UNIT 5

States of matter

I. Questions carrying one mark

5.1 What are van der Waals forces?

5.2 What type of van der Waals force exists between HCl molecules?

5.3 Between which type of molecules does dipole – induced dipole forces exist?

5.4 Even though HF has lower molecular mass compared to HCl, HF is in the liquid state and HCl is in the gaseous state at room temperature .why?

5.5 Why are liquids & solids are hard to compress?

5.6 State Boyle's law

5.7 What happens to the pressure when the volume of a gas is doubled at constant temperature?

5.8 Give the relationship between pressure and density of a gas

5.9 Mountaineers carry oxygen cylinders along with them . Which gas law will account to the above statement?

5.10 Relate absolute temperature scale or Kelvin temperature to Celsius scale.

5.11 If a volume vs temperature graph is plotted in degree centigrade at constant pressure, at what temperature the line cuts the temperature axis?

5.12 Each line of volume vs pressure graph at constant temperature is known as what?

5.13 Define absolute zero temperature

5.14 Represent Charles law graphically

5.15 What is the volume occupied by the gas at -273.15ºC?

5.16 State Gay – Lussac's law

5.17 Equal volumes of all gases under the same condition of temperature and pressure contain equal number of molecules. Name the gas law for the above statement

5.18 Which law relates temperature and pressure ?

5.19 If the numbers of moles of a gas are doubled by keeping the temperature and pressure constant, what would be the new volume of the gas?

5.20 Relate density and molar mass of a gas molecule

5.21 Give the value of R in SI unit.

5.22 Write the value of molar volume of an ideal gas at STP, when pressure is 1bar

5.23 State Dalton's law of partial pressure

5.24 Write a postulate of kinetic molecular theory of gases that explains the great compressibility of gases

5.25 Define aqueous tension

5.26 Why do the gases expand &occupy the entire space available to them?

5.27 How does a gas exert pressure?

5.28 Collision of the gas molecules does not change average kinetic energy.why?

5.29 Write van der Waals equation for ´n' moles of a gas

5.30Write the expression for compressibility factor Z for one mole of a gas.

5.31Define Boyle temperature

5.32 The value of Van der walls constant 'a' for a gas is zero, what does it signify?

5.33 Define boiling point temperature at a given pressure for a liquid

5.34 Give the value for standard boiling point of water

5.35 Define surface energy

5.36 What would be SI unit of a quantity $PV^2 T^2/n$?

5.37 The magnitude of coefficient of viscosity of liquid at 25°C ,45°C, 19ºC and 57°C are p, q, r, s respectively. Arrange them in the increasing value of co-efficient of viscosity

5.38 What is meant by most probable speed of gas molecule ?

5.39 Water has higher vapour pressure than mercury. Justify

5.40 Name the property of the liquid that measures the resistance to the flow of liquid due to internal friction.

5.41 How does the volume of a gas under given temperature and pressure vary with molar mass?

5.42. The size of the weather balloon becomes larger and larger as it ascends up into higher attitude. Which gas law explains the above phenomenon?

5.43 Arrange $U_{rms,}U_{mp,}U_{av}$ in the increasing value for a gas at a given temperature

II. Questions carrying Two marks

5.1 Name two types of forces which determines the physical state of substances

5.2 Write any two important physical properties of gases.

5.3 How does pressure for a given amount of gas vary with volume at a given temperature? Represent this graphically

5.4 In terms of Charles law, explain why -273.15ºC is the lowest possible temperature of gases.

5.5 Represent Charles law graphically. What is each line in the graph known as?

5.6 Write the Avogadro's law. Write the mathematical representation of the law.

5.7 Using ideal gas equation derive an equation that relates density and molar mass of a gaseous substance .

5.8 Deduce the value of R in SI unit

5.9 State Daltons law of partial pressure. How is partial pressure of a gas is related to mole fraction

5.10 Justify: collisions among the molecules in a gas are perfectly elastic

5.11 Two flasks of equal volumes contains nitrogen and oxygen gases at the same temperature and pressure. Which will have greater number of molecules? Justify the answer by stating the law.

5.12 If the number of moles of a gas is doubled by keeping the temperature and pressure constant, what will happen to the volume? Give reason.

