Q-1) D

from definition of chemical Equilibrium.

Q-2)

$$K_p = K_c (RT)^{\Delta n_g}$$

$$\text{if } \Delta n_g = 0$$

$$K_p = K_c.$$

i.e. C will be Answer,

Q-3) D

A) In terms of Partial Pressure K_p is used

B) In terms of Concentration K_c is used

c) relation between K_p & K_c

All are true

i.e- Ans is D.

④ $$\frac{K_P}{K_C} = (RT)^{\Delta n_g}$$

or $$\log\left(\frac{K_P}{K_C}\right) = \Delta n_g \log RT$$

if Δn_g is -1 then it will be
Same expression as ask in Question.
for option B, $\boxed{\Delta n_g = -1}$

Q.5 Ans (C)
from theory we know that K_C
depends only on temperature
for a fix reaction.

Q-6 At Constant Pressure, equilibrium
shifts in the direction where
number of moles are more.
but equilibrium constant
remain same.

Ans. <u>C</u>

2

Q.7 eq. const. for reverse of given reaction

$$K'_c = \frac{1}{5 \times 10^{-2}}$$

and after multiply by 2

$$K''_c = \left(\frac{1}{5 \times 10^{-2}}\right)^2 = \frac{1}{25 \times 10^{-4}}$$

$$= \frac{10000}{25} = 4000 \quad (A)$$

Q.8 from Q

$$K_1 = \frac{[CO_2][H_2]}{[CO][H_2O]}$$

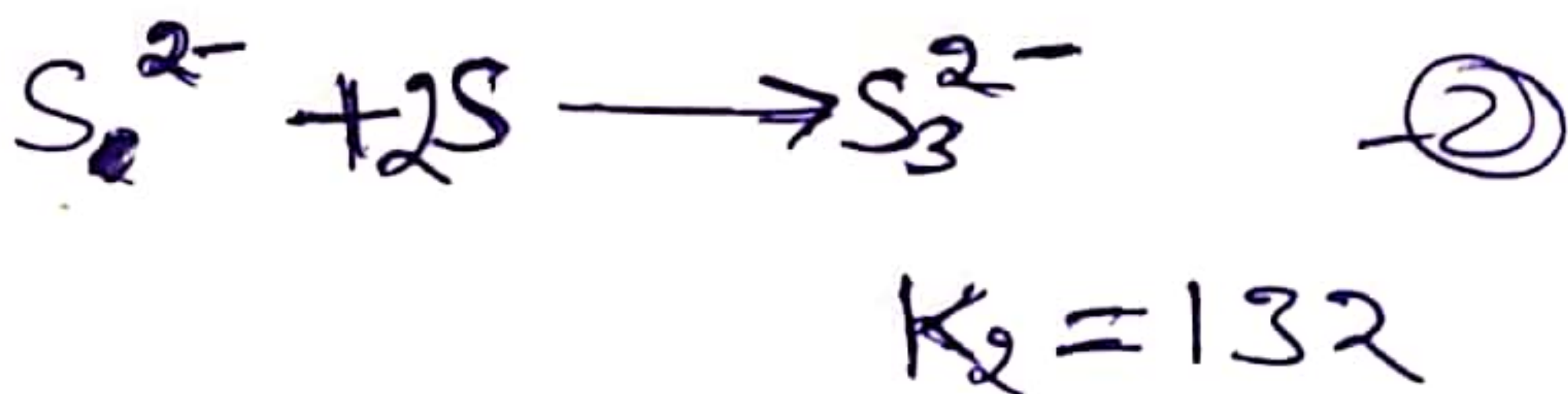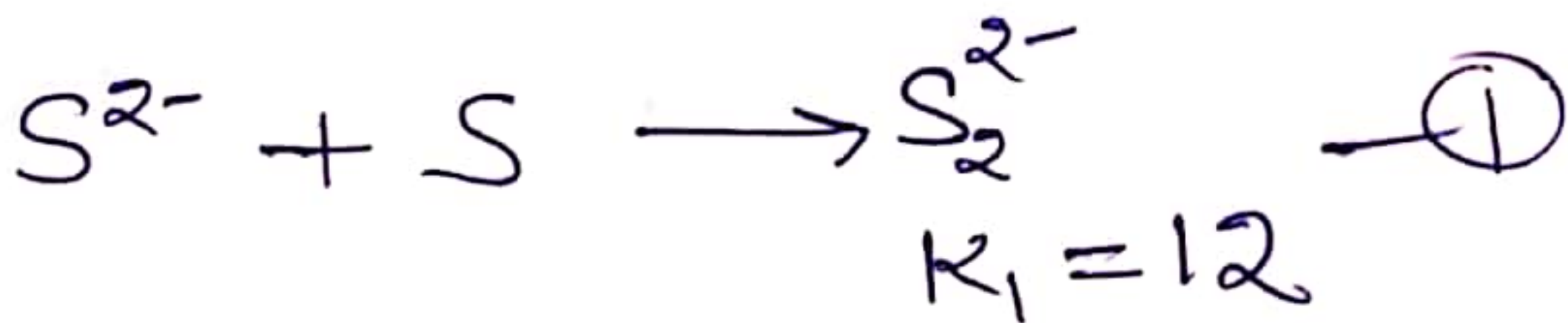$$K_2 = \frac{[CO][H_2]^3}{[CH_4][H_2O]}$$

Now check each option.

$$K_3 = \frac{[CO_2][H_2]^4}{[CH_4][H_2O]^2}$$
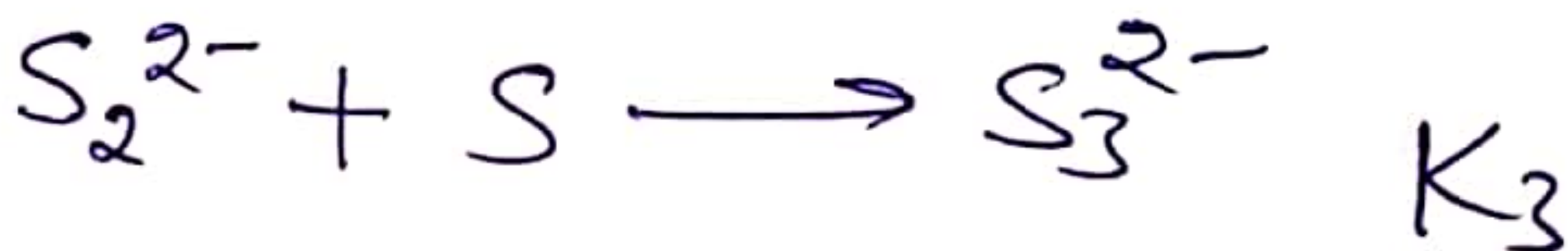
For option C.

