Problems Related with Mercury Tube & SPM

Course on States of Matter for Class XI

akhilesh • Lesson 12 • July 29, 2021

$$\frac{(r_A)}{(r_B)} = \frac{P_A}{P_B}\sqrt{\frac{M_B}{M_A}}$$

$$-\frac{dn}{dt} = \frac{PA_0}{(2\pi RTM)^{1/2}}$$

Assuming rate of effusion to be constant with time.

Instantaneous rate = average rate

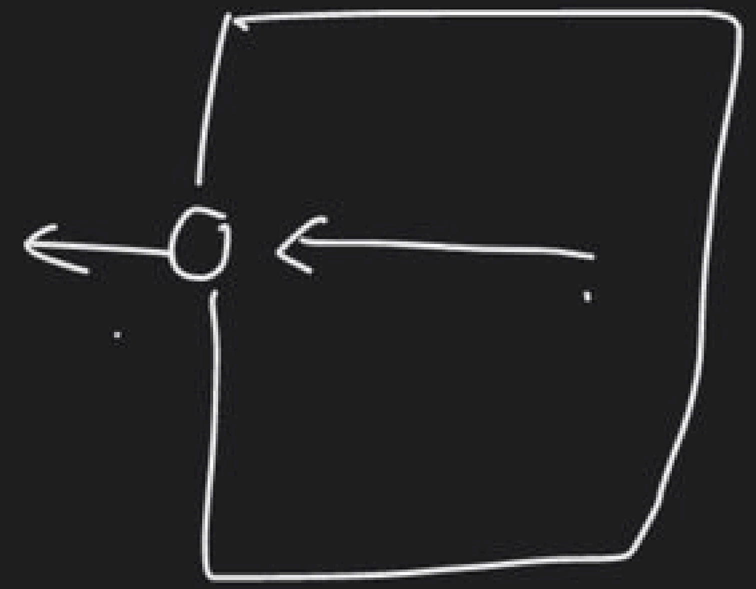
rate of effusion = $\dfrac{\text{no. of moles effused}}{\text{time taken}} \propto \dfrac{\text{vol. of effused gas}}{\text{time taken}}$

$$= n'_A / t_A$$

$$\frac{n'_A / t_A}{n'_B / t_B} = \frac{n_A}{n_B}\sqrt{\frac{M_B}{M_A}}$$

$$\frac{V_A / t_A}{V_B / t_B} = \frac{n_A}{n_B}\sqrt{\frac{M_B}{M_A}}$$

$$\frac{P'_A/t_A}{P'_B/t_B} = \frac{n_A}{n_B}\sqrt{\frac{M_B}{M_A}}$$



rate of effusion $\propto$ speed $= \dfrac{\text{distance travelled}}{\text{time taken}}$

$$\frac{d_A/t_A}{d_B/t_B} = \frac{n_A}{n_B}\sqrt{\frac{M_B}{M_A}}$$

Q. A container contains equal mass of He & CH_4. Calculate the no of moles of He effused in 10 sec if no. of moles of CH_4 effused are 0.5 in 10 sec.

$$\frac{n_{He}}{0.5} = \frac{4}{1}\sqrt{\frac{16}{4}} = 8$$

$$\underline{\underline{n_{He} = 4}}$$

A Classroom consist of 13 equidistant rows of benches. A student seating on 1st bench releases N_2O (laughing gas). simultaneous a student releases weeping gas (Mol. mass = 176) from last bench. find the bench at which students starts laughing and weeping simultaneously