5.13 Which two postulates of the kinetic theory of gases are not applicable for real gases?

5.14 Explain the physical significance of Van der Waals parameters 'a' & 'b'for a real gas.

5.15 Under what condition real gases tend to show ideal gas behaviour?

5.16 Draw Z vs P graph for ideal gas and CO_2 gas.

5.17 At high attitude time required to cook food is more than at sea level. Justify the statement.

5.18 Out of NH_3 and N_2, which will have higher value of 'a'- the van der Waals parameter and why?

5.19 What happens to the compressibility factor for gases like CO_2 at

i) Very high pressure & ordinary temperature

ii) Low pressure & ordinary temperature

5.20 Can Dalton's law of partial pressure be used to calculate pressure of mixture of NH_3 & HCl? Justify the answer .

5.21 Two gases A and B have critical temperature of 250K & 125K respectively. Which one of these can be liquefied easily and why?

5.22 Define surface tension. Write the SI unit of surface tension.

5.23 A drop of liquid assumes spherical shape. why?

5.24 Name the two factors on which the magnitude of surface tension depends?

5.25 A balloon has a volume of $175dm^3$ when filled with hydrogen gas at a pressure of 1.0 bar. Calculate the volume of the balloon when the pressure is 0.8bar. Assume that the temperature remains constant.

5.26 A gas cylinder containing cooking gas can withstand a pressure of 14.9bar. The pressure gauge of the cylinder indicates 12bar at 27ºC. Due to sudden fire in the building, the temperature starts rising. At what temperature will the cylinder explode?

5.27 A weather balloon filled with hydrogen at 1 atm & 27ºC has volume equal to $1200dm^3$. On ascending it reaches a place where the temperature is -23ºC and pressure is 0.5 atm. What is the volume of the balloon at this temperature?

5.28 Write two factors on which molecular speed of a gas depends?

5.29. The density of a gas is found to be 1.56g $/dm^3$ at 0.98bar pressure & 65ºC. Calculate the molar mass of the gas (R=0.083 bar dm^3/K/mol).

III.Questions carrying three marks

5.1 On a hot summer day, pressure in the well inflated tyre of an automobile increases considerably and the tyre may burst if the pressure is not adjusted properly. Name the gas law suitable for the above phenomenon .State the law & write the mathematical statement for the above law

5.2 Define an ideal gas. Derive ideal gas equation using gas laws

5.3. Enlist the three postulates of kinetic molecular theory of gases.

5.4. Define the terms

i) Critical temperature for a gas

ii) Aqueous tension

iii) Critical volume

5.5. What is the effect of temperature on -

i) Density ii) Surface tension iii) Vapour pressure of the liquid.

5.6 The mass of 0.5 dm^3 of hydrogen gas at a pressure of 1bar of Hg and at a temperature of 300K was found to be 4 x 10^{-2}g. Calculate the molar mass of hydrogen (R= 0.083 bar dm^3/K/mol).

5.7 2.9g of a gas at 95ºC occupies the same volume as 0.184 g of dihydrogen at 17 ºC at the same pressure . What is the molar mass of the gas?

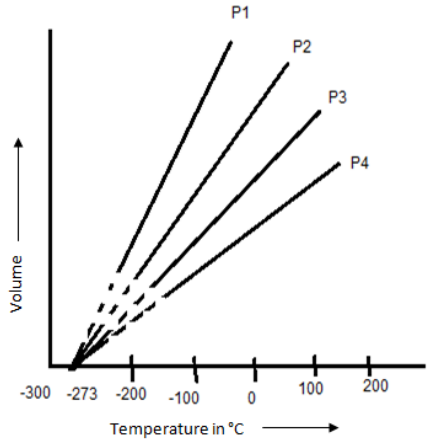
5.8 Calculate the total pressure of mixture of 8g of oxygen and 4g of hydrogen confined in a vessel of 1dm^3 at 27ºC (R=0.083 bar dm^3/K/mol).