$$K_1 \times K_2$$

$$= \frac{[CO_2][H_2]}{[CO][H_2O]} \times \frac{[CO][H_2]^3}{[CH_4][H_2O]} = K_3$$

(9)

$$S^{2-} + S \longrightarrow S_2^{2-} \qquad \text{—①}$$
$$K_1 = 12$$

$$S_2^{2-} + 2S \longrightarrow S_3^{2-} \qquad ②$$
$$K_2 = 132$$

Target rxⁿ : rev. of ① + ②

$$S_2^{2-} + S \longrightarrow S_3^{2-} \qquad K_3$$

i.e. $K_3 = \dfrac{K_2}{K_1} = \dfrac{132}{12}$

(A) $\qquad 11$

(10)
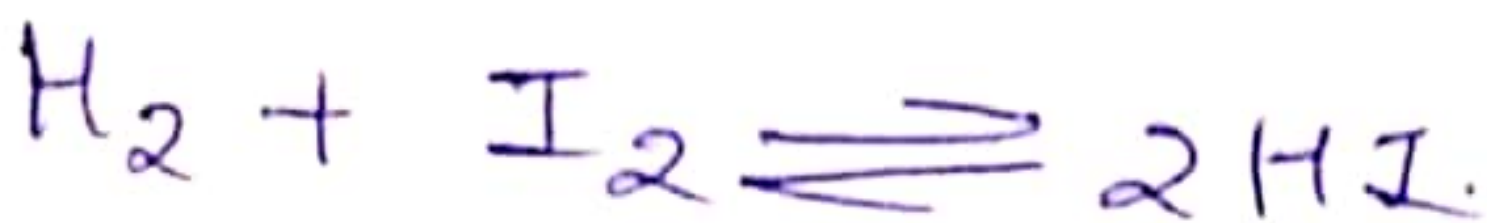
$$H_2 + I_2 \rightleftharpoons 2HI.$$

$t = t_{eq} \quad (.5-x) \quad (.5-x) \qquad 2x$

$$K_c = 49 = \frac{[HI]^2}{[H_2][I_2]}$$

or $\quad 7^2 = \dfrac{[HI]^2}{[H_2][I_2]}$

$\therefore$ ~~[H₂]~~ $\quad \therefore [H_2] = [I_2]$

$\therefore \quad 7^2 = \dfrac{[HI]^2}{[I_2]^2}$

$$\therefore \quad \frac{[HI]}{[I_2]} = 7$$

Ans $\quad$ A

Q.11

$$N_2 + O_2 \rightleftharpoons 2NO$$

$=$ t eq $a-x$ $b-x$ $2x$

from Q.

$2x = 1$
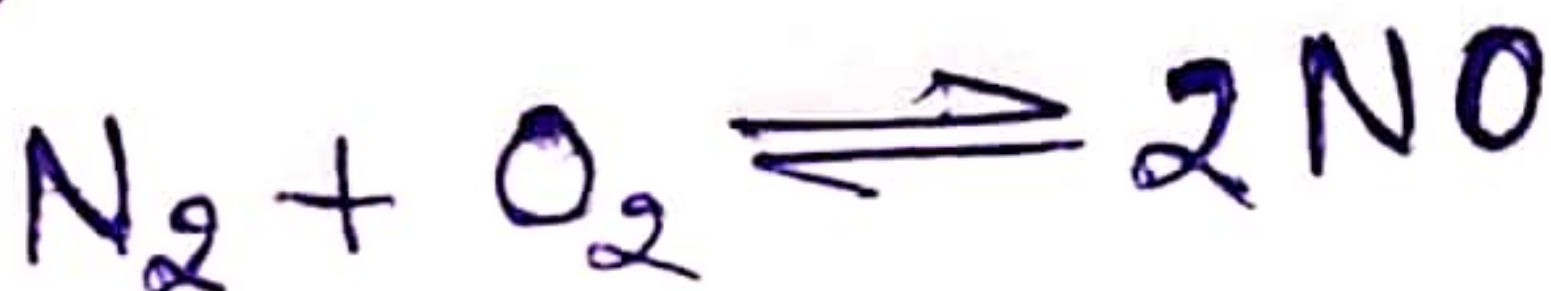
$\therefore x = .5$

Again

Now from Q.
At eq^m

$[N_2]$
$\Rightarrow a - .5 = 0.25$

$\therefore a = .75$

and

$[O_2] = b-x = b - .5$
$= .05$

$\therefore b = .55$

Ans (A)

(12)

