Chapter: 03

Gases

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1. Plasma is:
   - (A) Fourth state of matter
   - (B) Third state of matter
   - (C) Second state of matter
   - (D) First state of matter

2. Plasma consists of mixture of neutral particles , positive ions and:
   - (A) Positron
   - (B) Electrons
   - (C) Neutrons
   - (D) Protons

3. Kinetic theory was proposed by:
   - (A) Bernoulli
   - (B) Newton
   - (C) Maxwell
   - (D) Coulomb

4. If 10 g of a gas at one atmospheric pressure is cooled from 273 °C to 0 °C at constant volume , its pressure would become:
   - (A) 273 atm
   - (B) 1 atm
   - (C) 0.005 atm
   - (D) 0.5 atm

5. 4 gm of H_2 gas at STP occupies:
   - (A) 60 lit
   - (B) 44.8 lit
   - (C) 35.5 lit
   - (D) 25.5 lit

6. For an ideal gas at a constant T at which pressure its volume doubles, when the initial pressure is 2 atm:
   - (A) 4 atm
   - (B) 1 torr
   - (C) 101325 Nm^{-2}
   - (D) 101325 torr

7. For an ideal gas , the compressibility factor is equal to:
   - (A) 2
   - (B) 1
   - (C) 1.5
   - (D) 0.5

8. CH_4 gas is maintained at 0 °C and 1 atm pressure. Its density is 0.714 g dm^{-3} . What is its density at 0.5 atm and 0 °C?
   - (A) 0.35 dm^{-3}
   - (B) 7.14 dm^{-3}
   - (C) 1.428 dm^{-3}
   - (D) 0.714 dm^{-3}

9. A graph is plotted between two variable that is pressure and volume at constant temperature and fixed number of moles of the gas, the graph is called:
   - (A) Adiabat
   - (B) Isochor
   - (C) Isobar
   - (D) Isotherm

10. Equal masses of methane and oxygen are mixed in an empty container at 25 °C. The fraction of total pressure exerted by oxygen is:
    - (A) $\frac{1}{8}$
    - (B) $\frac{1}{3}$
    - (C) $\frac{1}{9}$
    - (D) $\frac{15}{17}$

11. The gases show more deviation at:
    - (A) High temperature and low pressure
    - (B) High temperature and high pressure
    - (C) Low temperature and high pressure
    - (D) Low temperature and low pressure

12. .... gas has lowest rate of diffusion.
    - (A) H_2
    - (B) N_2
    - (C) O_2
    - (D) He

13. The molar volume of O_2 is maximum at:
    - (A) 127 °C and 1 atm
    - (B) 0 °C and 2 atm
    - (C) 273 °C and 2 atm
    - (D) STP

14. The unit millibar is commonly used by:

Ⓐ Engineers Ⓑ Meteorologists Ⓒ Dalton Ⓓ Astronauts

15. The highest temperature at which a substance can exist as liquid state at its critical pressure is:
Ⓐ Critical temperature Ⓑ Transition temperature
Ⓒ Consulate temperature Ⓓ Absolute zero

16. The temperate of natural plasma is about:
Ⓐ 10,000 °C Ⓑ 5000 °C Ⓒ 20,000 °C Ⓓ 1000 °C

17. Temperature and number of moles are kept constant in:
Ⓐ Charles's law Ⓑ Boyles law Ⓒ Dalton's law Ⓓ Avogadro's law

18. Value of R at STP:
Ⓐ $0.0821\ dm^3\ atm\ K^{-1}\ Kmol^{-1}$ Ⓑ $0.00821\ dm^3\ atm\ K^{-1}\ Kmol^{-1}$
Ⓒ $0.000821\ dm^3\ atm\ K^{-1}\ Kmol^{-1}$ Ⓓ $8.21\ dm^3\ atm\ K^{-1}\ Kmol^{-1}$

19. Kinetic energy of gas molecules is zero at:
Ⓐ −1 °C Ⓑ 0 F Ⓒ 0 °C Ⓓ 0 K

20. At what temperature does the gaseous state of any type of matter can't exist?
Ⓐ −237.15 °C Ⓑ 273.15 °C Ⓒ −273.15 °C Ⓓ 100 °C

21. Density of an ideal gas can be calculated by using equation:
Ⓐ $PM = dRT$ Ⓑ $PM = dPV$ Ⓒ $PV = dRT$ Ⓓ $d = \frac{RT}{MP}$

22. Dalton's law of partial pressure can be derived from:
Ⓐ Charles's law Ⓑ General gas equation Ⓒ Boyles law Ⓓ Avogadro's law

23. At absolute zero total Kinetic energy of gas molecules is:
Ⓐ Zero Ⓑ Minimum Ⓒ Maximum Ⓓ Lower than 20 KJ

24. Kinetic equation $PV = \frac{1}{3} m\ \overline{Nc^2}$ is derived by:
Ⓐ Bernulli Ⓑ Clausius Ⓒ Boltzmann Ⓓ Maxwell

25. The sun is a ……… ball of plasma heated by nuclear fusion process.
Ⓐ 1.5 million Km Ⓑ 3 million Km Ⓒ 1.5 billion Km Ⓓ 3 billion Km

26. Gases deviate from ideal behavior at high pressure because:
Ⓐ At high pressure, the gas molecules move in all direction
Ⓑ At high pressure, there are significant attractive forces
Ⓒ Both A & B
Ⓓ At high pressure, the gas molecule move in one direction only

27. How should the conditions be changed to prevent the volume of a given gas from expanding when its mass is increased?
Ⓐ Temperature and pressure both are increased
Ⓑ Temperature is lowered and pressure is increased
Ⓒ Temperature is increased and pressure is lowered
Ⓓ Temperature and pressure both are lowered

28. Gases deviate from ideal behavior at high pressure. Which of the following is correct for non-ideality?
   (A) At high pressure, the collisions between the gas molecules are much increased
   (B) AT high pressure, the intermolecular attractions becomes significant
   (C) At high pressure, the volume of the gas becomes insignificant
   (D) At high pressure, the gas molecules move in one direction only

29. Feeling uncomfortable breathing in unpressurized cabin is due to:
   (A) high pressure of O_2 (B) low pressure of CO_2
   (C) low pressure of O_2 (D) high pressure of CO_2

30. Critical temperature of water vapours is:
   (A) 73.0 atm **(B) 217.0 atm** (C) 111.5 atm (D) 39.6 atm

31. Critical temperature of water vapours is:
   (A) 647.6 K (B) 405.6 K (C) 384.7 K (D) 304.3 K

32. 1 atmosphere is equal to:
   (A) 500 cm (B) 760cm of Hg (C) 1000 mm of Hg **(D) 760mm of Hg**

33. Constant factor in Charlie's law:
   (A) Temperature (B) Both V and T **(C) Pressure** (D) Volume

34. The S.I unit of pressure is:
   (A) m^{-2} **(B) Nm^{-2}** (C) mm Hg (D) torr

35. Formula used for conversion of °F into °C is:
   (A) °C = 5/9[°F−32] (B) °F = 5/9[°C]+32 (C) °C = 9/5[°F−32] (D) °F = 9/5[°C]+32

36. Equal masses of methane and oxygen are mixed in an empty container at 25 °C. The fraction of total pressure exerted by oxygen:
   (A) 1/9 (B) 16/17 (C) 8/9 **(D) 1/3**

37. Partial pressure of oxygen in human lungs in torr is:
   (A) 760 **(B) 116** (C) 161 (D) 159

38. The spreading of fragrance of scent in air is due to:
   (A) Density **(B) Diffusion** (C) Osmosis (D) Effusion

39. Number of molecules in one dm^3 of water is closed to:
   (A) $55.6 \times 6.02 \times 10^{23}$ (B) $\frac{18}{22.4} \times 10^{23}$ (C) $\frac{12.04}{22.4} \times 10^{23}$ (D) $\frac{6.02}{22.4} \times 10^{23}$

40. Normal human body temperature is:
   (A) 27 3K (B) 37 °F (C) 98.6 °C **(D) 37 °C**

41. When water freezes at 0 °C, its density decreases due to:
   (A) Change of bond angles **(B) Empty spaces present in the structure of ice**
   (C) Cubic structure of ice (D) Change of bond lengths

