

States of Matter

Q 1.

Calculate density of NH_3 at 30°C and 5 atm pressure

(IIT JEE 1978 – 3 Marks)

Q 2.

3.7 g of a gas at 25°C occupied the same volume as 0.184g of hydrogen at 17°C and at the same pressure. What is the molecular weight of the gas?

(IIT JEE 1979 – 4 Marks)

Q 3.

A straight glass tube has two inlets X and Y at two ends. The length of tube is 200 cm. HCl gas through inlets X and NH_3 gas through inlet Y are allowed to enter the tube at the same time. What fumes appear at point P inside the tube. Find distance of P from X.

(IIT JEE 1980 – 3 Marks)

Q 4.

1 litre of mixture of CO and CO_2 is taken. The mixture is passed through a tube containing red hot charcoal. The volume now becomes 1.6 litre. The volumes are measured under the same conditions. Find the composition of mixture by volume.

(IIT JEE 1980 – 3 Marks)

Q 5.

The pressure in a bulb dropped from 2000 to 1500 mm of mercury in 47 minutes when the contained oxygen leaked through a small hole. The bulb was then evacuated. A mixture of oxygen and another gas of molecular weight 79 in the molar ratio of 1 : 1 at a total pressure of 4000 mm of mercury was introduced. Find the molar ratio of the two gases remaining in the bulb after a period of 74 minutes.

(IIT JEE 1981 – 3 Marks)

Q 6.

At room temperature, ammonia gas at 1 atm pressure and hydrogen chloride gas at P atm pressure are allowed to effuse through identical pin holes from opposite ends of a glass tube of one meter length and of uniform cross-section. Ammonium chloride is first formed at a distance of 60 cm from the end through which HCl gas is sent in. what is the value of P?

(IIT JEE 1982 – 4 Marks)

Q 7.

Calculate the average of kinetic energy, in joules of the molecules in 8.0 g of methane at 27°C .

(IIT JEE 1982 – 2 Marks)

Q 8.

Oxygen is present in 1 litre flask at a pressure of 7.6×10^{-10} mm Hg. Calculate the number of oxygen molecular in the flask at 0°C .

(IIT JEE 1983 – 2 Marks)

Q 9.

When 2 gm of a gas A is introduced into an evacuated flask kept at 25°C, the pressure is found to be one atmosphere. If 3 gm of another gas B is then added to the same flask, the total pressure becomes 1.5 atm. Assuming ideal gas behavior, calculate the ratio of the molecular weights $M_A : M_B$. (IIT JEE 1983 – 2 Marks)

Q 10.

Equal volumes of gases contain equal number of atoms, is true at what conditions. (IIT JEE 1984 – 1 Marks)

Q 11.

Calculate the root mean square velocity of ozone kept in a closed vessel at 20°C and 82 cm mercury pressure. (IIT JEE 1985 – 2 Marks)

Q 12.

A spherical balloon of 21 cm diameter is to be filled up with hydrogen at N.T.P. from a cylinder containing the gas at 20 atmospheres at 27°C. If the cylinder can hold 2.82 litres of water, calculate the number of balloons that can be filled up. (IIT JEE 1987 – 5 Marks)

Q 13.

The average velocity at T_1K and the most probable velocity at T_2K of CO_2 gas is 9.0×10^4 cm sec⁻¹. Calculate the value of T_1 and T_2 . (IIT JEE 1990 – 4 Marks)

Q 14.

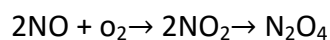
Calculate the volume occupied by 5.0 g of acetylene gas at 50°C and 740 mm pressure. (IIT JEE 1991 – 2 Marks)

Q 15.

At 27°C, hydrogen is leaked through a tiny hole into a vessel for 20 minutes. Another unknown gas at the same temperature and pressure as that of H_2 is leaked through the same hole for 20 minutes. After the effusion of the gases the mixture exerts a pressure of 6 atmosphere. The hydrogen content of the mixture is 0.7 mole. If the volume of the container is 3 litres, what is the molecular weight of the unknown gas? (IIT JEE 1992 – 4 Marks)

Q 16.

At room temperature the following reactions proceed nearly to complete :



The dimer, N_2O_4 , solidifies at 262 K. A 250 ml flask and a 100 ml. flask are separated by a stopcock. At 300 K, the nitric oxide in the larger flask exerts a pressure of 1.053 atm. And the smaller one contains oxygen at 0.789 atm. The gases are mixed by opening the stopcock and after the end of the reaction the flasks are cooled at 220K. Neglecting the vapour pressure of the dimer, find out the pressure and composition of the gas remaining at 220 K. (Assume the gases to behave ideally). (IIT JEE 1992 – 4 Marks)

Q 17.

A gas bulb of 1 litre capacity contains 2.0×10^{21} molecules of nitrogen exerting a pressure of $7.57 \times 10^3 \text{ Nm}^{-2}$. Calculate the root mean square (r.m.s) speed and the temperature of the gas molecules. If the ratio of the most probable speed to the root mean square speed is 0.82, calculate the most probable speed for these molecules at this temperature.

(IIT JEE 1993 – 4 Marks)

Q 18.

A 4 : 1 molar mixture of He and CH_4 is contained in a vessel at 20 bar pressure. Due to a hole in the vessel, the gas mixture leaks out. What is the composition of the mixture effusing out initially?

(IIT JEE 1994 – 2 Marks)

Q 19.

An LPG (liquefied petroleum gas) cylinder weighs 14.8 kg when empty. When full, it weighs 29.0 kg and shows a pressure of 2.5 atm. In the course of use at 27°C , the weight of the full cylinder reduces to 23.3 kg. Find out the volume of the gas in cubic meters used up at the normal usage conditions, find the final pressure inside the cylinder. Assume LPG to be *n*-butane with normal boiling point of 0°C .