$$PCl_5 \rightleftharpoons PCl_3 + Cl_2$$

$t = t_{eq}$ $a - x$ x x
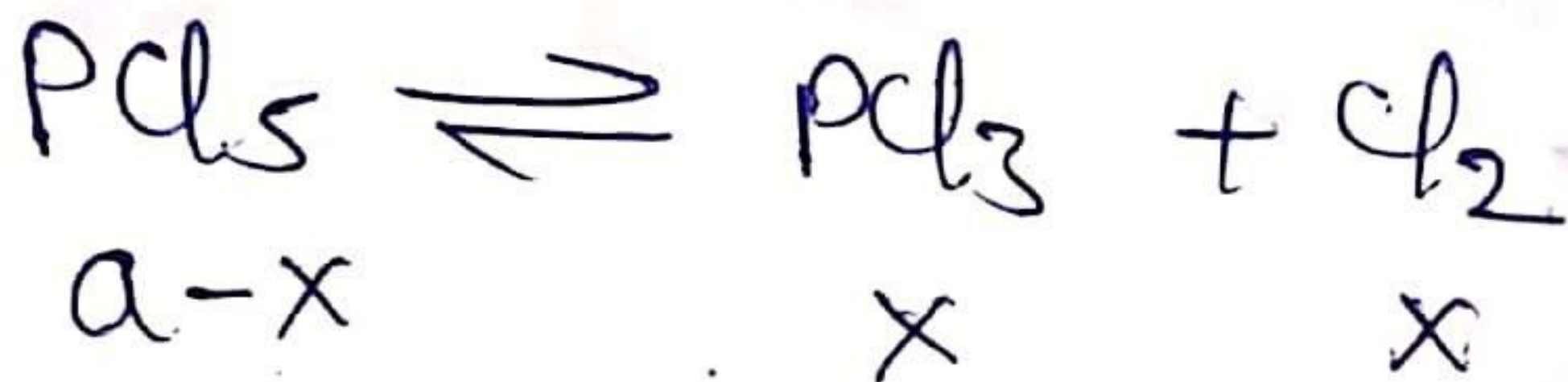
$x = 0.1$ (given)

$$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]} = .04$$

Ans C

$$\Rightarrow \frac{(0.1)^2}{a - 0.1} = .04$$

$$\Rightarrow .01 = .04\,a - .004$$

$$\Rightarrow \qquad \underline{a = 0.35}$$

13. In the beginning of the reaction, $A \rightleftharpoons B + C$, 2 moles of A are taken, out of which 0.5 mole gets dissociated. What is the degree of dissociation of A ?

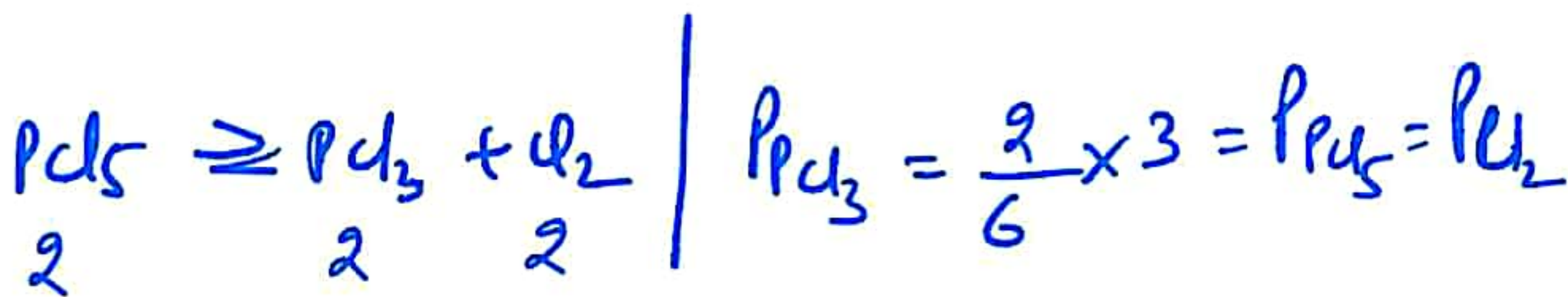(A) 0.5   (B) 1   (C) 0.25   (D) 4.2

Ans. (C)

$$\text{Sol}^n \quad \text{degree of dissociation} = \frac{\text{moles dissociated}}{\text{initial moles}}$$

$$\therefore \quad \alpha = \frac{0.5}{2} = \boxed{0.25}$$

14. In the reaction, $PCl_5 \rightleftharpoons PCl_3 + Cl_2$, the amount of each PCl_5, PCl_3 and Cl_2 is 2 mole at equilibrium and total pressure is 3 atmosphere. The value of K_p will be

(A) 1.0 atm.   (B) 3.0 atm.   (C) 2.9 atm.   (D) 6.0 atm.

Ans. (A)

$$\text{Sol}^n \quad \underset{2}{PCl_5} \rightleftharpoons \underset{2}{PCl_3} + \underset{2}{Cl_2} \quad \bigg| \quad P_{PCl_3} = \frac{2}{6} \times 3 = P_{PCl_5} = P_{Cl_2}$$
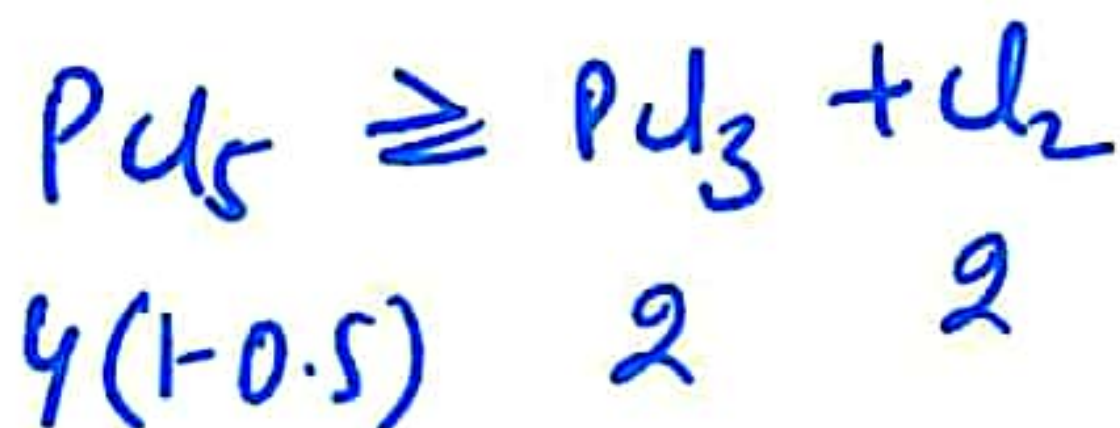
$$K_p = \frac{[P_{PCl_3}][P_{Cl_2}]}{[P_{PCl_5}]} \quad \therefore \quad \frac{1 \times 1}{1} = \boxed{1 = K_p}$$

15. 4 moles of PCl_5 are heated at constant temperature in closed container. If degree of dissociation for PCl_5 is 0.5 calculate total number of moles at equilibrium :-