42. Mass of 22.4 dm^3 of N_2 at STP is:
   (A) 2.8 gm **(B) 28 gm** (C) 14 gm (D) 1.4 gm

43. The molar volume of CO_2 is maximum at:
Ⓐ 127 °C and 1 atm Ⓑ 0 °C and 2 atm Ⓒ 273 °C and 2 atm Ⓓ STP

44. Escape out of gas molecules one by one through tiny hole is:
Ⓐ Osmosis Ⓑ Diffusion Ⓒ Both A & B Ⓓ Effusion

45. Which gas will diffuse more rapidly?
Ⓐ SO_2 Ⓑ HCl Ⓒ NH_3 Ⓓ CO_2

46. Which of the following will have highest rate of diffusion?
Ⓐ NH_3 Ⓑ SO_2 Ⓒ CO_2 Ⓓ O_2

47. Which of the following will have the same number of molecules at STP?
Ⓐ 28 g of N_2 and 5.6 dm^3 of oxygen Ⓑ 44 g of CO_2 and 11.2 dm^3 of CO
Ⓒ 11.2 dm^3 of O_2 and 32 g of O_2 Ⓓ 280 cm^3 of CO_2 and 280 cm^3 N_2O

48. In 1879, plasma was identified by scientist:
Ⓐ Chadwick Ⓑ Soddy Ⓒ William Crookes Ⓓ John Dalton

49. The order of rate of diffusion of gasses NH_3, SO_2, CO_2 and Cl_2 is:
Ⓐ $NH_3 > SO_2 > CO_2 > Cl_2$ Ⓑ $Cl_2 > SO_2 > CO_2 > NH_3$
Ⓒ $NH_3 > CO_2 > Cl_2 > Cl_2$ Ⓓ $NH_3 > CO_2 > SO_2 > Cl_2$

50. A real gas obeying Vander walls equation will resemble ideal gas if:
Ⓐ "a" is large and "b" is small Ⓑ "a" is small and "b" is large
Ⓒ both "a" and "b" are small Ⓓ if both "a" and ""b" are large

51. If "a" and "b" are zero for certain gas then gas is:
Ⓐ May be any diatomic gas Ⓑ Real Ⓒ Non-ideal Ⓓ Ideal

52. The deviation of gas from ideal behavior is maximum at:
Ⓐ 100 °C and 2.0 atm Ⓑ 0 °C and 2.0 atm
Ⓒ −10 °C and 5.0 atm Ⓓ −10 °C and 2.0 atm

53. An ideal gas has volume 1 dm^3 at 303 K. Keeping pressure constant. At which Kelvin temperature its volume will become 2 dm^3:
Ⓐ 303 K Ⓑ 330 K Ⓒ 606 K Ⓓ 240 K

54. If absolute temperature of a gas is doubled and the pressure is reduced to one half, the volume of the gas will:
Ⓐ Reduced to 1/8 Ⓑ increase four times Ⓒ be doubled Ⓓ Remain unchanged

55. The pair of gases which does not obey Dalton's law of partial pressure under normal condition is:
Ⓐ NH_3 and HCI Ⓑ He and Ne Ⓒ H_2 and He Ⓓ H_2 and O_2

56. Pressure remaining constant, at which temperature the volume of a gas will become twice of what it is at 0 °C:
Ⓐ 200 °C Ⓑ 273 K Ⓒ 456 °C Ⓓ 546 K

57. Partial pressure of oxygen in the air is:
Ⓐ 157 torr Ⓑ 158 torr Ⓒ 159 torr Ⓓ 156 torr

Fill in the blanks

Q1: The product PV has the S.I. unit of ....

Q2: Eight grams each of O_2 and H_2 at 27 °C will have total K.E in the ratio of ....

Q3: Smell of the cooking gas during leakage from a gas cylinder is detected because of the property of ....

Q4: Equal .... of ideal gases at same T and P contain .... number of molecules.

Q5: The temperature above which a substance exists only as a gas is called ....

Answers

1.	atm dm^3	2.	1:16	3.	diffusion	4.	Volumes, euqal
5.	Critical temperature						

Chapter : 03 Gases

Subjective

Q1: ***Write any four properties of liquids.***

Ans: These are the following properties of liquids:

- *Molecules of liquids possess kinetic energy due to their motion.*
- *Liquids do not have definite shape but they adopt shape of container.*
- *Liquids show evaporation and diffusion.*
- *Intermolecular spaces in liquids are negligible.*

Q2: ***Liquids are less common than gases and solids. Justify.***

Ans: Liquid state of any substance can exist only within a relatively narrow range of temperature and pressure.

Q3: ***Why the graph plotted between pressure and volume moves away from pressure axis at higher temperature?***

Ans: The reason is that at higher temperature, the volume of the gas has increased. Similarly, if we increase the temperature further, make it constant and plot another isotherm. It further goes away from both axes.

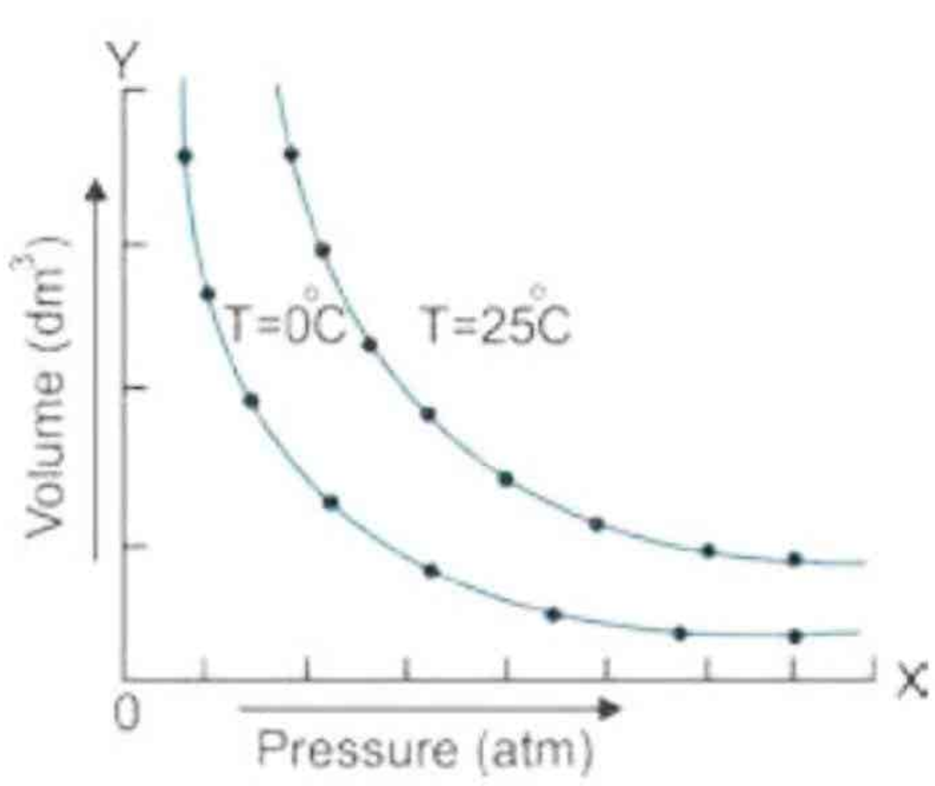

Fig Isothermes o f a gas at different temperatures.

Q4: ***Define pressure. Give its various units.***

Ans: *The force exerted by* 76 cm *long column of mercury on an area of* 1 cm² *at* 0 °C *is called standard atmospheric pressure.*

Units:

$1\ atm = 60\ torr = 760mm\ Hg = 101325\ Nm^2$

$1\ atm = 101325\ Pa = 101.325\ kPa$

$760\ torr = 14.7\ pound\ inch\ (PSI).$

Q5: ***Define atmospheric pressure. Give its two units.***

Ans: *The pressure of air that can be support* 760 mmHg *column at sea level is called one atmospheric pressure.*

It is force exerted by 760 mm *or* 76 cm *long column of mercury on an area of* 1 cm² *at* 0 °C.