(IIT JEE 1994 – 3 Marks)

Q 20.

A mixture of ethane (C_2H_6) and ethane (C_2H_4) occupies 40 litres at 1.00 atm and at 400 K. the mixture reacts completely with 130 g of O_2 and H_2O . Assuming ideal gas behaviors, calculate the mole fractions of C_2H_2 and C_2H_6 in the mixture.

(IIT JEE 1995 – 4 Marks)

Q 21.

The composition of the equilibrium mixture ($\text{Cl}_2 \rightleftharpoons 2\text{Cl}$), which is attained at 1200°C , is determined by measuring the rate of effusion through a pin-hole. It is observed that at 1.80 mmHg pressure, the mixture effuses 1.16 times as fast as krypton effuses under the same conditions. Calculate the fraction of the chlorine molecules dissociated into atoms. (relative atomic mass of Kr = 84.)

(IIT JEE 1995 – 4 Marks)

Q 22.

A 20.0 cm^3 mixture of CO, CH_4 and He gases is exploded by an electric discharge at room temperature with excess of oxygen. The volume contraction is found to be 13.0 cm^3 . A further contraction of 14.0 cm^3 occurs when the residual gas is treated with KOH solution. Find out the composition of the gaseous mixture in terms of volume percentage.

(IIT JEE 1995 – 4 Marks)

Q 23.

One litre of a mixture of O_2 and O_3 at NTP was allowed to react with an excess of acidified solution of KI. The iodine liberated required 40 ml of M/10 sodium thiosulphate solution for titration. What is the weight percent of ozone in the mixture? Ultraviolet radiation of wavelength 300 nm can decompose ozone. Assuming that one photon can decompose one

ozone molecule, how many photons would have been required for the complete decomposition of ozone in the original mixture? **(IIT JEE 1997C – 5 Marks)**

Q 24.

One way of writing the equation of state for real gases is $PV = RT[1 + B/V + \dots]$ where B is a constant. Derive an approximate expression for B in terms of the Van der Waal's constant a and b . **(IIT JEE 1997C – 2 Marks)**

Q 25.

An evacuated glass vessel weighs 50.0 g when empty, 148.0 g when filled with a liquid of density 0.98 g mL^{-1} and 50.0 g when filled with an ideal gas at 760 mmHg at 300K. Determine the molar mass of the gas **(IIT JEE 1998 -3 Marks)**

Q 26.

The degree of dissociation is 0.4 at 400K and 1.0 atm for the gaseous reaction $\text{PCl}_5 \rightleftharpoons \text{PCl}_3 + \text{Cl}_2$. Assuming ideal behavior of all gases, calculate the density of equilibrium mixture at 400 K and 0.1 atmosphere. (Relative atomic mass of P = 31.0 and Cl = 35.5)

(IIT JEE 1998 – 3 Marks)

Q 27.

Using van der 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 atmospheres at a temperature of 300 K. The value of 'b' is 0.05 L mol^{-1} . **(IIT JEE 1998 – 4 Marks)**

Q 28.

For the reaction, $\text{N}_2\text{O}_5(\text{g}) = 2\text{NO}_2(\text{g}) + 0.5 \text{O}_2(\text{g})$, calculate the mole fraction of $\text{N}_2\text{O}_5(\text{g})$ decomposed at constant volume temperature, if the initial pressure is 600 mm Hg and the pressure at any time is 960 mm Hg. Assume ideal gas behavior. **(IIT JEE 1998 – 3 Marks)**

Q 29.

One mole of nitrogen gas at 0.8 atm takes 38 s to diffuse through a pinhole, whereas one mole of an unknown compound of xenon with fluorine at 1.6 atm takes 57 s to diffuse through the same hole. Calculate the molecular formula of the compound. **(IIT JEE 1999 – 5 Marks)**

Q 30.

The pressure exerted by 12 g of an ideal gas at temperature $t^\circ\text{C}$ in a vessel of volume V litre is one atm. When the temperature is increased by 10 degrees at the same volume, the pressure increases by 10%. Calculate the temperature t and volume V . (Molecular weight of the gas = 120.) **(IIT JEE 1999 – 5 Marks)**

Q 31.

Calculate the pressure exerted by one mole of CO_2 gas at 273 K if the van der Waal's constant $a = 3.592 \text{ dm}^6 \text{ atm mol}^{-2}$. Assume that the volume occupied by CO_2 molecules is negligible. **(IIT JEE 2000 – 2 Marks)**

Q 32.

The compression factor (compressibility factor) for one mole of a van der Waal's at 0°C and 100 atmospheric pressure is found to be 0.5. Assuming that the volume of a gas molecule is negligible, calculate the van der Waals constant a . **(IIT JEE 2001 – 5 Marks)**

Q 33.

The density of the vapour of a substance at 1 atm pressure and 500 K is 0.36 kg m^{-3} . The vapour effuses through a small hole at a rate of 1.33 times faster than oxygen under the same condition.

(a) Determine

(i) Molecular weight,

(ii) molar volume,

(iii) Compression factor (Z) of the vapour and

(iv) Which forces among the gas molecules are dominant, the attractive or the repulsive?

(b) If the vapour behaves ideally at 1000 K, determine the average translational kinetic energy of a molecule. **(IIT JEE 2002 – 5 Marks)**

Q 34.

The average velocity of gas molecules is 400 m/sec. Calculate its rms velocity at the same temperature. **(IIT JEE 2003 – 2 Marks)**

Q 35.

A graph is plotted between PV_m along Y-axis and P along X-axis, where V_m is the molar volume of a real gas. Find the intercept along Y-axis. **(IIT JEE 2004 – 2 Marks)**