(A) 4.5   (B) 6   (C) 3   (D) 4
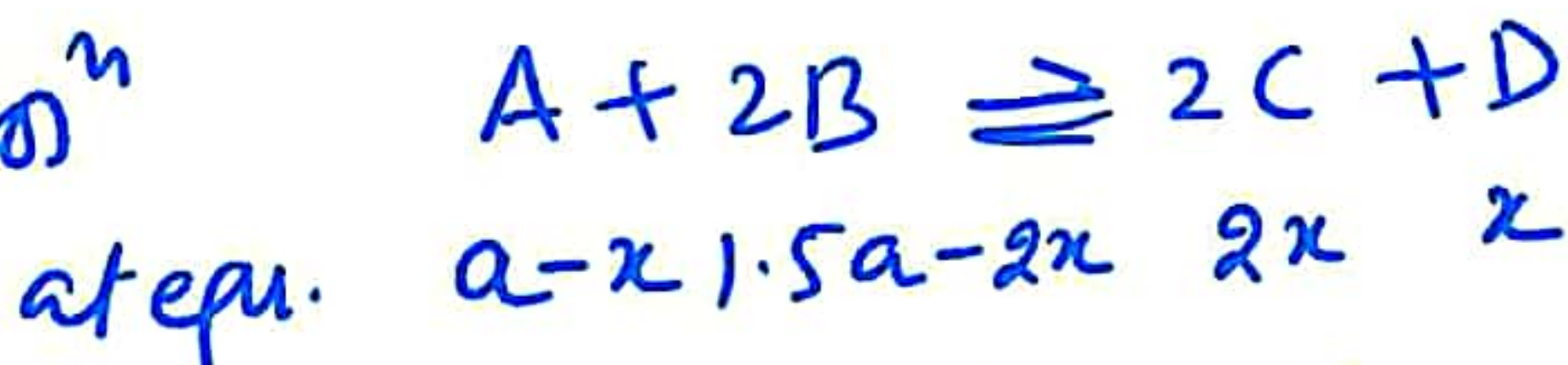
Ans. (B)

Soln

$$PCl_5 \rightleftharpoons PCl_3 + Cl_2$$
$$4(1-0.5) \quad\quad 2 \quad\quad 2$$

∴ total no. of moles = $\boxed{6}$

16. For the reaction $A + 2B \rightleftharpoons 2C + D$, initial concentration of A is a and that of B is 1.5 times that of A. Concentration of A and D are same at equilibrium. What should be the concentration of B at equilibrium ?

(A) $\frac{a}{4}$ (B) $\frac{a}{2}$ (C) $\frac{3a}{4}$ (D) All of the above.

Ans. (B)

Soln

$$A + 2B \rightleftharpoons 2C + D$$
at eqm. $a-x$ $1.5a-2x$ $2x$ x

Now if $[A] = [D]$ ∴ $a-x = x$
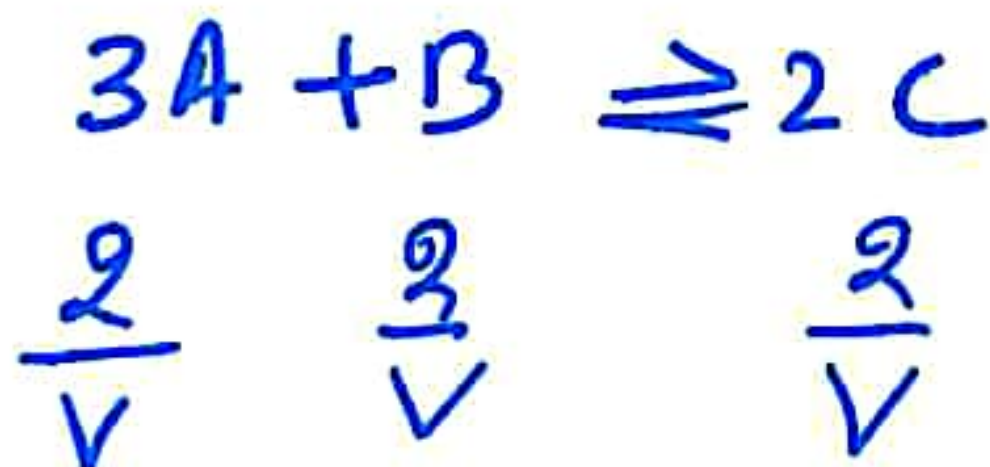
∴ $x = a/2$

∴ $[B]$ at eqm. $= 1.5a - 2x$
$$= 1.5a - a$$
$$\boxed{[B] = a/2}$$

17. For the reaction $3A(g) + B(g) \rightleftharpoons 2C(g)$ at a given temperature, $K_c = 9.0$. What must be the volume of the flask, if a mixture of 2.0 mol each of A, B and C exist in equilibrium?

(A) 6L   (B) 9L   (C) 36 L   (D) None of these
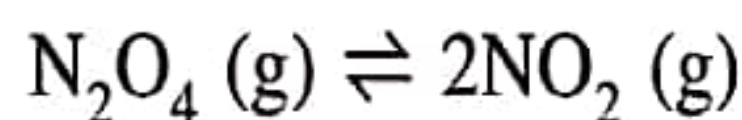
Ans. (A)

$$\text{Sol}^n \quad 3A + B \rightleftharpoons 2C$$
$$\frac{2}{V} \quad \frac{2}{V} \quad \frac{2}{V}$$

$$K_c = \frac{\left[\frac{2}{V}\right]^2}{\left[\frac{2}{V}\right]^3 \left[\frac{2}{V}\right]}$$

$$\therefore \quad 9.0 = \left[\frac{V}{2}\right]^2 \qquad V^2 = 36$$

$$\therefore \boxed{V = 6L}$$

18. For the following gases equilibrium. $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

K_p is found to be equal to K_c. This is attained when temperature is

(A) 0°C   (B) 273 K   (C) 1 K   (D) 12.19 K

Ans. (D)