Units:

- *S.I unit of pressure is* Nm^2 *which is also called Pascal.*
- *Another unit of atmospheric pressure is pound per square inch (PSI).*

Q6: ***Define Boyle's law and give its mathematical expression.***

Ans: *Boyle's law:*

At constant temperature volume of given mass of a gas is inversely proportional to the pressure exerted on it.

$$V \propto \frac{1}{P}$$

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

$$PV = K$$

Q7: ***Why do we get a straight line when pressures are plotted against inverse of volume for gas?***

Ans: *The plot of "P" on y-axis against* 1/V *on x-axis gives a straight line. It shows that "P" is directly proportional to* 1/V. *This straight line passes through the origin because when the pressure is close to zero then volume is so high that* 1/V *is very close to zero.*

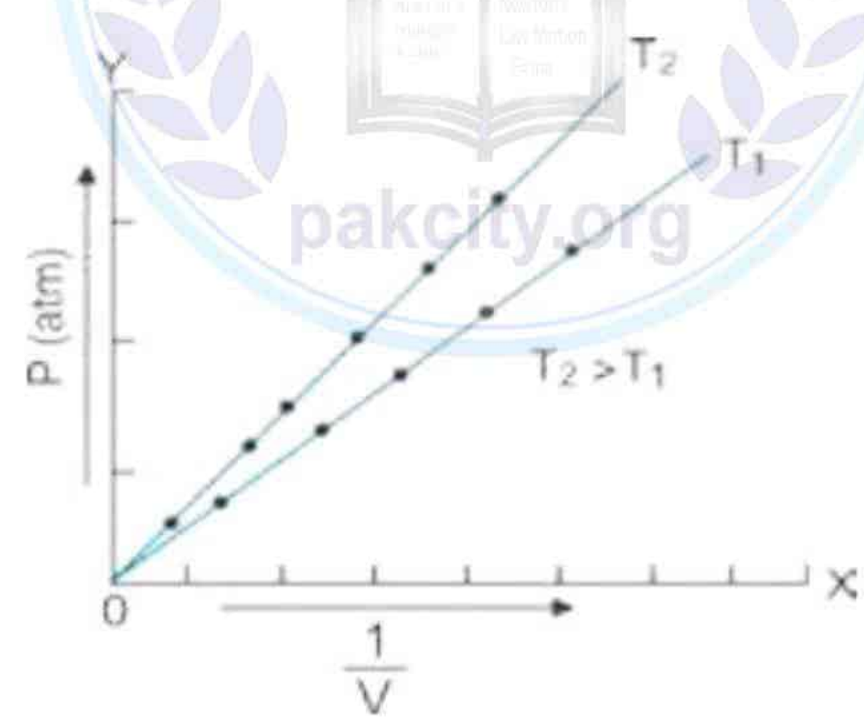

Fig .A plot between P and 1/v

Q8: ***What is absolute zero?*** ***OR***
What happens to real gasses while approaching this temperature?

Ans: *The hypothetical temperature at which the volume of all the gasses becomes zero is called absolute zero.*

In Celsius scale it is −273.16 °C.

Graphical expression:

When a graph is plotted between V *and* T *for a gas a straight line is obtained which intersects the temperature axis at* −273 °C *which is considered as the lowest temperature.*

It would be achieved if the substance remains in gaseous state. But all gasses liquefy before reaching this temperature.

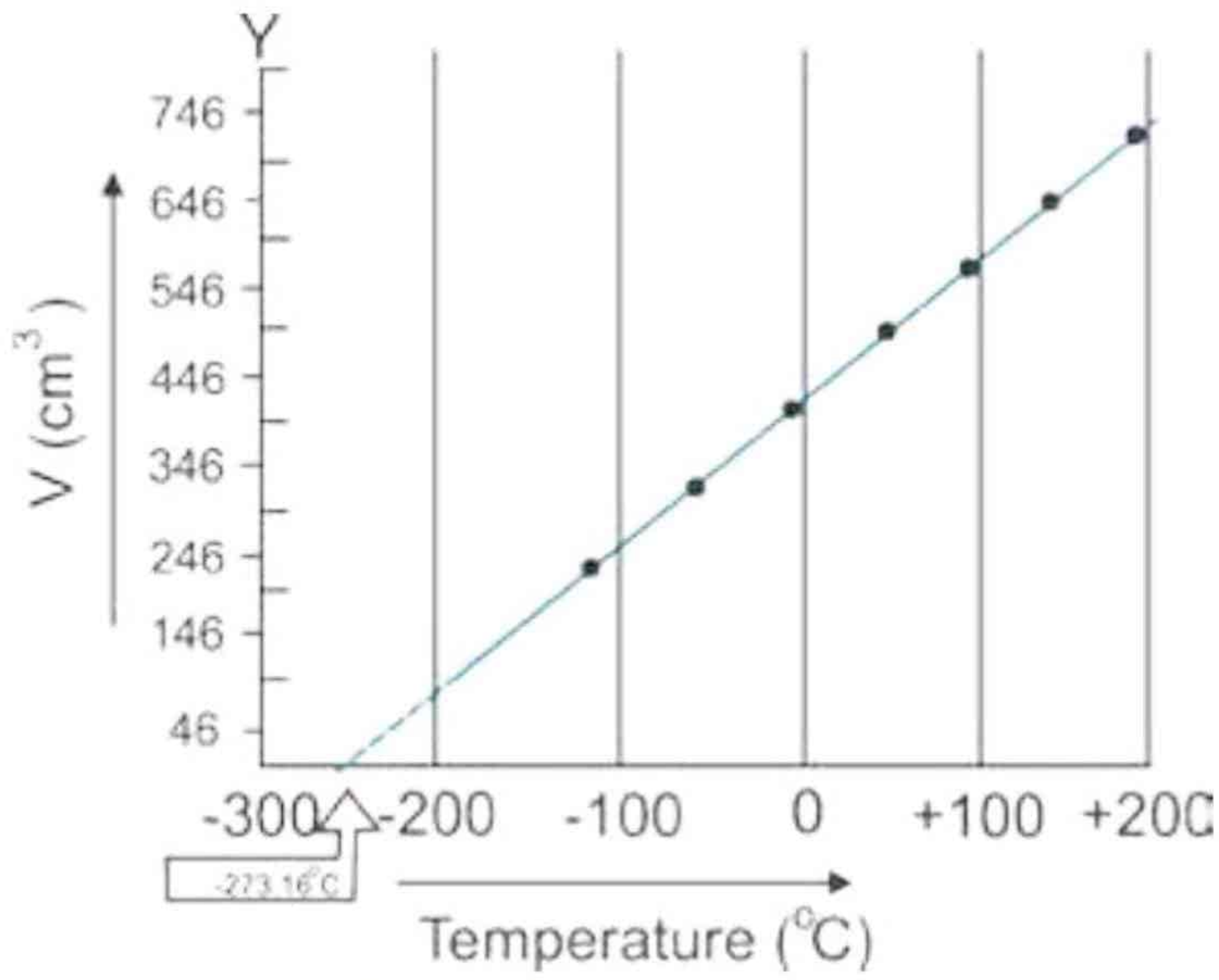

Fig The graph between volume and temperature for a gas

Q9: ***Convert − 40 °F temperature to (a) Centigrade scale (b) Kelvin scale.***

Ans: *Centigrade scale:*

$$^{\circ}C = \frac{5}{9}(^{\circ}F - 32)$$

$$^{\circ}C = \frac{5}{9}(-40 - 32)$$

$$^{\circ}C = \frac{5}{9}(-72)$$

$$^{\circ}C = -40$$

Kelvin scale:

$$K = {^{\circ}C} + 273.16$$

$$K = -40 + 273.16$$

$$K = 233.16\ K$$

Q10: ***What is absolute scale?***

Ans: *Kelvin scale of temperature is called absolute temperature scale because it starts from absolute zero. i.e.* − 273.16 °C. K = 0.

Q11: ***State Charles's Law and write its mathematical form.***

Ans: *The volume of the given mass of gas is directly proportional to the absolute temperature when the pressure is kept constant is known as Charles's law.*

Mathematically it can be written as:

$$V \propto T \quad \text{(at constant pressure and number of moles)}$$

$$V = KT$$

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

If the temperature is changed from T_1 *to* T_2 *and volume change from* V_1 *to* V_2 *then*

$$\frac{V_1}{T_1} = K \quad \text{and} \quad \frac{V_2}{T_2} = K$$

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

Q12: ***SO_2 is non-ideal at 273 K but behaves like an ideal gas at 327 K. Justify the statement?***

Ans: *At low temperature of 273 K molecules of SO_2 gas have considerable attractions for each other and thus SO_2 gas behaves non-ideally. When temperature is increased to 327 K the forces of attraction among SO_2 molecules decreases and hence SO_2 gas shows ideal behaviors.*

Q13: ***Define Quantitative Definition of Charles's Law.***

Ans: *At constant pressure, the volume of the given mass of gas increases or decreases by $\frac{1}{273}$ of its original volume at 0 °C for every 1 °C rise or fall in temperature respectively.*

Q14: ***What is Fahrenheit Scale? Write formula to convert centigrade scale to Fahrenheit scale.***

Ans: *Fahrenheit scale:*

Fahrenheit is a scale of thermometry which is used to measure temperature. The melting point of ice at 1 atmospheric pressure has a mark 32 °F and that of boiling water is 212 °F. The space between these temperature marks is divided into 180 equal parts and each part is 1 °F.