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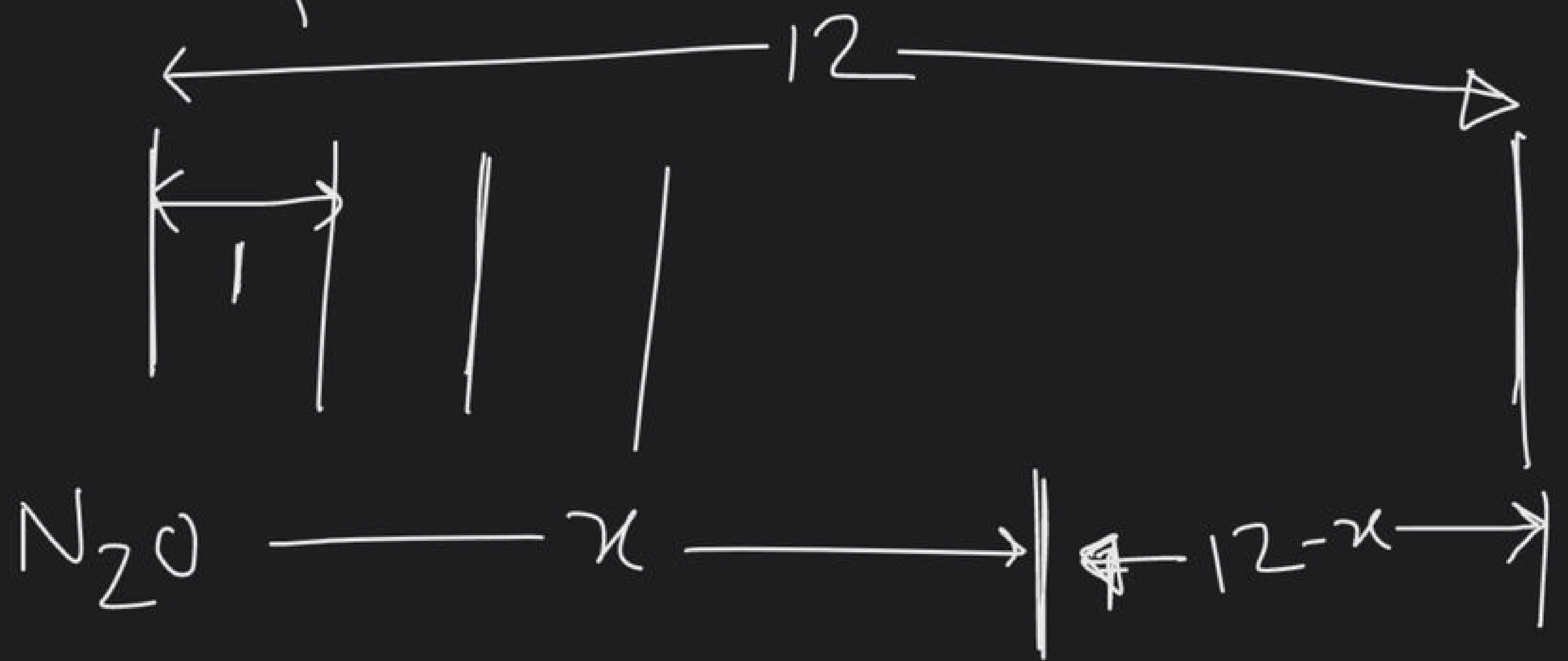
no. of bench from front