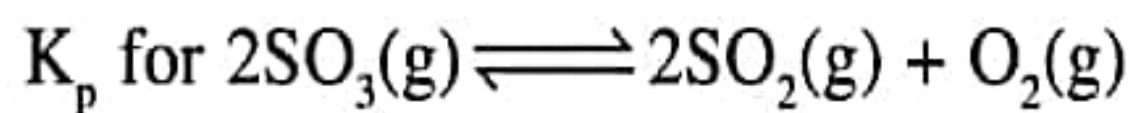$$\text{Sol}^n \quad K_p = K_c(RT)^{\Delta n} \quad \& \text{ here } \Delta n = 1$$

$$\text{if } K_p = K_c \quad \text{means } RT = 1$$

$$\therefore \quad T = \frac{1}{0.0821} \quad \approx 12.19 \, K$$

$$\therefore \boxed{T = 12.19}$$

19. The degree of dissociation of SO_3 is α at equilibrium pressure p^0.

K_p for $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$
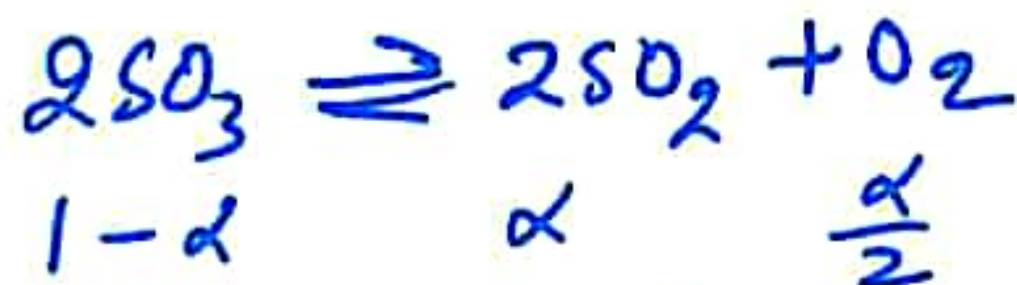
(A) $\dfrac{p^0\alpha^3}{2(1-\alpha)^3}$

(B) $\dfrac{p^0\alpha^3}{(2+\alpha)(1-\alpha)^2}$

(C) $\dfrac{p^0\alpha^2}{2(1-\alpha)^2}$

(D) None of these

Ans. (B)

Sol^n

$$2SO_3 \rightleftharpoons 2SO_2 + O_2$$
$$1-\alpha \qquad \alpha \qquad \frac{\alpha}{2}$$

$$\therefore \quad K_p = \dfrac{\left[\frac{\alpha}{1+\frac{\alpha}{2}} \times p^0\right]^2 \left[\frac{\alpha/2}{1+\alpha/2} \times p^0\right]}{\left[\frac{1-\alpha}{1+\alpha/2} \times p^0\right]^2}$$

$$\therefore \quad \boxed{K_p = \dfrac{p^0\alpha^3}{(2+\alpha)(1-\alpha)^2}}$$

20. For the reaction : $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$, the degree of dissociated (α) of HI(g) is related to equilibrium constant K_p by the expression

(A) $\dfrac{1+2\sqrt{K_p}}{2}$

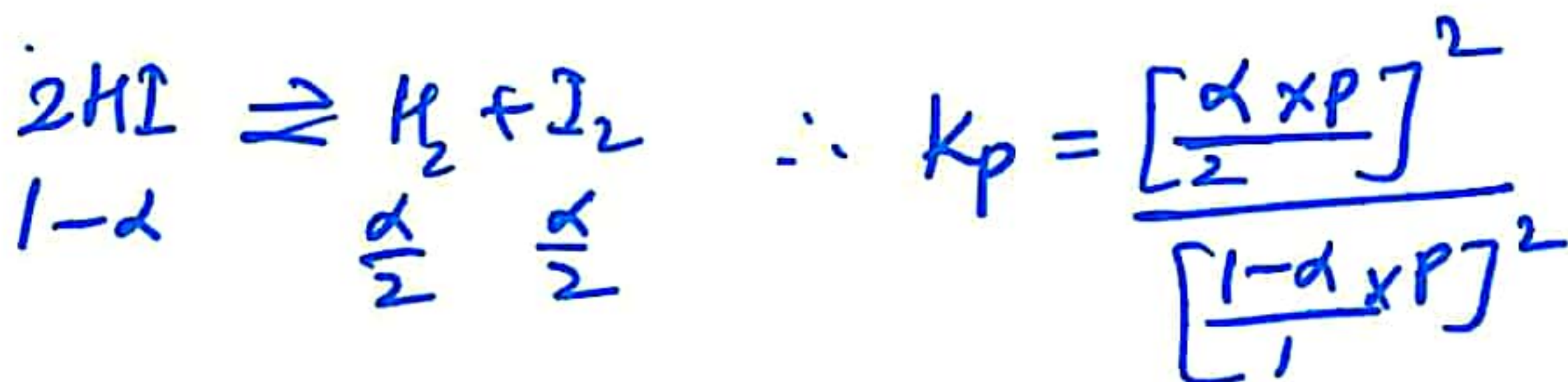(B) $\sqrt{\dfrac{1+2K_p}{2}}$

(C) $\sqrt{\dfrac{2K_p}{1+2K_p}}$

(D) $\dfrac{2\sqrt{K_p}}{1+2\sqrt{K_p}}$

Ans. (D)