Formula:

$$^{\circ}\mathrm{F} = \frac{9}{5}(^{\circ}\mathrm{C}) + 32$$

Q15: ***Convert −40 °C to Fahrenheit scale.***

Ans:

$$^{\circ}\mathrm{F} = \frac{9}{5}(^{\circ}\mathrm{C}) + 32$$

$$^{\circ}\mathrm{F} = \frac{9}{5}(-40) + 32$$

$$^{\circ}\mathrm{F} = -72 + 32$$

$$^{\circ}\mathrm{F} = -40\ ^{\circ}\mathrm{F}$$

Q16: ***Convert 37 °C into °F scale.***

Ans:

$$^{\circ}\mathrm{F} = \frac{9}{5}(^{\circ}\mathrm{C}) + 32$$

$$^{\circ}\mathrm{F} = \frac{9}{5}(37) + 32$$

$$^{\circ}\mathrm{F} = 66.6 + 32$$

$$^{\circ}\mathrm{F} = 98.6$$

Q17: ***Define thermometry. Name the scale and device used for thermometry.***

Ans: *Thermometry:*

The study of measurement of temperature is called thermometry. Temperature is the average kinetic energy of particles of a substance. There are three measuring scales of thermometry.

- *Celsius or Centigrade scale* (°C)
- *Fahrenheit scale* (°F)
- *Kelvin scale* (K)

Q18: *Derive the units of "R" in general gas equation when the pressure is in atmosphere and volume in dm^3?*

Ans:

Pressure (P) = 1 atm T = 273.15 K

Volume (V) = 22.414 dm^3 n = 1 mole

By putting the value

$$R = \frac{PV}{nT}$$

$$R = \frac{1\ \text{atm} \times 22.414\ \text{dm}^3}{1\ \text{mole} \times 273.15\ \text{K}}$$

$$R = 0.0821\ \text{atm dm}^3\ \text{K}^{-1}\ \text{mole}^{-1}$$

Q19: *Calculate density of CH_4 gas at 0 °C and 760 mm Hg pressure. Molecular mass of CH_4 = 16.*

Ans: Density of CH_4 (d) = ?

Temperature (T) = 273.16 K

Pressure (P) = 1 atm

Molar mass of CH_4 (M) = 16 g $mole^{-1}$

R = 0.0821 atm dm^3 K^{-1} $mole^{-1}$

Formula:

$$d = \frac{PM}{RT}$$

By putting the value

$$d = \frac{1\ \text{atm} \times 16\ \text{g mole}^{-1}}{0.0821\ \text{atm dm}^3\ \text{K}^{-1}\ \text{mole}^{-1} \times 273.16\ \text{K}}$$

$$d = 0.71\ \text{g dm}^{-3}$$

Q20: *Calculate the value of gas constant R in S.I units.*

Ans: Using S.I units of pressure, volume and temperature in general gas equation value of "R" is calculated as:

In S.I units,

Pressure (P) = 101325 Nm^{-2} T = 273.15 K

Volume (V) = 0.022414 m^3 n = 1 mole

By putting the value

$$R = \frac{PV}{nT}$$

$$R = \frac{101325\ \text{Nm}^{-2} \times 0.022414\ \text{m}^3}{1\ \text{mole} \times 273.15\ \text{K}}$$

$$R = 8.3143\ \text{Nm K}^{-1}\ \text{mole}^{-1}$$

Q21: *Derive an expression to calculate density of a gas from ideal gas equation.* *OR*

Prove that $d = \frac{PM}{RT}$ **?**

Ans: For calculating the density of ideal gas, we substitute the value of number of moles (n) *of the gas of the mass* (m) *and the molar mass* (M) *of the gas.*

$$PV = nRT$$

So,

$$n = \frac{m}{M}$$

$$PV = \frac{m}{M} R T$$

Rearranging equation

$$PM = \frac{m}{V} R T$$

Here, $$d = \frac{m}{V}$$

$$PM = d R T$$

Rearranging equation:

$$d = \frac{PM}{RT}$$ *Proved.*

Q22: ***Derive molecular mass of a gas by general gas equation.***

Ans: *For calculating the molecular mass of ideal gas, we substitute the value of number of moles (n) of the gas of the mass (m) of the gas.*

$$PV = n R T$$

So, $$n = \frac{m}{M}$$

$$PV = \frac{m}{M} R T$$

Rearranging equation

$$M = \frac{m}{V} \frac{R T}{P}$$

Here, $$d = \frac{m}{V}$$

$$M = d \frac{R T}{P}$$

Q23: ***Define Avogadro's law of gases.***

Ans: *Avogadro's law:*

"Equal volume of all the ideal gases at same temperature and pressure contain equal number of molecules".

$$V \propto n$$

For example:

1 mole of CO_2 = 44 g of CO_2 = 6.02×10^{23} particles = 22.414 dm^3 at S.T.P.

Q24: ***Why do pilots feel uncomfortable breathing at high altitude?***

Ans: *At higher altitude the partial pressure of oxygen is low. It makes breathing difficult. That's why pilots feel uncomfortable.*

Q25: ***Define Dalton's law of partial pressures. Give mathematical expression.***

Ans: *Dalton law of partial pressure state that the total pressure exerted by a mixture of non-reacting gasses is equal to the sum of the individual partial pressure of all the gasses present in a mixture.*

For example:

Three gases have partial pressure P_1, P_2 *and* P_3.

So according to Dalton's law

$$P_{Total} = P_1 + P_2 + P_3$$

Q26: How Dalton's law of partial pressure is useful in determining pressure of a gas collected over water? OR
What is aqueous tension?

Ans: According to the Daltons Law of partial pressure, 'The total pressure exerted by the mixture of non-reacting gases is equal to the sum of their individual partial pressures'

$$P = P_1 + P_2 + P_3 \ldots\ldots$$

Some gases are collected over water in laboratory. The gas during collection gathers water vapours and becomes moist. The partial pressure exerted by the water vapours is called aqueous tension.

$$P_{moist} = P_{dry} + P_{w.vapors}$$

$$P_{moist} = P_{dry} + P_{aqueous\ tension}$$

$$P_{dry} = P_{moist} - P_{aqueous\ tension}$$

Q27: Derive an expression to find out the partial pressure of a gas.

Ans: In a mixture of gasses partial pressure of any gas can be calculated.
Consider two gasses A and B. Let total pressure of mixture is P_t and number of moles n_t. While partial pressure of gas A is P_A and partial pressure of gas B is P_B.
Then we can write:

$$P_tV = n_t\,R\,T \longrightarrow \text{(i)}$$

$$P_AV = n_A\,R\,T \longrightarrow \text{(ii)}$$

$$P_BV = n_B\,R\,T \longrightarrow \text{(iii)}$$

Divide equation (ii) by equation (i)

$$\frac{P_AV}{P_tV} = \frac{n_A\,R\,T}{n_t\,R\,T}\ ,\qquad \frac{P_A}{P_t} = \frac{n_A}{n_t}$$

$$P_A = \frac{n_A}{n_t} \times P_t \quad or$$

$$P_A = X_A \times P_t$$

Similarly for gas "B"

$$P_B = X_B \times P_t$$

Q28: Animals inhale oxygen and exhale CO_2. Why? OR
How does the respiration process involve Dalton's law of partial pressure?

Ans: The process of respiration involves Dalton's law, Partial pressure of oxygen in air is 159 torr while in lungs, it is 116 torr. When animals inhale, oxygen diffuses from air into lungs. CO_2 moves in opposite direction, as its partial pressure in lungs is greater as compared t0 air.

Q29: State Dalton's law of partial pressure. Write its two applications.