5.9 Calculate volume occupied by 8.8gof CO_2 at 31.1^{0}C&1bar pressure (R =0.083 bar LK^{-1} mol^{-1}).

Answers

I. Answers for Questions carrying 1 mark

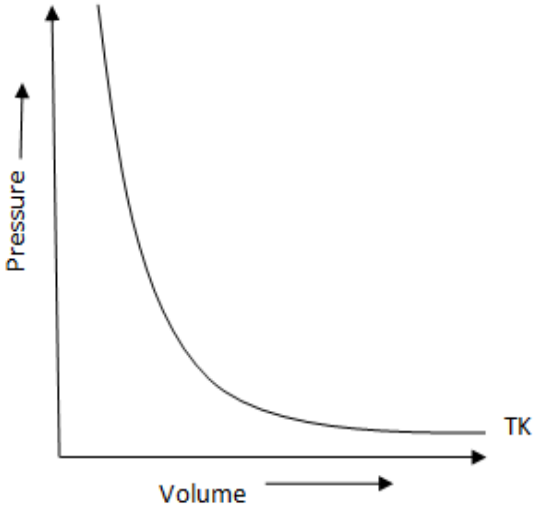
Q. NO	Value point	Marks
5.1	Attractive intermolecular forces	1
5.2	Dipole- dipole forces	1
5.3	Polar molecule &non-polar molecule	1
5.4	Due to the presence of hydrogen bonding between the molecules in HF.	1
5.5	Intermolecular forces are very strong or Particles in liquids &solids are very close to each other	1
5.6	At constant temperature, the pressure of fixed amount of a gas varies inversely with its volume	1
5.7	Reduces to half of the initial pressure	1

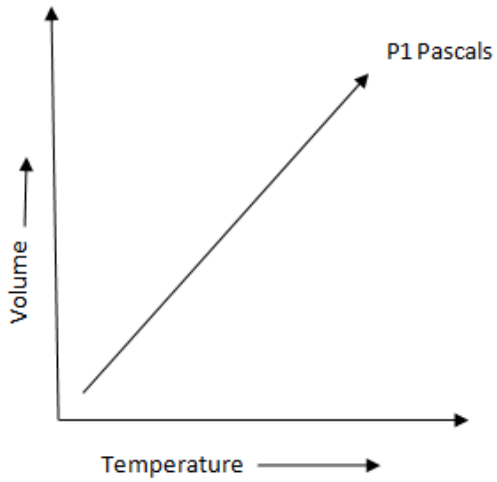
5.8	Pressure α density OR PM=dRT	1
5.9	Boyles Law	1
5.10	T= 273+t Where T is Kelvin temp scale and t is Celsius scale	1
5.11	-273.15ºC	1
5.12	Isotherms	1
5.13	lowest imaginary temperatures at which gases are supposed to occupy zero volume	1
5.14		1
5.15	Zero or 0	1
5.16	At constant volume, pressure of fixed amount of a gas varies directly with temperature	1
5.17	Avogadro's law	1
5.18	Gay – Lussacs law	1
5.19	Doubles	1
5.20	Density α Molar mass or M= (d/P) RT	1
5.21	8.341J/K/mol	1
5.22	22.7 L/ mol	1

5.23	The total pressure exerted by the mixture of non- reactive gases is equal to the sum of the partial pressures of individual gases under same conditions of volume &temperature.	1
5.24	Gases consists of large number of identical particles called atoms or molecules .The volume of the molecule is negligible in comparison to the empty space between them.	1
5.25	Pressure exerted by saturated water	1
5.26	There is no force of attraction between the particles of the gases at ordinary temperature & pressure	1
5.27	collision of the gas molecule with the walls of the container during their random motion	1
5.28	Collisions of the gas molecule is elastic.	1
5.29	$(P+ an^2/ v^2) (v-nb) = n RT$	1
5.30	$Z= PV/RT$	1
5.31	Temperature at which a real gas obeys ideal gas law over an appreciable range of pressure	1
5.32	attractive forces among the gas molecules are absent or gas cannot be liquified	1
5.33	The temperature at which vapour pressure of liquid is equal to the external pressure	1
5.34	99.6ºC	1
5.35	The energy required to increase the surface area of the liquid by one unit	1
5.36	Nm^4K^2/mol	1
5.37	s<q< p < r	1
5.38	Speed possessed by maximum number of molecules.	1
5.39	The inter molecular attraction in water are lower than mercury	1
5.40	Viscosity	1
5.41	Volume is inversely proportional to molar mass or $V\alpha 1/M$ or $V= mRT/MP$	1