Sol^n

$$2HI \rightleftharpoons H_2 + I_2$$
$$1-\alpha \qquad \frac{\alpha}{2} \quad \frac{\alpha}{2}$$

$$\therefore K_p = \dfrac{\left[\dfrac{\alpha}{2} \times P\right]^2}{\left[\dfrac{1-\alpha}{1} \times P\right]^2}$$

$$\therefore K_p = \dfrac{\alpha^2}{4(1-\alpha)^2}$$

By taking root at both side

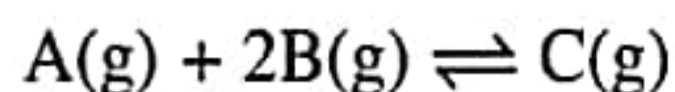$$\sqrt{K_p} = \dfrac{\alpha}{2(1-\alpha)}$$

$$\therefore 2\sqrt{K_p} - 2\alpha\sqrt{K_p} = \alpha$$

$$\therefore 2\sqrt{K_p} = \alpha + 2\alpha\sqrt{K_p}$$

$$\therefore \boxed{\alpha = \dfrac{2\sqrt{K_p}}{1+2\sqrt{K_p}}}$$

21. The equilibrium constant for the reaction

$$A(g) + 2B(g) \rightleftharpoons C(g)$$

is 0.25 dm⁶mol⁻². In a volume of 5 dm³, what amount of A must be mixed with 4 mol of B to yield 1 mol of C at equilibrium.
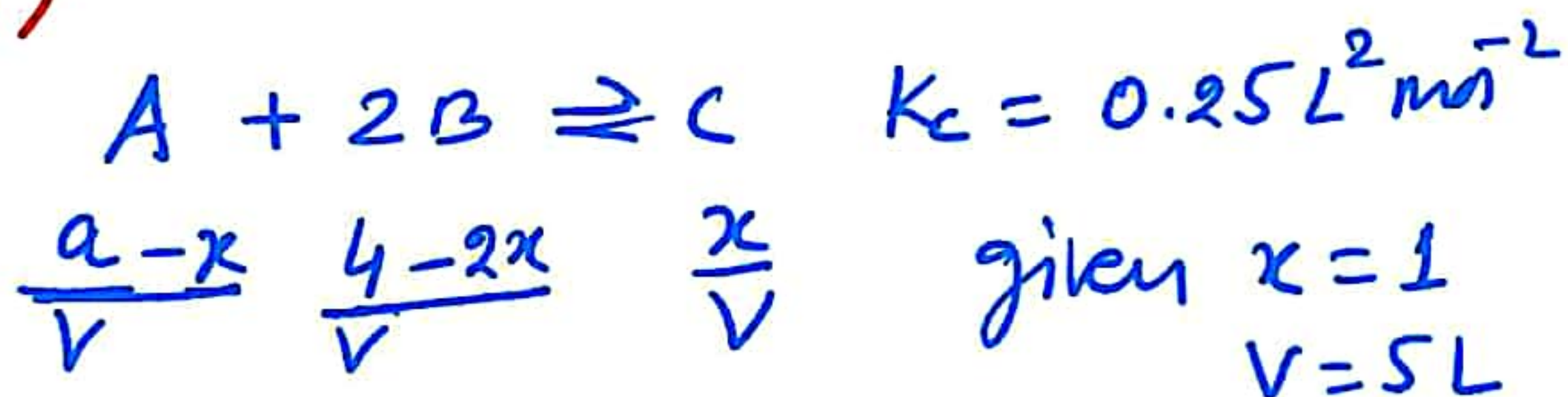
(A) 3 moles   (B) 24 moles   (C) 26 moles   (D) None of these

Ans. (C)

Sol.

$$A + 2B \rightleftharpoons C \qquad K_c = 0.25 \, L^2 mol^{-2}$$

$$\frac{a-x}{V} \quad \frac{4-2x}{V} \quad \frac{x}{V} \qquad given \ x = 1$$
$$V = 5L$$

$$\therefore \quad 0.25 = \frac{1/5}{\left(\frac{a-1}{5}\right)\left(\frac{4-2}{5}\right)^2} \qquad \therefore$$

$$0.25 = \frac{0.2}{\left(\frac{a-1}{5}\right) \ 0.4 \times 0.4}$$

$$a = \frac{0.2 \times 5}{0.25 \times 0.4 \times 0.4} + 1$$

$$= \frac{1}{0.04} + 1 = 26$$

$$\boxed{a = 26 \ mole}$$

22. A 20.0 litre vessel initially contains 0.50 mole each of H_2 and I_2 gases. These substances react and finally reach an equilibrium condition. Calculate the equilibrium concentration of HI if $K_{eq} = 49$ for the reaction $H_2 + I_2 \rightleftharpoons 2HI$.
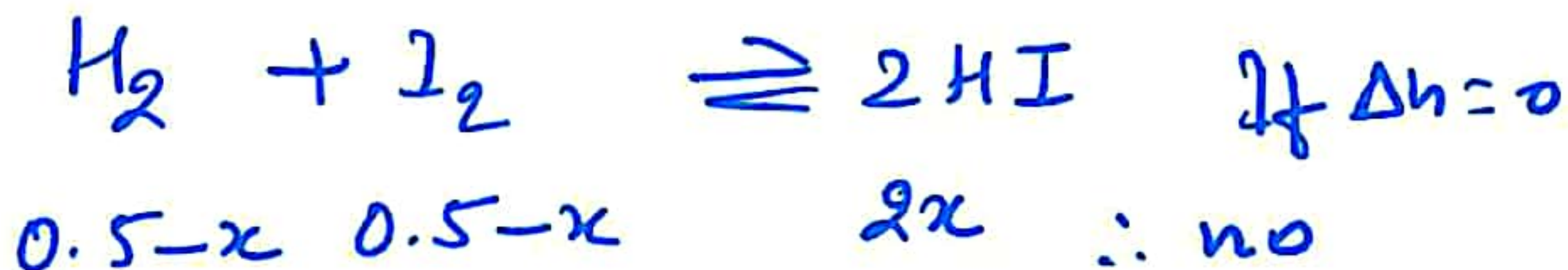
(A) 0.78 M   (B) 0.039 M   (C) 0.033 M   (D) 0.021 M

Ans. (B)

Sol^n

$$H_2 + I_2 \rightleftharpoons 2HI \qquad \text{If } \Delta n = 0$$

$$0.5-x \quad 0.5-x \qquad\qquad 2x \qquad \therefore \text{ no}$$

significance of volume

$$\therefore \quad K_c = \frac{(2x)^2}{(0.5-x)^2}$$

$$\therefore \quad 49 = \left[\frac{2x}{(0.5-x)}\right]^2$$

By taking root at both side

$$7 = \frac{2x}{0.5-x} \qquad\qquad \therefore \quad 3.5 - 7x = 2x$$

$$\therefore \quad x = \frac{3.5}{9} \quad ; \quad [HI] = \frac{2x}{20} = \frac{0.35}{9}$$

$$\therefore \quad \boxed{[HI] = 0.039 \text{ mol } L^{-1}}$$

23. At 675 K, $H_2(g)$ and CO_2 (g) react to form CO(g) and H_2O (g), K_p for the reaction is 0.16. If a mixture of 0.25 mole of $H_2(g)$ and 0.25 mol of CO_2 is heated at 675 K, mole % of CO(g) in equilibrium mixture is :