(A) 4

(B) 5

(C) 8

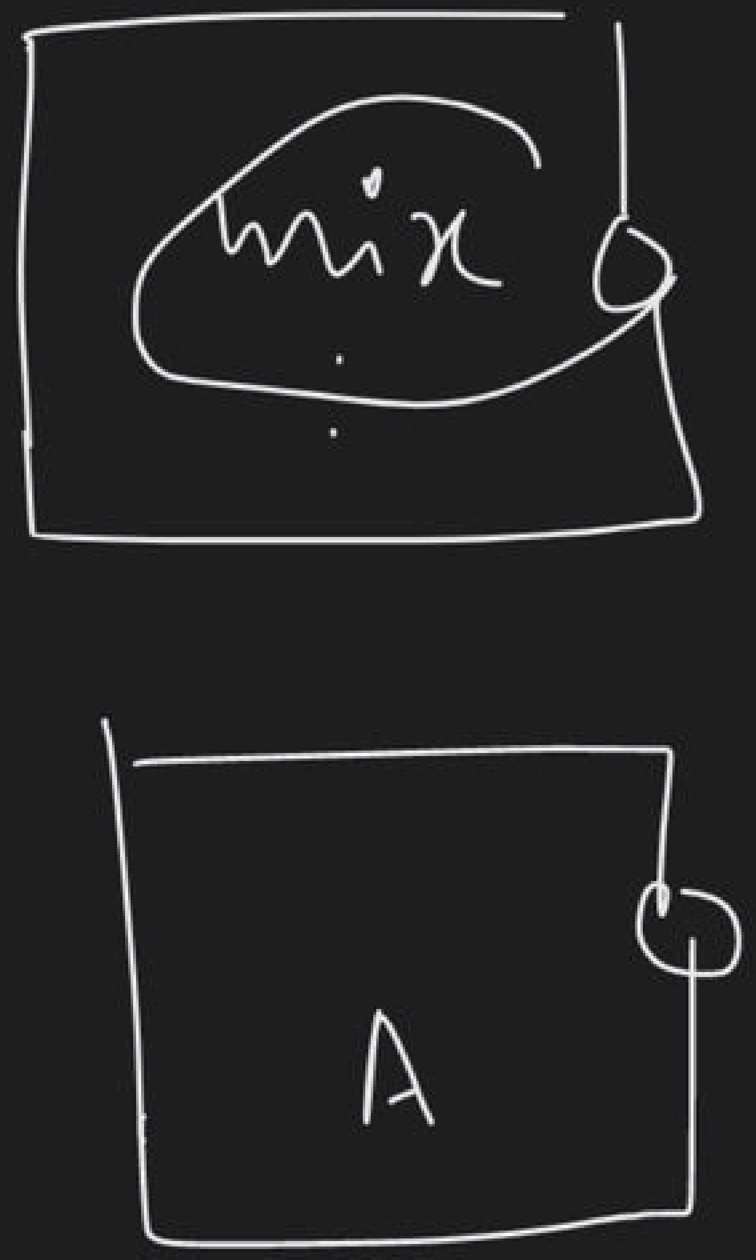
(D) 9



$$\frac{x}{12-x} = \sqrt{\frac{176}{44}} = 2$$

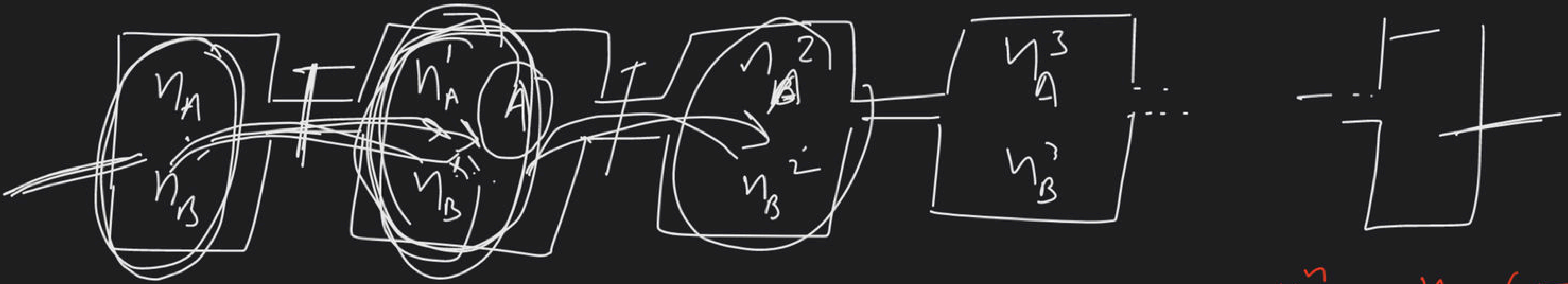
$$x = 8$$

9^{th} Bench



$$\frac{r_{mix}}{r_A} = \sqrt{\frac{M_A}{M_{avg}}}$$

No. of effusion steps :→ Enrichment



$$\frac{n_A^1}{n_B^1} = \underbrace{\frac{n_A}{n_B}\sqrt{\frac{M_B}{M_A}}}$$

$$\frac{n_A^2}{n_B^2} = \frac{n_A^1}{n_B^1}\sqrt{\frac{M_B}{M_A}}$$

$$= \frac{n_A}{n_B}\left(\sqrt{\frac{M_B}{M_A}}\right)^2$$

$$\frac{n_A^n}{n_B^n} = \frac{n_A}{n_B}\left(\sqrt{\frac{M_B}{M_A}}\right)^n$$

Q. A mixture contains CH_4 & O_2 in 1 : 4 mol ratio. find the no. of effusion step required to achieve 4 : 1 mole ratio of CH_4 to O_2.