Ans: Dalton law of partial pressure state that the total pressure exerted by a mixture of non-reacting gasses is equal to the sum of the partial pressure of all the gasses present in a mixture.

- *Deep sea divers take oxygen mixed with an inert gas and adjust the partial pressure of oxygen according to requirement.*

- *At higher altitudes the pilot's feel uncomfortable breathing because the partial pressure of oxygen in the un-pressurized cabin is low as compared to 159 torr, where one feels comfortable breathing.*

Q30: *Why do we feel comfortable in expressing the densities of gases in unite of $g\,dm^{-3}$ rather than $g\,cm^{-3}$ a unit which is used to express the densities of liquids and solids?*

Ans: *We feel comfortable in expressing the densities of gases in unite of $g\,dm^{-3}$ rather than $g\,cm^{-3}$ because gases have low masses and more volume are required to occupy. Gases are the lightest form of matter. Their densities are very low about 1000 times less than that of liquids and solids.*

Q31: *State Graham's law of diffusion and write its mathematical form.*

Ans: *The rate of diffusion or effusion of a gas is inversely proportional to the square root of its density at constant temperature and pressure.*

Mathematical form:

$$\text{Rate of diffusion} \propto \frac{1}{\sqrt{d}} \qquad \text{(at constant T and P)}$$

$$\text{Rate of diffusion} = \frac{K}{\sqrt{d}}$$

$$\text{Rate of diffusion} \times \sqrt{d} = K$$

Q32: *Why lighter gases diffuse more rapidly than heavier gases?*

Ans: *According to the Graham's law of diffusion, rate of diffusion of gases is inversely proportional to the square root of their molecular masses at constant temperature and pressure.*

Mathematically it can be represented as:

$$\frac{r_1}{r_2} = \frac{\sqrt{M_2}}{\sqrt{M_1}}$$

The diffusion of gas depends upon the rate of diffusion of gas. As the rate of diffusion is inversely proportional to the molecular mass of gas, so the lighter gases diffuse faster than the heavier gas.

Q33: *Differentiate between diffusion and effusion of gasses.*

Ans: *The difference between diffusion and effusion of gasses is:*

Diffusion of gasses	***Effusion of gasses***
Spontaneous mixing up of gas molecules by their random motion and collision to form a homogeneous mixture is called diffusion.	*The escaping out of gas molecules into low pressure region one by one without collisions through a tiny hole is called effusion.*

Q34: *Rate of diffusion of NH_3 gas is more than HCl gas. Why?*

Ans: Molar mass of $NH_3 = 17\ g\ mole^{-1}$

Molar mass of $HCl = 36.5\ g\ mole^{-1}$

According to Graham's law, rate of diffusion of gasses is inversely proportional to square root of their molar masses. Hence NH_3 has lower molar mass diffuse faster as compare to HCl.

$$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

Q35: ***Define Diffusion with two examples.***

Ans: *The spontaneous intermingling of molecules of one gas with another at a given temperature and pressure is called diffusion.*

The spreading of fragrance of a rose or a scent is due to diffusion. When two gases diffuse into each other, they tend to make their partial pressures same everywhere. Suppose NO_2 *a brown coloured gas and* O_2 *a colour less gas, are separated from each other by a partition (Fig). When the partition is removed, both diffuse into each other due to collisions and random motion.*

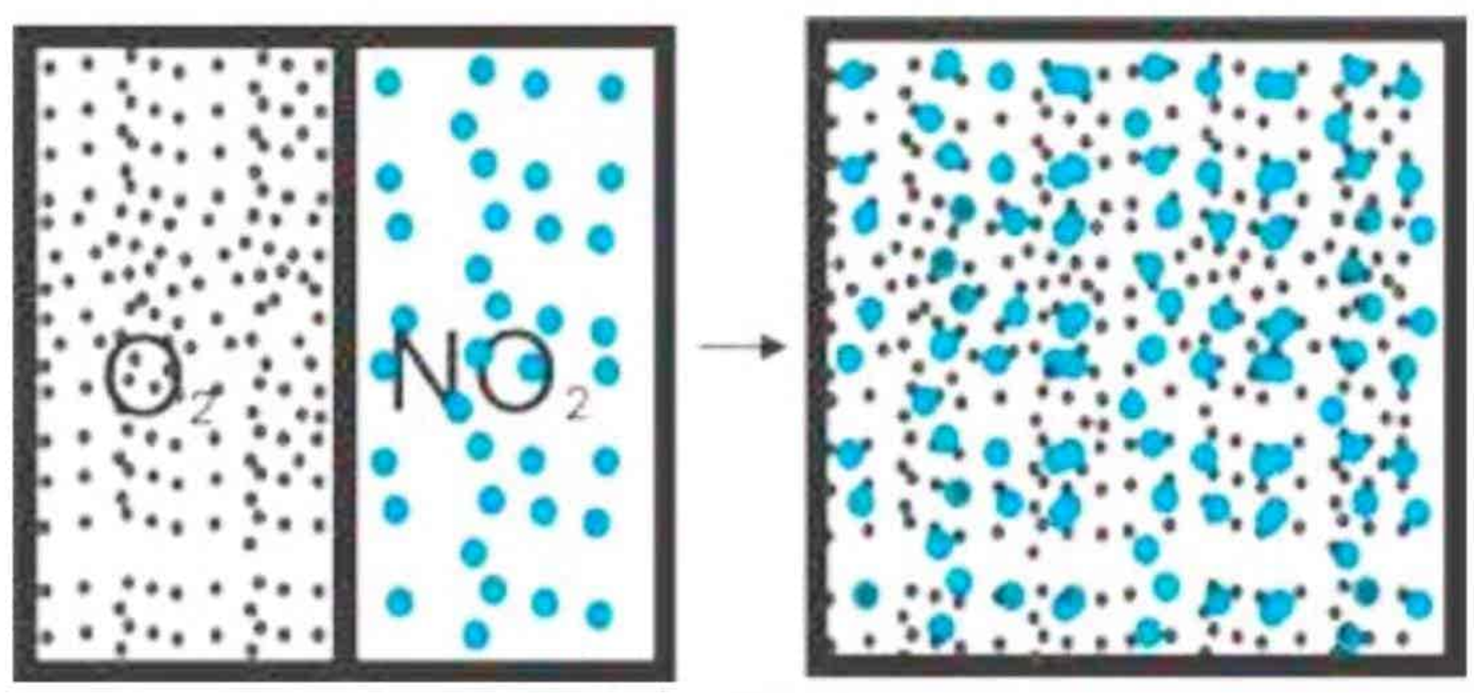

Fig Diffusion

Q36: ***Why*** H_2 ***diffuses more quickly than*** O_2***?***

Ans: *According to Graham's law:*

The rate of diffusion is inversely proportional to the square root of their molecular masses at constant temperature and pressure.

Mathematically:

$$\text{Rate of diffusion} \propto \frac{1}{\sqrt{M}}$$

As hydrogen (H_2) *has low molecular mass i.e* $2.016\ \text{g mol}^{-1}$ *than oxygen* O_2 *which has molecular mass* $= 32\ \text{g mol}^{-1}$. *Therefore* H_2 *diffuses more quickly than* O_2.

Q37: ***One*** dm^3 ***of*** H_2 ***and*** O_2 ***has different masses but occupy same volume. Give reason.***

Ans: *Although, Oxygen* (O_2) *molecule is 16 times heavier than hydrogen* (H_2) *but this does not disturb the volume occupied, because molecules of gases are widely separated from each other at STP.*

One molecule is approximately at a distance of 300 times its own diameter from its neighbour at room temperature.

Q38: ***Why deep sea divers do not use normal air for breathing in depth of sea?***

Ans: *Deep Sea divers take oxygen mixed with inert gas say "helium" adjust the partial pressure of oxygen according to the requirement. Actually, in sea after every 100 feet depth the diver experiences approximately 3 atm pressure, so normal air cannot be breathed in depth of sea. Moreover, the pressure of* N_2 *increases in depth of sea and it diffuses in the blood.*

Q39: ***What is the effect of pressure and heat on the behavior of gases?***

Ans: *At low pressure gas molecule move far apart and intermolecular attraction become insignificant. At high temperature, kinetic energy of molecules increases and intermolecular forces become weakens. Therefore, gases are ideal at low pressure and high temperature.*

Q40: ***List four postulates of kinetic theory of gases.***

Ans: The postulates of kinetic theory of gases are:

- *Gas molecules are in constant random motion.*
- *The actual volume of gas molecules in negligible as compared to total volume of the gas.*
- *The molecules of gasses are widely separated from one another therefore large empty space exists between them.*
- *All gasses consist of very small particles called molecules. Gasses like He, Ne, Ar have monoatomic molecules.*

Q41: *Apply kinetic molecular theory of gases to explain the Avogadro's law.* OR *Derive Avogadro's law from KMT.*

Ans: Consider two gasses 1 and 2 having same "P" and "V". Their number of molecules is N_1 *and* N_2 *and masses* m_1 *and* m_2.