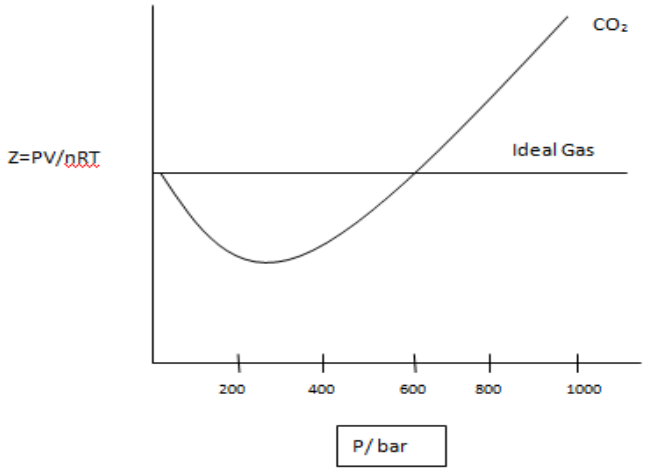
5.42	Boyles law	1
5.43	$U_{mp} < U_{av} < U_{rms}$	1

II. Answers for Questions carrying 2 marks

Q. NO	Value point	Marks
5.1	i. Thermal energy ii Inter molecular forces	1 1
5.2	i) Gases are highly compressible . ii) Gases exert pressure equally in all direction. iii) Gases have much lower density than solids and liquids. iv) The volume and the shape of the gases are not fixed. NOTE: Write any two.	1 1
5.3	At constant temperature the pressure of fixed amount of gas varies inversely with its volume. or $\frac{P_1}{P_2} = \frac{V_2}{V_1}$ Or $P \alpha \frac{1}{V}$  	1 1

5.4	$V_t = V_0 \frac{(273.15 + t)}{273.15}$ Substitute $t = -273.15^0$ C $V_t = 0$ Or volume of a gas at - 273.15^0 C is zero indicates that substances fails to exist as gas below this temperature.	1 1
5.5	 Isobar	1 1
5.6	It states that equal volumes of all gases under same conditions of temperature and pressure contain equal number of molecules Vα n	1 1
5.7	P V = n R T $P = \frac{m\ R\ T}{M\ X\ V}$ PM = d R T since $\frac{m}{V} = d$ where M is the molar mass &d is the density	1 1
5.8	PV = n R T where R is proportionality constant. $R = P V / n T = \frac{10^5 \times 22.7 \times 10^{-3}}{1 \times 273} = 8.314$ Pa m^3/K/mol = 8.314 J/K/mol.	1 1

5.9	The total pressure of exerted by the mixture of non-reactive gases is equal to the sum of the partial pressures of individual gases. Partial pressure = mole fraction x total pressure. or $P_A = X_A \times P_{Total}$	1 1
5.10	It means that total energy of molecules before and after the collision remains same. If there were loss of kinetic energy, the motion of the molecules would stop & gases will settle down.But this does not happen shows that collisions are elastic.	1 1
5.11	The two gases will have equal number of molecules .This is according to Avagadro's law which states that equal volumes of different gases under similar conditions of temperature and pressure contains equal number of molecules.	1 1
5.12	Volume will be doubled. Since v α n - according to Avogadro's law.	1 1
5.13	i) The volume occupied by the gas molecule is negligible as compared to the total volume of the gas. ii) The force of attraction and repulsion among the gas molecules are negligible.	1 1
5.14	Van der Waals constant 'a' is measure of magnitude of intermolecular attractive forces with in the gas. Van der waals constant 'b' represent co-volume or excluded volume which is effective volume of the molecules in a gas.	1 1
5.15	i) At low pressure ii) high temperature	1 1

5.16 **Z=1**		2
5.17	At high attitude atmospheric pressure is low. Hence boiling point of water is lowered since pressure is directly proportional to temperature; more time is required to cook the food.	1 1
5.18	NH_3 Attraction forces in NH_3 is higher due to the presence of inter molecular hydrogen bounding	1 1
5.19	i) Z > 1 or compressibility factor is more than 1. ii) Z < 1 or compressibility factor is less than 1.	1 1
5.20	No It is applicable to a mixture of non reacting molecules.	1 1
5.21	Gas A Higher the critical temperature ,greater the inter molecular force of attraction	1 1
5.22	Surface tension is defined as the force acting on unit length perpendicular to the line drawn on the surface of the liquid. SI unit is expressed as N m^{-1}.	1 1
5.23	Because of the surface tension, a liquid tends to possess minimum surface area. For a given volume sphere has minimum surface area.Hence drop of liquid assumes spherical shape	1 1