(A) 4

(B) 2

(C) 8

(D) None

$$\frac{n_{CH_4}}{n_{O_2}} = \frac{1}{4}\left(\sqrt{\frac{32}{16}}\right)^n = \frac{4}{1}$$

$$n = 8$$

U^{235}

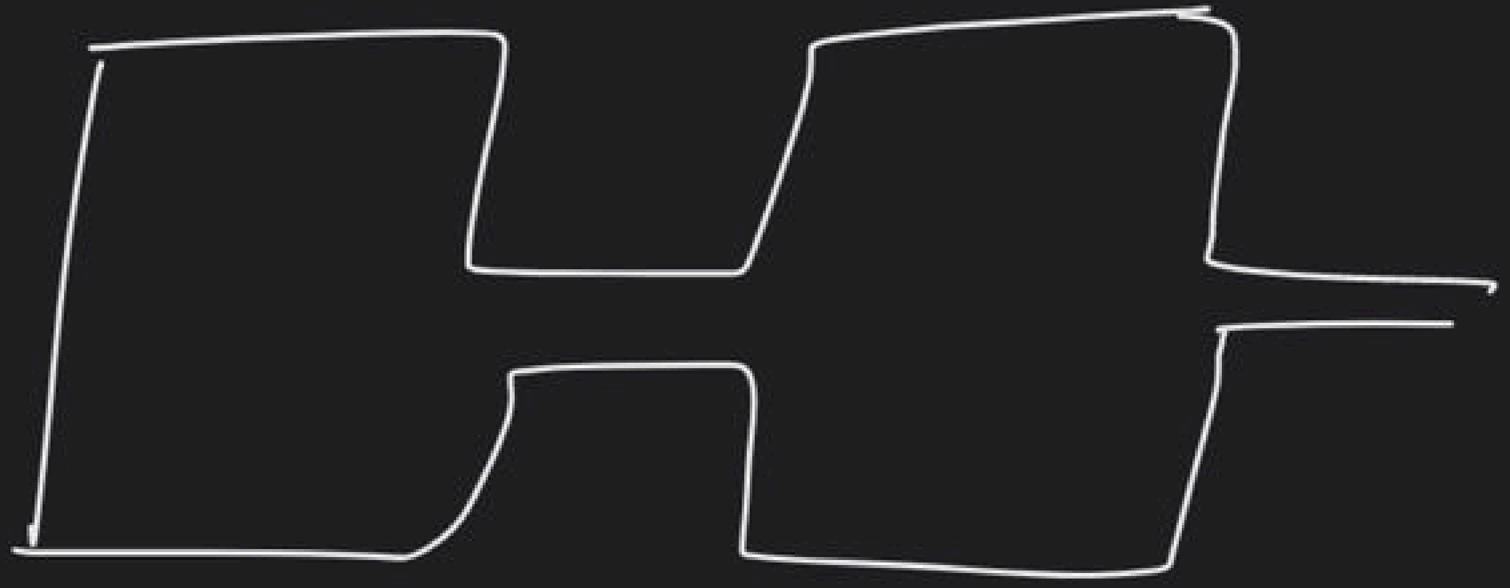
U^{238}

$U^{235}F_6$

349

$U^{238}F_6$

352



If rate of effusion is not const

$$\boxed{-\frac{dn}{dt} = \frac{PA_0}{(2\pi MRT)^{1/2}}}$$

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

$$= \frac{nRT}{V}\frac{A_0}{(2\pi MRT)^{1/2}}$$

$$C = \frac{A_0}{V}\left(\frac{RT}{2\pi M}\right)^{1/2}$$

$$\int_{n_0}^{n_t}\frac{dn}{n} = -\frac{A_0}{V}\left(\frac{RT}{2\pi M}\right)^{1/2}\int_0^t dt$$

