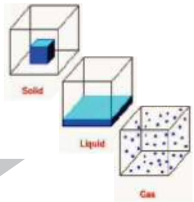


Chapter - 5

States of Matter

Part A

- On the basis of nature of intermolecular forces/molecular interactions, matter exists in three physical states : **solid, liquid and gas.**
- Intermolecular forces are the forces of attraction or repulsion between interacting particles (atoms and molecules). Attractive/repulsive intermolecular forces are known as van der Waal's forces.

  Different types of van der Waal's forces are :

  (a) **Disperson forces or London forces :** The interaction which is present between two non polar molecules *i.e.*, between induced dipole and induces dipole is called disperson forces, for example : noble gases.

  (b) **Dipole-dipole forces :** The interaction which is present between molecules having permanent dipoles *i.e.*, between polar molecules, for example NH_3, HCl etc.

  (c) **Dipole-induced dipole forces :** The interaction which is present between a polar and non polar molecule.
- **Boyle's law :** A constant temperature, the pressure of a fixed amount of gas, varies inversly with volume.

  $$P \; \alpha \; \frac{1}{V}$$

  $$P_1V_1 = P_2V_2 \text{ [At constant temperature]}$$
- **Charle's law :** At constant pressure, the volume of a fixed mass of gas is directly proportional to its absolute temperature.

  $$V \; \alpha \; T$$

  $$\frac{V_1}{T_1} = \frac{V_2}{T_2} \text{ [At constant pressure } (p) \text{ and } n]$$
- **Gay Lussac's law :** At constant volume, pressure of a fixed amount of

gas varies directly with the temperature.

$$P \quad \sigma T \quad \frac{P_1}{T_1} = \frac{P_2}{T_2} \text{ [At constant volume (V) and } n\text{]}$$

- **STP (Standard Temperature and Pressure) :** STP means 273.15 K (0°C) temperature and 1 bar (*i.e.*, exactly 10^5 Pascal.) Volume occupied by 1 mole gas at STP = 22.7 L.

  If pressure is taken in atm (atmosphere), then the standard molar volume is 22.4 L.

Part-B

- **Ideal gas equation :** $PV = nRT$

  R is universal gas constant.

  $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1} = 0.0821 \text{ L atm mol}^{-1} \text{ K}^{-1} = 0.083 \text{ L bar mol}^{-1} \text{ K}^{-1}$

- **Combined gas law :** $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

- **Density and molar mass of a gaseous substance :**

$$M = \frac{dRT}{P}$$

- **Dalton's law of partial pressure :** Dalton states that the total pressure exerted by the mixture of non reacting gases is equal to the sum of the partial pressures of individual of gases.

  $P_{total} = P_1 + P_2 + P_3 + \ldots$ [at constant T, V]

  $P_1 = x_1 \times P_{Total}$ = Here x_1 is called mole fraction of the gas.

  $P_{dry\ gas} = P_{Total}$ – Aqueous tension.

  Here aqueous tension is the pressure exerted by water vapours.

- **Compressibility factor :** The extent of deviation of a real gas from an ideal behaviour is expressed in terms of compressibility factor, $Z = \frac{PV}{nRT}$

  For ideal gas, Z = 1 at all temperatures and pressures. For real gases, greater is the deviation in the value of Z from 1, more is the deviation from ideal behaviour. When Z < 1, the gas is said to show negative deviation. This implies that gas is more compressible then expected from ideal behaviour. When Z > 1, the gas is said to show positive deviation and the gas is less compressible than expected from ideal behaviour.

At ordinary temperatures (T ≥ 273 K), only H_2 and He show positive deviations. However at low temperatures, even these gases show negative deviation *i.e.*, < 1. *For example*, in case of these gases, if T << 273 K, Z < 1.

- **Boyle temperature :** The temperature at which a real gas behaves like an ideal gas over an appreciable pressure range is called Boyle temperature or Boyle point.
- **Causes of deviation from ideal behaviour :** The following two assumptions of the kinetic theory of gases are faulty :

  (a) The volume occupied by the gas molecules is negligible as compared to the total volume of the gas.

  (b) The forces of attraction or repulsion between the gas molecules are negligible.

  The above assumptions are correct only if the temperature is high or pressure is low.

  van der Waal's equation :

  $$\left(P + \frac{a}{V^2}\right)(V - b) = RT \qquad \text{for 1 mole of the gas}$$

  $$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT \qquad \text{for } n \text{ moles of the gas}$$

  Here a and b are constants called van der Waal's constants.

- **Significance and units of van der Waal's constants : '*a*'** gives the idea of the magnitude of attractive forces among the gas molecules. As correction in pressure is $P = \frac{an^2}{V^2}$, therefore $a = (P \times V^2)/n^2$ = atm L^2 mol^2.
  As correction in volume V = nb, therefore **'*b*'** has the unit of L mol^{-1}. The near constancy in the volume of b shows that the gas molecules are incompressible.