5.24	i) Attractive forces between the molecules ii) Temperature.	1 1
5.25	By Boyles law $P_1 V_1 = P_2 V_2$ $V_2 = \frac{1x175}{0.8} = 228.75 \text{ d m}^3$	1 1
5.26	Gay-Lussac's law $\frac{P_1}{P_2} = \frac{T_1}{T_2}$ $T_2 = \frac{P_2T_1}{P_1}$, $T_2 = \frac{14.9X300}{12} = 372.8$ K = 99.5^O C. Cylinder will explode at 99.5^oc.	1 1
5.27	$\frac{P_1V_1}{T_1} = \frac{P_2 V_2}{T_2}$ $\frac{1x1200}{300} = \frac{0.5xV_2}{250}$ $V_2 = 2000 \text{ dm}^3$	1 1
5.28	i)Temperature ii) Molecular mass of a gas	1 1
5.29	PM = dRT or M = dRT/P M = 1.56x 0.083 x 338/ 0.98 = 44.66g/mol	1 1

III. Answers for 3 Marks questions

Q. NO	Value point	Marks
5.1	Gay-Lussacs's law At constant volume, pressure of a fixed amount of a gas varies directly with the temperature P α T Or P/T = Constant at constant volume	1 1 1

5.2	A gas that follows Boyle's law, Charles law & Avogadro's law strictly is called an ideal gas At constant T V α 1/P – Boyles law At constant P V α T_ Charles Law At constant P& T V α n Avogadro's Law ∴ V α n T/p PV= nRT where R is constant called as gas constant.	1 1 1
5.3	1) Gases consists of large number of tiny particles, of negligible volume , identical particles called as atoms or molecules 2) There is no force of attraction between these particles 3) These particles are always in constant random motion 4) The particles of a gas move in all possible directions in a straight line 5) Collisions of gas molecules are perfectly elastic 6) Different particles in the gas have different speeds & hence different kinetic energies 7) The average kinetic energy of gas molecules is directly proportional to the absolute temperature. Note: Write any three- each carry 1 mark	1 1 1
5.4	i) critical temperature -It is the highest temperature at which liquifaction of gas first occurs ii)Aqueous tension - Pressure exerted by saturated water vapour iii) Critical volume - Volume of one mole of the gas at a highest temperature where liquefaction of gas first occurs or volume of one mole of a gas at critical temperature	1 1 1

5.5	i) Density of liquid decreases with increase in temperature ii) Surface tension decreases with increases in temperature iii) vapour pressure of the liquid increases with increase in temperature .	1 1 1
5.6	PV = nRT - ideal gas equation. n = PV/RT. n = 1x 0.5/ 0.083x300. $= 2x\ 10^{-2}$ mol. $n = m/M$, $M = m/n = 4x\ 10^{-2}/2x\ 10^{-2}$ = 2g/mol	1 1 1
5.7	$PV=n_1 R T_{1=}n_2RT_2$ since pressure and volume kept constant $n_1T_{1 =} n_2T_2$ $(m_1/M_1)T_{1=}(m_2/M_2)T_2$ Where m & M are mass & molecular mass $M_2 =M_1m_2 T_2/m_1T_1$ Substituting $M_{2=}$ (2x 2.9x368)/(0.184x290) M_2=40g mol^{-1}	1 1 1
5.8	n=m/M No of moles of oxygen =8/32= 0.25mol No of moles of Hydrogen=4/2=2mol Partial pressure =nRT/V P_{O_2}=0.25x0.083x300/1=6.225bar $P_{H_2=}$2x0.083x300/1=49.8bar Total pressure=$P_{O_2+}P_{H_2=}$6.225+49.8=56.025bar	1 1 1
5.9	No. of moles of $CO_{2\ (n)} =$ Mass of CO_2 / Molar Mass = 8.8 / 44 = 0.2 mol According to ideal gas equation V= nRT/P = 0.2x 0.083 x304.1 / 1 = 5.048L	1 1 1