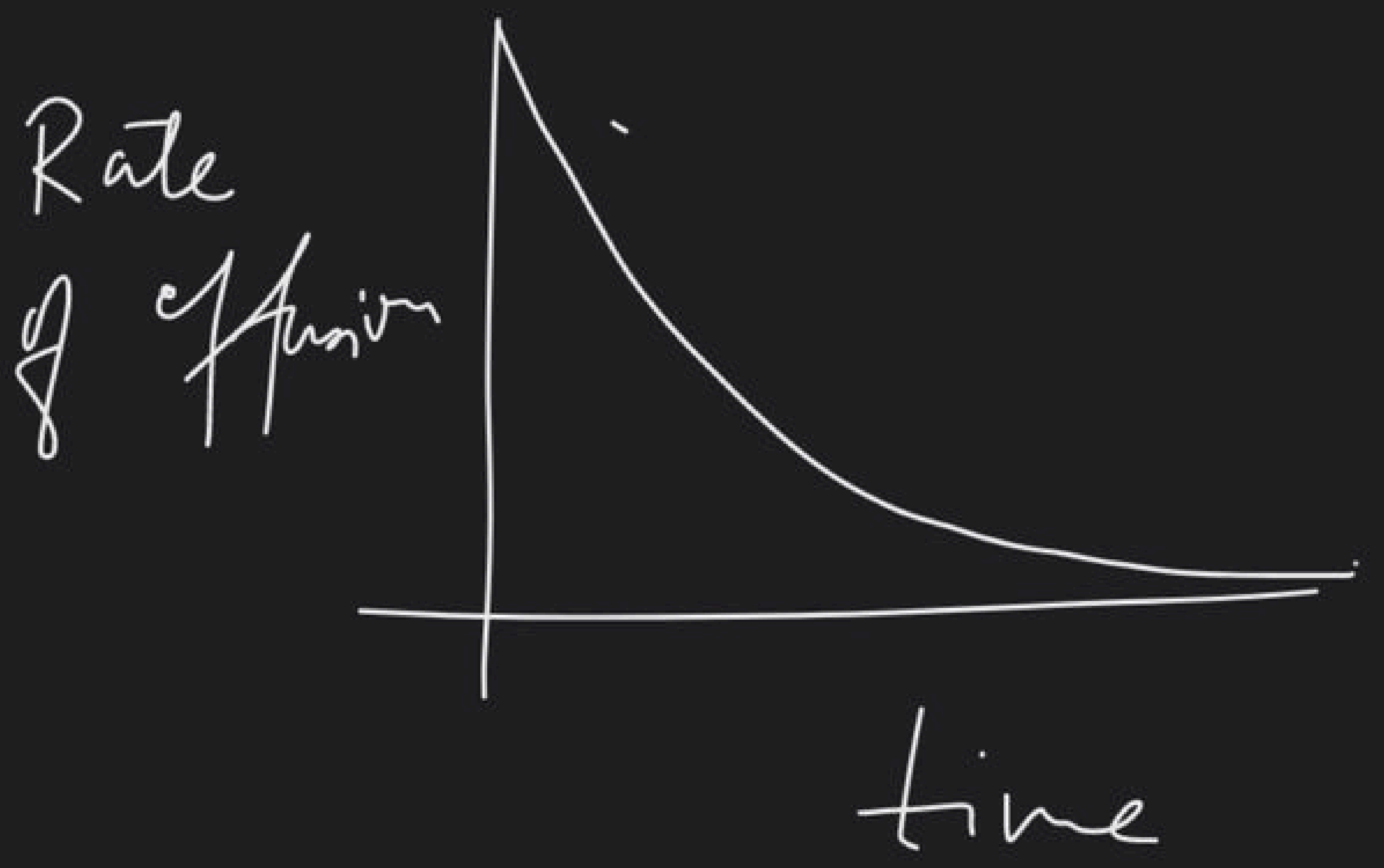
$$\boxed{n_t = n_0 e^{-Ct}}$$

$$\frac{P_t V}{RT} = \frac{P_0 V}{RT} e^{-ct}$$

$$\boxed{\begin{aligned} P_t &= P_0 e^{-ct} \\ n_t &= n_0 e^{-ct} \end{aligned}}$$

$$\left(-\frac{dn_t}{dt}\right) = n_0 c \, e^{-ct}$$

rate of effusion



$$\frac{4/5}{4/10} = \sqrt{\frac{36}{M_{mix}}} = \frac{2}{1}$$

$$\boxed{M_{mix} = 9}$$

113. Under identical conditions of pressure and temperature. 4 L of gaseous mixture (H_2 and CH_4) effuses through a hole in 5min whereas 4 L of a gas X of molecular mass 36 takes to 10 min to effuse through the same hole. The mole ratio of $H_2 : CH_4$, in the mixture is -

(A) 1 : 2 (B) 2 : 1 (C) 2 : 3 (D) 1 : 1

H_2 CH_4

2 16

9

5-1 15-22

6-1 12-23

129. For the reaction $2NH_3(g) \rightarrow N_2\ (g) + 3H_2\ (g)$. What is the % of NH_3 converted if the mixture diffuses twice as fast as that of SO_2 under similar conditions

