

Previous year JEE questions 10

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 metre 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 ?
(1982 - 4 Marks)

Since the pressures of gases are different, and the temperature is constant, the rate at which molecules of the two gases diffuse is directly proportional to the pressure. This rate of diffusion is also directly proportional to the distance travelled by the gas. Hence

$$r_1 \text{ (of HCl gas) at pressure } P = 60 = \frac{kP}{\sqrt{36.5}} \quad \dots(i)$$

$$\text{and } r_2 \text{ (of NH}_3\text{) at 1 atm. pressure } P=40 = \frac{k \times 1}{\sqrt{17}} \quad \dots(ii)$$

From (i) and (ii)

$$\frac{r_1}{r_2} = \frac{60}{40} = \frac{kP}{\sqrt{36.5}} \times \frac{\sqrt{17}}{k \times 1}$$

$$P = \frac{60}{40} \times \frac{\sqrt{36.5}}{\sqrt{17}} = \mathbf{2.197 \text{ atm}}$$