There kinetic equation can be written as:

For gas 1:

$$PV = \frac{1}{3} m_1 N_1 \overline{C_1^2}$$

For gas 2:

$$PV = \frac{1}{3} m_1 N_2 \overline{C_2^2}$$

So,

$$\frac{1}{3} m_1 N_1 \overline{C_1^2} = \frac{1}{3} m_1 N_2 \overline{C_2^2}$$

$$m_1 N_1 \overline{C_1^2} = m_1 N_2 \overline{C_2^2} \longrightarrow (i)$$

When temperature is same than K.E of both gasses will also same so;

$$\frac{1}{2} m_1 N_1 \overline{C_1^2} = \frac{1}{2} m_1 N_2 \overline{C_2^2}$$

$$m_1 N_1 \overline{C_1^2} = m_1 N_2 \overline{C_2^2} \longrightarrow (ii)$$

Divide equation (ii) by equation (i)

$$N_1 = N_2$$

Hence equal volumes of all the gasses at same temperature and pressure contain equal number of molecules.

At higher altitudes the pilots' feel uncomfortable breathing because the partial pressure of oxygen in the un-pressurized cabin is low, as compared to 159 torr, where one feels comfortable breathing.

Q42: *Derive Graham's law of diffusion in the light of kinetic molecular theory of gases.*

Ans: According to kinetic molecular equation:

$$PV = \frac{1}{3} m N \overline{C^2} \longrightarrow (i)$$

If we take one mole of a gas having Avogadro's number of molecules N_A *then the equation (i) can be written as:*

$$PV = \frac{1}{3} m N_A \overline{C^2} \qquad (M = m N_A)$$

$M =$ *molar mass of gas*

$$\bar{C^2} = \frac{3PV}{M} \longrightarrow (ii)$$

We know that $d = \frac{M}{V}$ *and* $\frac{1}{d} = \frac{V}{M}$

Putting the value of $\frac{V}{M}$ *in equation* (ii)

$$\bar{C^2} = \frac{3P}{d} \longrightarrow (iii)$$

$$\sqrt{\bar{C^2}} = \sqrt{\frac{3P}{d}}$$

Where $\sqrt{\bar{C^2}} \infty r$

$$C_{r.m.s} = \sqrt{\frac{3P}{d}}$$

$$r \propto \frac{1}{\sqrt{d}}$$

That is called Graham's law.

Q43: *Explain Boyle's law in the light of kinetic molecular theory of gases.*

Ans: According to kinetic equation for ideal gas is:

$$PV = \frac{1}{3} m N \bar{C^2} \longrightarrow (i)$$

According to kinetic molecular theory of gasses the kinetic energy of gas molecules i-e is $\frac{1}{2}$ $m N \bar{C^2}$ *directly proportional to absolute temperature.*

$$\frac{1}{2} m N \bar{C^2} \propto T$$

$$\frac{1}{2} m N \bar{C^2} = KT \longrightarrow (ii)$$

Multiplying and divide equation (i) *by* 2

$$PV = \frac{2}{2} (\frac{1}{2} m N \bar{C^2})$$

$$PV = \frac{2}{3} (\frac{1}{2} m N \bar{C^2}) \longrightarrow (iii)$$

Putting equation (ii) *in equation* (iii)

$$PV = \frac{2}{3} KT$$

If $T =$ *constant then* $PV = K$

This is Boyle's law. It shows that at constant "T" volume of gas is inverse of its pressure.

Q44: *Derive Charles's law from kinetic theory of gases.* OR
Derive Charles's law by kinetic equation of gases.

Ans: According to kinetic theory, kinetic energy $\propto$ *Absolute temperature:*

$$\frac{1}{2} m N \bar{C^2} \propto T$$

$$\frac{1}{2}\, m\, N\, \bar{C^2} = KT \longrightarrow (i)$$

According to kinetic equation

$$PV = \frac{1}{3}\, m\, N\, \bar{C^2} \longrightarrow (ii)$$

Or, $$PV = \frac{2}{3}\left(\frac{1}{2}\, m\, N\, \bar{C^2}\right)$$

Or, $$PV = \frac{2}{3}\, KT$$

$$V = \frac{2}{3}\,\frac{KT}{P} = \frac{2K}{3P}\,T$$

Here, $$\frac{2K}{3P} = \text{Constant} = K'$$

$$V = K'\,T \quad \textit{Or} \quad \frac{V}{T} = K'$$

This is Charles's law.

Q45: ***What is mean square velocity?***

Ans:

$$PV = \frac{1}{3}\, m\, N\, \bar{C^2} \longrightarrow (i)$$

$$PV = nRT \longrightarrow (ii)$$

By comparing question (i) *and* (ii), *we get*

$$\frac{1}{2}\, m\, N\, \bar{C^2} = nRT$$

$$\bar{C^2} = \frac{3nRT}{mN}$$

Here, $n = 1$, $N = N_A$

$$\bar{C^2} = \frac{3RT}{mN_A}$$

$$\bar{C^2} = \frac{3RT}{M}$$

$$\sqrt{\bar{C^2}} = \sqrt{\frac{3RT}{M}}$$

$$C_{r.m.s} = \sqrt{\frac{3RT}{M}}$$

Q46: ***Describe two causes of deviation from ideality.*** **OR**
Give two faulty postulates of Kinetic Molecular Theory.

Ans: *The faulty postulates of Kinetic Molecular Theory are:*

- *There are no forces of attraction among the molecules of a gas.*
- *The actual volume of the gas molecules is negligible as compared to the volume of the vessel.*

Q47: ***Why is the plot of PV verses P a straight line at constant temperature and with a fixed number of moles of ideal gas?***

Ans: *Graph between* P *and* PV:

Plot of PV versus P at constant temperature and with fixed number of moles of an ideal gas is a straight line as shown below:

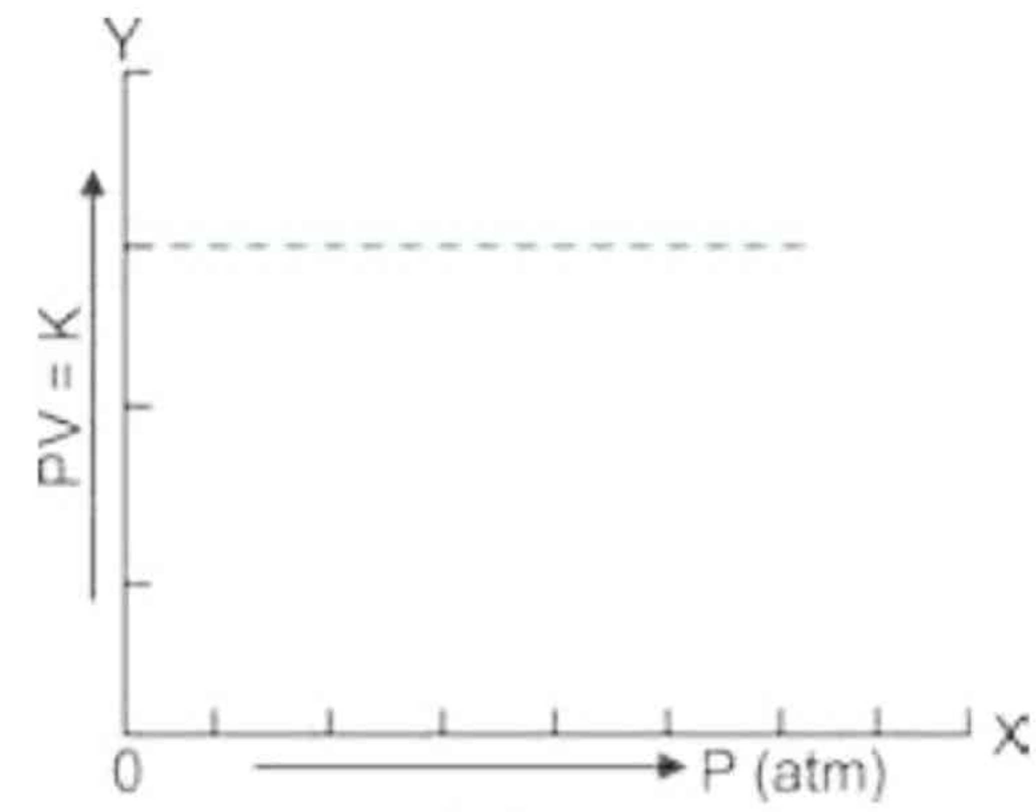

Fig A plot between pressure and product of P V

This straight line indicates that $PV = K$ *at all pressure and indicates ideality of gases.*

Q48: Water vapours do not behave ideally at 273 K?

