308}$$

$$V_2 = \boxed{89.39 \text{ ml}}$$

The volume will become 89.39 ml, which shows the increase in volume with raising the temperature.

4. A gas occupies a volume of 40.0 dm^3 at standard temperature (0°C) and pressure (1 atm), when pressure is increased up to 3 atm unchanged temperature what would be the new volume?

Solution:

Data: V_1 = 40.0 dm^3 P_1 = 1 atm

P_2 = 3 atm V_2 = ?

Calculation: $P_1V_1 = P_2V_2$

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

$$V_2 = \frac{1 \times 40}{3} = \frac{40}{3}$$

$$V_2 = \boxed{13.33 \text{ dm}^3}$$

5. The 800 cm^3 of a gas is enclosed in a container under a pressure of 750 mm. If the volume is reduced to 250 cm^3, what will be the pressure?

Solution:

Data: $V_1 = 800\ cm^3$ $P_1 = 750\ mm$

$P_2 = ?$ $V_2 = 250\ cm^3$

Calculation: $P_1V_1 = P_2V_2$

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

$$P_2 = \frac{750 \times 800}{250} = \frac{600000}{250}$$

$$P_2 = \boxed{2400mm}$$

6. The pressure of a sample gas is 8 atm and the volume is 15 litres. If the pressure is reduced to 6 atm, what is the volume?

Solution:

Data: $V_1 = 15$ liters $P_1 = 8$ atm

$P_2 = 6$ atm $V_2 = ?$

Calculation: $P_1V_1 = P_2V_2$

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

$$V_2 = \frac{8 \times 15}{6} = \frac{120}{6}$$

$$V_2 = \boxed{20\ liters}$$

Summary

- The states of matter are solid, liquid, gas, plasma, and BE condensate.
- The kinetic particle theory states that all matter is made up of tiny particles that are in constant random motion.
- Solids have fixed shapes and volumes. They cannot be compressed.
- Liquids do not have fixed shapes. They have fixed volumes and cannot be compressed easily.
- Gases do not have fixed shapes or volumes. They can be compressed.
- Boyle's law states that the volume of a given mass of a gas is inversely proportional to the pressure at a constant temperature.
- Charles law states that the volume of a gas is directly proportional to the absolute temperature at a constant pressure.
- Diffusion is the mixing up of a gas throughout a space or other gases. Gases diffuse very rapidly.
- Effusion is escaping of a gas molecule through a fine hole into an evacuated space.
- The pressure exerted by vapours in equilibrium with their pure liquid at a particular temperature is called vapour pressure.
- The temperature at which the vapour pressure of a liquid becomes equal to atmospheric pressure is called the boiling point of the liquid.
- The density of liquid depends upon mass per unit volume. Affected by temperature and pressure.
- The temperature at which a solid starts melting and coexist in equilibrium with the liquid state is called the melting point.
- The freezing point of a liquid is the temperature at which the vapour pressure of a liquid state is equal to the vapour pressure of a solid-state.
- Solids are rigid and denser than liquid and classified as amorphous and crystalline.
- Amorphous solids are shapeless and do not have a sharp melting point.

- Crystalline solids have a definite three-dimensional pattern of arrangement of molecules. They have a sharp melting point.
- The solids that exist in different physical forms are known as allotropy.
- Plasma is super-hot and super excited atoms.
- The atoms in a Bose-Einstein condensate (BEC) are super unexcited and super cold atoms.

Solution of Textbook Exercise

SECTION-A: MULTIPLE CHOICE QUESTIONS

Tick Mark (✓) the correct answer:

See "Multiple Choice Questions (M.C.Qs)" - (i) to (x)

SECTION-B: SHORT QUESTIONS:

1 ***Define the allotropy with examples.***

Ans: See 'Short & Detailed Answer Questions' - Q.38

2. ***What is effusion? Explain with examples.***

Ans: See 'Short & Detailed Answer Questions' - Q.5

3. ***Define the following? (i) Boiling Point, (ii) Melting Point, (iii) Freezing Point***

Ans: (i) See 'Short & Detailed Answer Questions' - Q.22 (1st two lines)

(ii) See 'Short & Detailed Answer Questions' - Q.32 (1st two lines)

(iii) See 'Short & Detailed Answer Questions' - Q.23 (1st two lines)

4. ***What is density, how the density of a liquid is affected by temperature and pressure?***

Ans: See 'Short & Detailed Answer Questions' - Q.26

5. ***Explain plasma with daily life examples.***

Ans: See 'Short & Detailed Answer Questions' - Q.39

6. ***Justify that atoms of Bose-Einstein condensate are super unexcited and supercooled.***

Ans: See 'Short & Detailed Answer Questions' - Q.40

7. ***How kinetic molecular theory differentiates states of matter?***

Ans: See 'Short & Detailed Answer Questions' - Q.41

SECTION-C: DETAILED QUESTIONS:

1. ***Discuss the property of evaporation in liquids. Which factors affect the evaporation process?***

Ans: See 'Short & Detailed Answer Questions' - Q.20

2. ***Describe Boyle's law with an example.***

Ans: See 'Short & Detailed Answer Questions' - Q.13

3. ***Differentiate between amorphous and Crystalline Solids.***

Ans: See 'Differences' - Q.1

4. ***Define and explain Charles' law of gases.***

Ans: See 'Short & Detailed Answer Questions' - Q.14

5. ***Describe the process of diffusion in liquids. State the factors which influence it.***

Ans: See 'Short & Detailed Answer Questions' - Q.24

6. ***How boiling point is affected by different factors?***

Ans: See 'Short & Detailed Answer Questions' - Q.22

7. ***Define vapour pressure and justify that it is visible in a closed system only.***

Ans: See 'Short & Detailed Answer Questions' - Q.21 & 27

Section-D: NUMERICALS

1. *Convert the following units :*
   (a) 100°C to K (b) 150°C to K (c) 780K to °C (d) 170 K to °C

Ans: See 'Solved Numericals' - Q.1

2. ***It is desired to increase the volume of a fixed amount of gas from 90.5 to 120 cm^3 while holding the pressure constant. What would be the final temperature if the initial temperature is 33°C.***

Ans: See 'Solved Numericals' - Q.2

3. ***A 78ml sample of gas is heated from 35°C to 80°C at constant pressure. What is the final volume?***

Ans: See 'Solved Numericals' - Q.3

4. ***A gas occupies a volume of 40.0 dm^3 at standard temperature (0°C) and pressure (1 atm), when pressure is increased up to 3 atm unchanged temperature what would be the new volume?***

Ans: See 'Solved Numericals' - Q.4

5. ***The 800 cm^3 of a gas is enclosed in a container under a pressure of 750 mm. If the volume is reduced to 250 cm^3, what will be the pressure?***

Ans: See 'Solved Numericals' - Q.5

6. ***The pressure of a sample gas is 8 atm and the volume is 15 litres. If the pressure is reduced to 6 atm, what is the volume?***

Ans: See 'Solved Numericals' - Q.6