(A) 3.125 (B) 6.25 (C) 12.5 (D) none

$t_{1/2}$ when $n_t = n_0/2 = \cancel{n_0}\, e^{-ct_{1/2}}$

$$\ln 1/2 = -ct_{1/2}$$

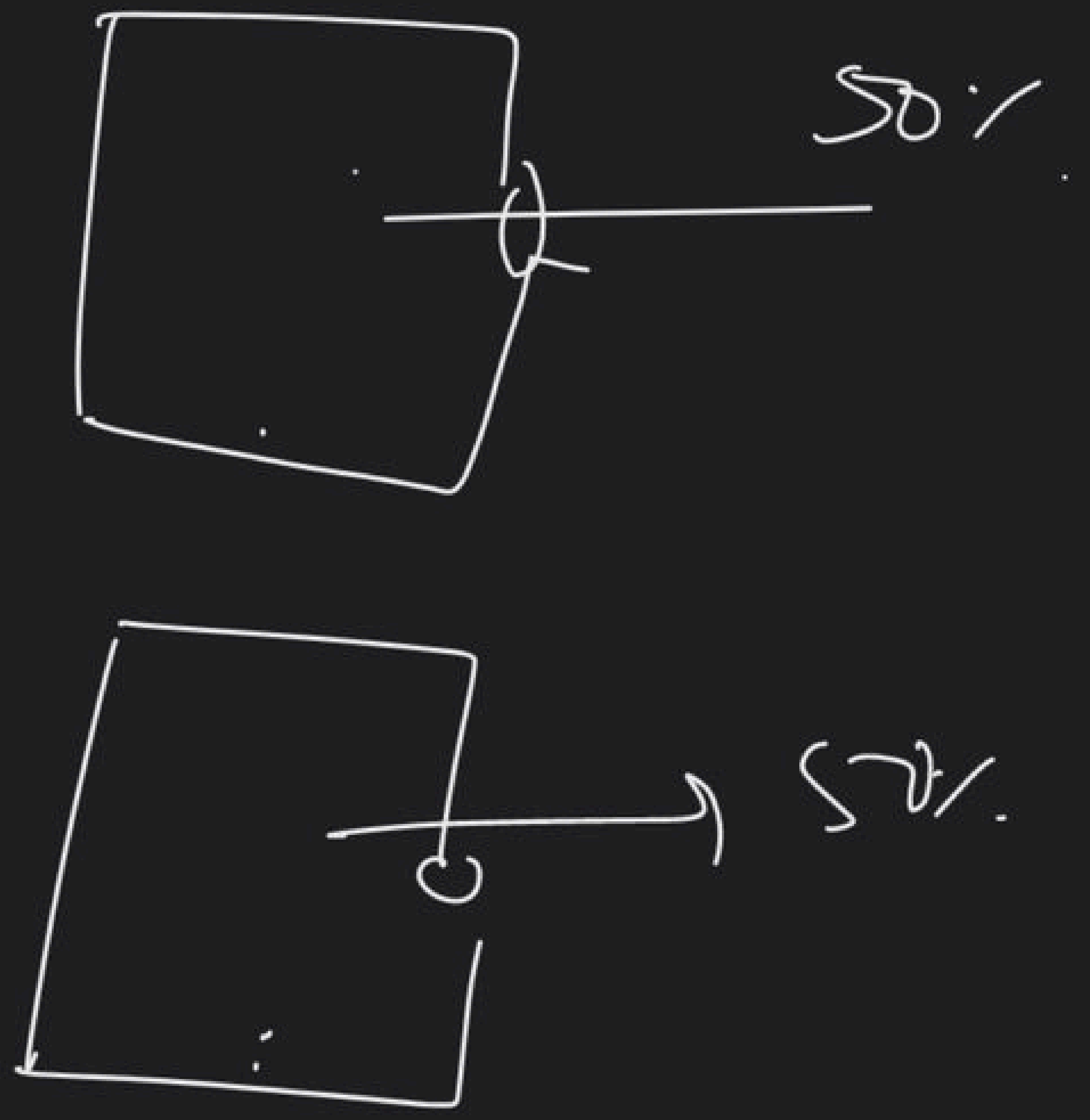
$$\boxed{\frac{\ln 2}{c} = t_{1/2}}$$

$100 \rightarrow 50$

time = same

$500 \rightarrow 250$

In equal interval of time, equal percentages of gases are effused



time Same