Ans: 273 K *is the freezing point of water. At this temperature vapours of water have appreciable forces of attraction between them. Hence water vapours behave non-ideally at* 273 K.

Q49: What is critical temperature of a gas? What is its importance for liquefaction of gases?

Ans: The highest temperature, at which a substance can exist as liquid, is called critical temperature (T_C)'. *OR*

The temperature above which gas cannot be liquefied, no matter how much pressure is applied is called critical temperature (T_C)'.

Importance:

The value of critical temperature and critical pressure provide us information about the condition under which gases liquefy.

Q50: Define critical temperature and the critical volume of the gas.

Ans: Critical volume:

The volume occupied by one mole of a gas at critical temperature (T_C) *and critical pressure* (P_C) *is called critical volume. It is denoted by* V_C.

Just for information.

Table Critical Temperatures and Critical Pressures of Some Substances

Substance	Critical Temperature T_c (K)	Critical Pressure P_c (atm)
Water vapours, H_2O	647.6 (374.44 °C)	217.0
Ammonia, NH_3	405.6 (132.44 °C)	111.5
Freon-12 , CCl_2F_2	384.7 (111.54 °C)	39.6
Carbon dioxide, CO_2	304.3 (31.142 °C)	73.0
Oxygen, O_2	154.4 (-118.75 °C)	49.7
Argon, Ar	150.9 (-122.26 °C)	48
Nitrogen, N_2	126.1 (-147.06 °C)	33.5

Q51: Why critical temperature of NH_3 ***is higher than*** CO_2***?***

Ans: The critical temperature depends upon size, shape and intermolecular forces. As ammonia NH_3 *is polar molecule and larger in size than carbon dioxide. So the critical temperature of* NH_3 *is higher than* O_3.

Q52: ***Differentiate between critical temperature and critical pressure.***

Ans: *The difference between critical temperature and critical pressure is:*

Critical temperature	Critical pressure
➢ *The highest temperature at which a substance can exist as a liquid is called critical temperature.* ➢ *It is denoted by* T_C. ➢ *Example:* T_C *of water is* 647.6 K	➢ *The minimum pressure required to liquefy the gas at critical temperature is called critical pressure.* ➢ *It is denoted by* P_C. ➢ *Example:* P_C *of water is* 217 atm.

Q53: ***Why is the Critical temperature of Water is higher than Argon?***

Ans: *Non-polar gases of low polarizability like Ar have a very low critical temperature. The substances like* H_2O *vapours and* NH_3 *gas are among the polar gases and they have better tendencies to be liquefied. So that's why their critical temperature is high.*

Q54: ***Justify that the volume of given mass of a gas becomes theoretically zero at −273 °C.***

Ans: *Critical temperature of water is* 374.44 °C (647.6 K). *It means even at this temperature intermolecular forces of attraction operate between water vapors. As* 273 K *is lesser than* 373 K *so intermolecular forces become stronger at* 273 K *and water vapors will show extreme non-ideal behaviour.*

Q55: **H_2 *and* He *cannot be liquefied by Linde's method.***

Ans: *Both* H_2 *and* He *gases, have exceptionally low critical temperatures. These temperatures cannot be achieved by Linde's method. So, these gases cannot be liquefied by this method.*

Q56: ***Give general method for liquefactions.***

Ans: *To liquefy a gas, generally we require two conditions,*

- ➢ Low Temperature
- ➢ High Pressure

High pressure brings molecules of a gas close to each other while low temperature deprives the molecules from kinetic energy and attractive forces start dominating. Thus, a gas must be cooled below its critical temperature and then critical pressure is applied to bring about liquefaction.

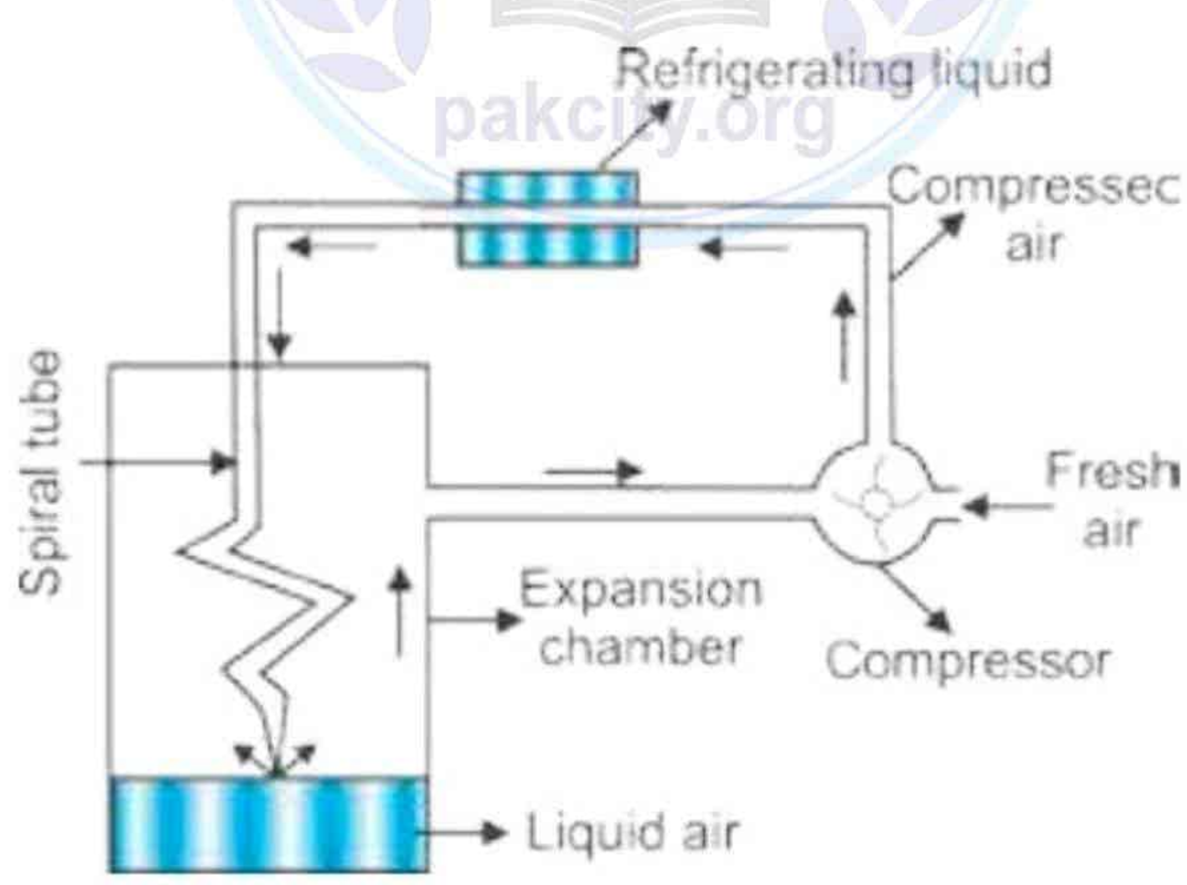

Fig Linde's method for the liquefaction of air

Q57: ***Real gases show non-ideal behaviour due to two assumptions of kinetic molecular theory. Explain?***

Ans: *Real gases show non-ideal behaviour due to these two assumptions of kinetic molecular theory is:*

- *The molecules of a gas have no forces of attraction for each other.*
- *The actual volume of molecules of a gas is negligible as compared to the volume of the gas.*

Keeping in view the basic assumptions given above, R.J Clausius deduced an expression for the pressure of an ideal gas. Actually, pressure on the walls of the vessel is due to collisions. Whenever the molecules move they collide among themselves and with the walls of the container. Due to these collisions force is exerted on the walls of the container.