Part-C

- **Vapour pressure :** The pressure exerted by the vapours of a liquid, when it is in equilibrium with the liquid surface, at const. temperature.
- Boiling temperature : The temperature at which vapour pressure of a liqid is equl to the external pressure.
- At 1 atm, boiling temperature is called normal boiling point.
- At 1 bar boiling temperature is called standard boiling point.

- Vapour pressure of a pure liquid depends upon (i) intermolecular forces, (ii) Temperature.
- Surface tension is defined as force acting per unit length perpendicular to the line drawn on the surface. Its units is Nm^{-1}.
- **Effect of temperature on surface tension :** Surface tension decreases with increase in temperature with the increase in temperature, kinetic energy of molecules increases. At a result, intermolecular forces decreases and hence force acting per unit length decreases.
- **Viscosity :** It is defined as resistance offered to the flow of liquid due to internal fiction between layers of fluids as they pass over each other.

$$F = \eta A.\frac{du}{dx}$$

η is called coefficient of viscosity.

- **Effect of temperature on viscosity :** Viscosity decrease with increase in temperature because wth the increase in temperaure the average kinetic energy increasesa and the intermolecular forocoes can be easily overcome.

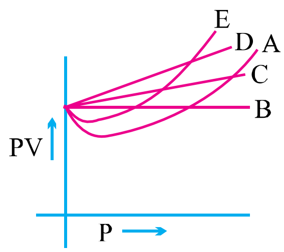
1-Mark Questions

Part-A

1. Name the intermolecular forces, which include the term. Vander Waal's forces. [**Ans.** LONDON forces, Dipole-Dipole, Dipole-induced dipole]
2. Define Boyle's law.
3. Write the condition in terms of temperature and pressure, under which all gases obey Charle's law. [**Ans.** High temperature, low pressure]
4. Mention the volume occupied by one mole of an ideal gas at STP. [**Ans.** 22.7 L]
5. Define the term absolute zero. [**Ans.** 0K]

Part-B

6. Define aqueous tension.
7. Mention the S.I. unit for the quantity $\frac{PV^2T^2}{n^2}$. [**Ans.** $Nm^4\,K^2\,mol^{-1}$]
8. Define the term critical temperature.
9. Write any two postulates of kinetic molecular theory of gases.
10. Which curve in the figure represents the curve for ideal gas ? [**Ans.** B]



Part-C

11. Define the term normal boiling point of a liquid.

12. Mention the factors on, which the vapour pressure of a pure liquid depends ?

13. Define surface tension.

14. What do you understand by the term laminar flow ?

15. Out of Ethyl alcohol or Dimethylether, which one have higher vapour pressure at same temperature ? [**Ans.** Dimethylether]

Part-A

2 Marks Questions

1. What will be the minimum pressure required to compress 500 dm^3 of air at 1 bar to 200 dm^3 at 30°C ? [NCERT] [**Ans.** 2.5 bar]

2. Name the intermolecular force present in :

(i) H_2O (ii) HCl [**Ans.** H-bonding, Dipole-Dipole]

3. Explain Avogadro's law.

4. Find the molar mass of a gas if 300 ml of this has mass of 0.368 g at STP.

[**Ans.** 27.84 g/mol]

5. Why do real gases show deviation from ideal behaviour ? Write Van der Waal's equation for *n* moles of a gas.

Part-B

6. Calculate the temperature of 4 mole of a gas occupying in 5 dm^3 at 3.32 bar. (R = 0.083 bar dm^3 K^{-1} mol^{-1}) [NCERT] [**Ans.** 50K]

7. Calculate the volume occupied by 8.8 g of CO_2 at 31.1°C and 1 bar pressure.

[R = 0.83 bar LK^{-1} mol^{-1}] [NCERT] [**Ans.** 5.05 L]

8. Explain the physical significance of vander Waal's parameter.

9. Compressibility factor 'Z' of a gas is given as $Z = \frac{PV}{nRT}$.

(i) What is the value of Z for an ideal gas ?

(ii) For real gas, what will be the effect on value of Z above Boyle temperature? [**Ans.** $Z = 1$, $Z > 1$]

10. At 25°C and 760 mm Hg pressure a gas occupies 600 ml volume. What will be its pressure at a height where temperature is 10°C and volume of the gas is 640 mL. [NCERT] [**Ans.** 676.6 mm Hg]

Part-C

11. Define the terms :

(i) Standard boiling point.

(ii) Vapour pressure of a liquid.

12. Drops of liquid are spherical in nature. Explain. Mention the effect of temperature on surface tension.

13. Write the S.I. units of :

(i) Surface tension.

(ii) Coefficient of viscosity.