(A) 7.14   (B) 14.28   (C) 28.57   (D) 33.33

Ans.(B)

at 675 K

$$Soln \quad H_2(g) + CO_{2(g)} \rightleftharpoons CO_{(g)} + H_2O \text{ (g)}$$

H_2O will be gas.

$$\underset{0.25-x}{} \quad \underset{0.25-x}{} \quad \underset{x}{} \quad \underset{x}{}$$
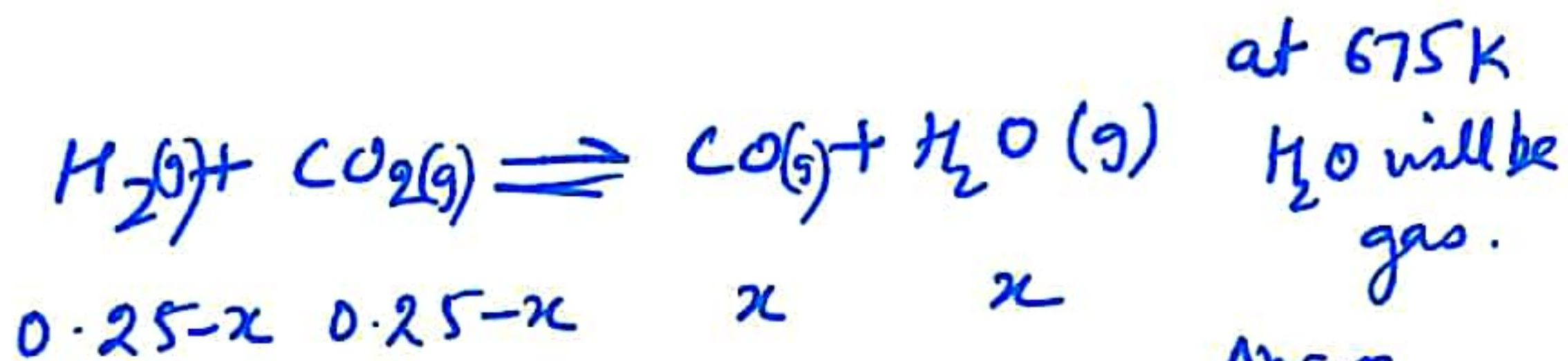
$\Delta n = 0$

$\therefore K_p = K_c$

$$0.16 = \frac{x^2}{(0.25-x)^2}$$

$$\therefore \quad 0.4 = \frac{x}{0.25-x}$$

$$0.1 - 0.4x = x$$

$$x = \frac{0.1}{1.4} = 0.714 = \text{moles of CO at mixture}$$

Total moles of mixture $= 0.25 + 0.25 = 0.5$

$\therefore$ mole % of CO in mixture $= \frac{0.714}{0.5} \times 100 = \boxed{14.28}$

24. The vapour density of N_2O_4 at a certain temperature is 30. What is the % dissociation of N_2O_4 at this temperature?

(A) 53.3%   (B) 106.6%   (C) 26.7%   (D) None

Ans. (A)

soⁿ

$$\alpha = \frac{D-d}{(n-1)d}$$

$$= \frac{46-30}{(2-1)\,30}$$

$$= 0.533$$

∴ in % $\boxed{53.3\% = \alpha}$

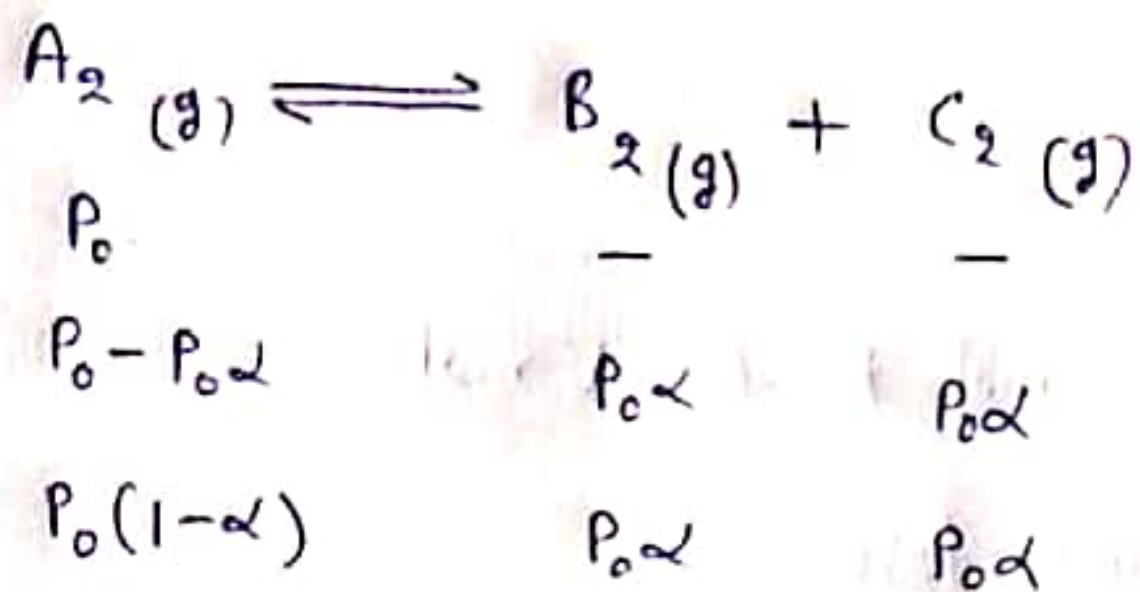D = initial vapour density

$$= M/2$$

$$= 92/2 = 46$$

(25)

$$A_2\,(g) \rightleftharpoons B_2\,(g) + C_2\,(g)$$

$$P_o$$
$$P_o - P_o\alpha \qquad P_o\alpha \qquad P_o\alpha$$
$$P_o(1-\alpha) \qquad P_o\alpha \qquad P_o\alpha$$