Q58: ***Why gases show non-ideal behaviour at low temperature and high pressure?***

Ans: At low temperature, kinetic energy of gas molecules decreases and intermolecular attraction increases. At high pressure, molecules come close to each other and intermolecular attraction becomes significant. Due to intermolecular forces, real gases deviate from ideality.

Q59: ***Hydrogen and Helium are ideal at room temperature but SO_2 and Cl_2 are non-ideal. Explain?***

Ans: Both SO_2 *and* Cl_2 *have strong intermolecular forces between their molecules at room temperature due to greater size and greater polarizability. Factor* "b" *for both gases is very high. That's why* SO_2 *and* Cl_2 *are non-ideal.*

H_2 and He *both have small size and lesser polarizability. Due to which they have very weak forces of attraction and hence are ideal at room temperature.*

Q60: ***Pressure of NH_3 gas at given condition is less as calculated by Vander Wall's equation than that of calculated by general gas equation?***

Ans: Real gases always show somewhat less pressure as compared to an ideal gas at same conditions of temperature. NH_3 *is a real gas which possesses significant intermolecular forces. The force of attractions reduces the pressure. Hence the observed pressure is lower, which is calculated by Vander wall's equation.*

Q61: ***Give units of Vander wall's constants "a" and "b".***

Ans: (i) Units of "a":

$$P = \frac{an^2}{V^2}$$

$$a = \frac{PV^2}{n^2}$$

$$a = \frac{atm(dm^3)^2}{(mol)^2}$$

$$a = atm\ dm^6\ mol^{-2}$$

For S.I units:

$$P = Nm^{-2} \qquad V = m^3$$

$$a = \frac{PV^2}{n^2}$$

$$a = \frac{Nm^{-2}(m^3)^2}{(mol)^2} = \frac{Nm^{-2}(m^6)}{(mol)^2}$$

$$a = \frac{Nm^{+4}}{(mol)^2}$$

$$a = Nm^4 . mol^{-2}$$

(ii) Units of "b":

$$b = \frac{v}{n}$$

$$b = \frac{dm^3}{mol}$$

$$a = dm^3\ mol^{-1}$$

For S.I units:

$$b = \frac{m^3}{mol}$$

$$b = m^3 . mol^{-1}$$

Q62: ***Define plasma state. Give its one application.***

Ans: *Plasma state:*

Plasma is a mixture of neutral particles, positive ions and negative electrons. OR

Plasma is a substance in which many of the atom or molecules are effectively ionized allowing the charge to flow freely.

Applications: (From daily life)

- *Plasma can be used for cleaning and sterilization of operation theaters and food.*
- *Plasma can be used to destroy bacteria, virus, fungi etc.*

Q63: ***Where is plasma found?***

Ans: *Entire universe is almost of plasma. It existed before any other forms of matter came into being.*

Plasmas are found in everything from the sun to quarks, the smallest particles in the universe.

As stated earlier plasma is the most abundant form of matter in the universe. It is the stuff of stars. A majority of the matter in inner–stellar space is plasma.

All the stars that shine are all plasma. The sun is a 1.5 million kilometer ball of plasma, heated by nuclear fusion. One earth it only occurs in a few limited places, like lightning bolts, lames, auroras, and fluorescent lights. When an electric current is passed through neon gas, it produces both plasma and light.

Q64: ***What is Future Horizon of plasma?***

Ans: *Scientists are working on putting plasma to effective use. Plasma should have to be low energy and should be able to survive without instantly reacting and degenerating. The application of magnetic fields involves the use of plasma. The magnetic fields create low energy plasma which creates molecules that are in what scientist call a metastable state. These metastable particles are selective in their reactivity.*

It makes them a potentially unique solution to problems like radioactive contamination. Scientist is currently experimenting with mixtures of gases to work as metastable agents on plutonium and uranium, and this is just the beginning.

Q65: ***Write name of fourth state of matter. How can it be obtained.***

Ans: *Plasma is the fourth state of matter. It is obtained by heating the substance at high temperature. On heating substances change into atomic state and on further heating it changes to ions.*

Q66: ***Difference between artificial and natural plasma.***

Ans: The difference between artificial and natural plasma is:

Artificial plasma	Natural plasma
Artificial plasma can be created by using electrical charges on a gas as neon signs.	Natural plasma exists only at very high temperature or low temperature vacuum. Natural plasma does not react rapidly.

Q67: **Give two characteristics of plasma.**

Ans: The characteristics of plasma are:

Plasma must have sufficient number of charged particles so as a whole it exhibits a collective response to electric and magnetic fields. The motion of the particles in the plasma generates fields and electric currents from within plasma density. It refers to the density of the charged particles. This complex set of interactions of electrons and ions are fascinating and complex state of matter.

Although plasma includes electrons and ions and conducts electricity, it is macroscopically neutral. In measurable quantities the number of electrons and ions are equal.

Q68: **Write two uses of plasma.**

Ans: Plasma use in following terms:

- Plasma can be used to destroy bacteria, virus and fungi etc.
- Plasma can be used in semiconductors, sterilization of medical products.

Chapter : 03 Gases

Long Questions

Q1: State Boyle's law. Give its experimental verification.

Q2: What is ideal gas constant "R"? Calculate its value in different units? OR

State and explain general gas equation. Calculate value of "R" in S.I units.

Q3: Explain Avogadro's number. Explain principal and magnetic quantum numbers.

Q4: What is Dalton's law of Partial Pressure? Also discuss its applications. OR

State and explain Dalton's Law of Partial pressures. Derive an expression of calculating Partial pressure of a gas.

Q5: State and explain Graham's law of diffusion of gases. Give its experimental verification.

Q6: What is kinetic molecular theory of gases? Derive Boyle's law from kinetic equation. OR

How are Boyle's law and Charles's law derived from kinetic molecular theory of gases?

Q7: Explain non - ideal behavior of Gas. OR

Gases show non-ideal behaviour at low temperature and high pressure? Explain with the help of graph.

Q8: Describe Linde's method for the liquefaction of gases.

Q9: What is plasma? Write its three applications.

Q10: State Charles's law. Explain its experimental verification.

Q11: What is Kinetic Interpretation of temperature? Explain

Q12: Write down eight postulates of Kinetic molecular theory of gases.

Q13: 250cm^3 *of hydrogen gas is cooled from* 127 °C *to* −27 °C *keeping the pressure constant. Calculate the new volume of the gas at low temperature.*

Q14: Calculate the density of methane (CH_4) *at* 0 °C *and* 1 *atmospheric pressure.*

Q15: There is a mixture of Hydrogen, helium and methane occupying a vessel of volume 13 dm^3 *at* 37 °C *and* 1 atm. *The masses of* H_2 *and* He *are* 0.8 g *and* 0.12g *respectively. Calculate the mole fraction of each gas.*

Q16: A sample of Krypton with a volume of 6.25 dm^3 *a pressure of* 765 torr *and a temperature of* 20 °C *is expanded to a volume of* 9.55 dm^3 *and a pressure of* 375 torr. *What will be its final temperature in* °C?

Q17: What pressure is exerted by a mixture of 2.00 g *of* H_2 *and* 8.00 g *of* N_2 *at* 273 K *in a* 10 dm^3 *vessel?*

Q18: Calculate the number of atoms in 20 cm^3 *of* CH_4 *at* 0 °C *and pressure of* 700 mm *of* Hg.

Q19: One mole of methane is maintained at 300 K. *Its volume is* 250 cm^3. *Calculate the pressure exerted by the gas when it considered as an ideal gas.*

Q20: 250 cm^3 *of sample of hydrogen effuses four times as rapidly as* 250 cm^3 *of an unknown gas. Calculate the molar mass of unknown gas.*

Q21: A sample of N_2 *gas is enclosed in a vessel of volume* 380 cm^3 *at* 120 °C *and pressure of* 101325 Nm^{-2}. *This gas is transferred to a* 10 dm^3 *flask and cooled to* 27 °C. *Calculate the pressure in* Nm^{-2} *exerted by the gas at* 27 °C.

Q22: Calculate the mass of 1 dm^3 *of* NH_3 *gas at* 30 °C *and* 100mm/Hg *pressure considering the* NH_3 *is behaving ideally.*