14. Define viscosity. Mention the effect of temperature and pressure on viscosity of a liquid.

15. Explain :

(i) Fire polishing of glass.

(ii) Liquid tend to rise in a capillary.

Part-A

3-Mark Questions

1. Define and explain Dalton's Law of partial pressure.

2. A balloon is filled with hydrogen at room temperature. It will burst if pressure exceeds 0.2 bar. If at 1 bar pressure the gas occupies 2.27 L volume, upto what volume can the ball on be expanded.

[NCERT] [**Ans.** 11.35 L]

3. Calculate the total pressure in a mixture of 8g of dioxygen and 4g of dihydrogen confined in a vessel of $1 dm^3$ at 27°C.

[$R = 0.083$ bar $dm^3 K^{-1} mol^{-1}$] [NCERT] [**Ans.** 56.025 bar]

4. 300 ml of oxygen gas at – 10°C are heated to 10°C. Find the volume of gas at 10°C if pressure remains constant. [**Ans.** 322.8 mL]

5. A gas at a pressure of 5 atm is heated from 0° to 546°C nd is simultaneously compressed to one third of its originl volume. Find the final pressure f the gas. [**Ans.** 45 atm]

Part-B

6. Pressure of one gram of an ideal gas A at 27°C is found to be 2 bar. When 2g of another gas (ideal) B is introduced in the same flask at the same temperature the pressure becomes 3 bar. Find a relationship between their molecular masses. [**Ans.** $M_B = 4M_A$]

7. What will be the pressure exerted by a mixture of 3.2g of methane and 4.4 g of carbon dioxide contained in a 9 dm^3 flask at 27°C. [NCERT] [**Ans.** 0.82 atm]

8. A neon-dioxygen mixture contains 70.6 dioxygen and 167.5 neon. If the pressure of the mixture of gases in cylinder is 25 bar. What is the partial pressure of dioxygen and neon in the mixture.[**Ans.** 5.25 bar, 17.75 bar]

9. With the help of a gas laws, deduce an expression for the ideal gas equation. What is the utility of the gas equation ?

10. A vessel of 120 mL capacity contains a certain mass of a gas at 20°C and 750 mm pressure the gas was transferred to a vessel whose volume is 180 mL. Calculate the pressure of the gas at 20°C. [**Ans.** 500 mm]

Part-C

11. Explain :
    (i) Liquid at higher altitudes boil at low temperature.
    (ii) In hospital surgical instruments are sterlised in auto caves.
    (iii) Out of, alcohols and ethers of comparable mass which one have higher boiling points ?

12. (i) Define surface energy in relation to surface tenstion.
    (ii) Name the temperature at which the density of water is maximum.
    (iii) Moist soil grains are pulled together. Explain.

13. (i) Define the term cofficient of viscosity. Name the unit of viscosity coefficient in cgs system.
    (ii) Give the difference between boiling and evaporation.

14. Explain :

(i) Tea or coffee is sipped from the saucer, when it is quite hot.

(ii) Liquids posseses fluidity.

15. Which among the following will have ?

(i) HCl or H_2O (Higher boiling point)

(ii) Ether or water (Higher viscosity)

(iii) $Br_2(l)$ or water (Lower surface tension)

5-Mark Questions

1. Mention the intermolecular forces present between :

(a) H_2O and alcohol (b) Cl_2 and CCl_4 (c) He and He atoms (d) Na^+ ion and H_2O (e) HBr and HBr.

2. (a) Find the pressure of 4g of O_2 and 2g of H_2 confined in a bulb of 1 litre at 0°C. [**Ans.** 25.215 atm]

(b) What is the molar volume of a gas at SATP conditions ?

(c) Define and explain Gay Lussac's law.

Part-B

3. (a) For Dalton's law of pressure derive the expression $P_{gas} = X_{gas} P_{total}$.

(b) A 2-L flask contains 1.6 g of methane and 0.5 g of hydrogen at 27°C . Calculate the partial pressure of each gas in the mixture and hence, calculate the total pressure.

[**Ans.** $p CH_4$ = 1.23 atm, $p H_2$ = 3.079 atm, P_{total} = 4.31 atm.]

4. (a) Using Vander waal's equation calculate the constant '*a*' when two moles of a gas confined in a four litre flask exerts a pressure of 11.0 atm. at a temperature of 300 K. The value of '*b*' is 0.05 litre mol^{-1}.

[**Ans. 6.**49 atm L^2 mol^{-2}]

5. (a) Mention the factors on which vapour pressure of a pure liquid depends.

(b) Define boiling point of a liquid.

(c) Which will have higher viscosity Glycerol or Ethylene glycol.

[**Ans.** Glycerol]

(d) Surface tension of a liquid .... with increase in the magnitude of intermolecular forces. [**Ans.** Increases]