Acc. to ques
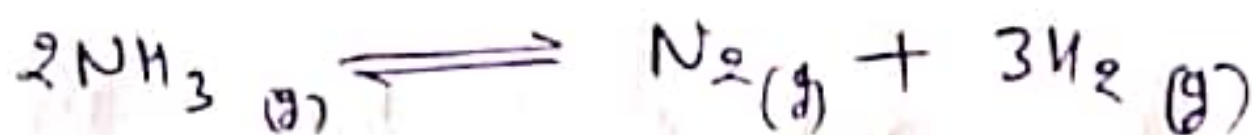
$$P_o + P_o\alpha = 7$$
$$P_o = \frac{7}{(1+\alpha)}$$

$$K_p = \frac{P_o\alpha \cdot P_o\alpha}{P_o(1-\alpha)}$$

$$M_{av} = \frac{\text{total mass}}{\text{total mol}} = \frac{P_o \times 70}{P_o + P_o\alpha} = \frac{70}{1+\alpha}$$

$$= \frac{7}{(1+\alpha)} \cdot \frac{\alpha^2}{(1-\alpha)}$$

$$M_{av} = \frac{70}{1 + \frac{3}{4}} = 40$$

$$9 = \frac{7\alpha^2}{1-\alpha^2} \Rightarrow \alpha = \frac{3}{4}$$

(26)

$$2NH_3\,(g) \rightleftharpoons N_2\,(g) + 3H_2\,(g)$$

$$1\,mol = 17\,gm$$

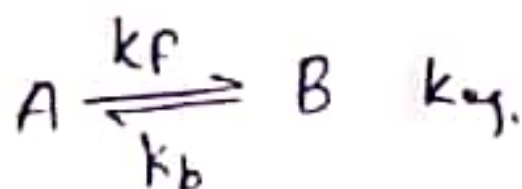$$1 - 2\alpha \qquad\qquad \alpha \qquad\qquad 3\alpha$$

$$M_{av} = \frac{17}{1+2\alpha} = 12 \qquad\qquad [VD]_{mix} \times 2 = M_{av}$$

$$\alpha = \frac{5}{24}$$

$$\% \text{ dissociation} = \frac{2\alpha}{1} \times 100 = 2 \times \frac{5}{24} \times 100 = 41.66\,\%$$

(27) $$A \underset{k_b}{\overset{k_f}{\rightleftharpoons}} B \quad k_{eq}.$$

$$k_{eq} = \frac{k_f}{k_b} = \frac{[B]_e}{[A]_e}$$

$$[B]_e = k_f\, k_b^{-1}\, [A]_e$$

(28) Acc. to Le-chatelier's principle

At const. Volume

$$n_{product} \downarrow \quad eq^m \text{ shift forward } dir^n$$

(29) $$\Delta n_g = 0 \Rightarrow \text{no effect of pressure}$$

$$\Delta H = +ve \qquad T\uparrow \quad eq^m \text{ shift forward}$$

(30) (D) Bcoz $\Delta n_g = 0$

(31) (A) Bcoz $\Delta n_g = 0$

(32) (A) P↑ eqⁿ shift from higher mol to lower mol

$\Delta H = -ve$ T↓   eqⁿ shift forward

(33) (C)

$$C \text{ (diamond)} \rightleftharpoons C \text{ (graphite)}$$

d = 3.5   d = 2.5
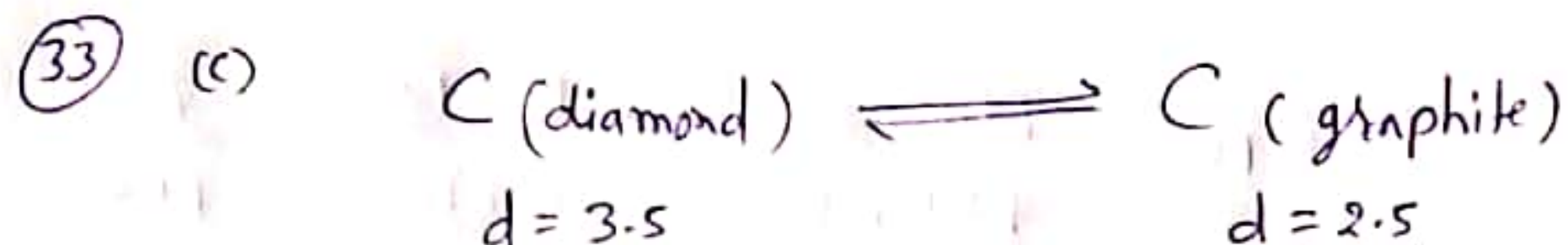
In phase eqⁿ ⇒ P↑ eqⁿ shift toward higher dense phase

i.e. backword dirⁿ

⇒ $\Delta H = -1.9$ T↑   eqⁿ shift backword

exothermic

(34) At const. Volume by adding inert gas moles of reactant & product

do not change

(35) $2A_{(g)} + B_{(g)} \rightleftharpoons 2C_{(g)} + Q \, kJ$ exothermic reacⁿ
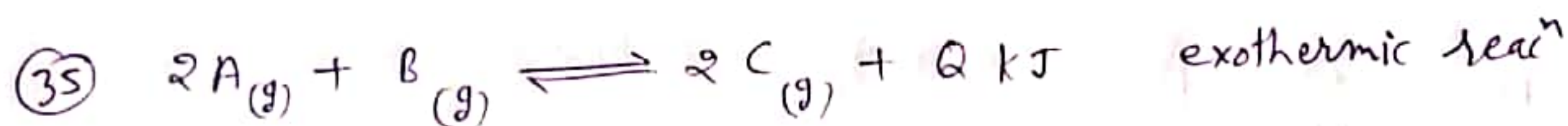
P↓ eqⁿ shift toward higher mole i.e. barword direcⁿ

$\Delta H = -ve$ exothermic   T↑ eqⁿ shift backword