

* CHEMICAL EQUILIBRIUM *

①

FB (objective)

① Reversing rxn II and adding with I
we get rxn III

$$\text{So } K_3 = \frac{K_1}{K_2} = 10^{-14} \quad \text{(B)}$$

②

For the rxn $\text{H}_2 + \text{I}_2 \rightleftharpoons 2\text{HI}$

$$r_f = 1.7 \times 10^{-18} [\text{H}_2][\text{I}_2] \Rightarrow k_f = 1.7 \times 10^{-18}$$

$$r_b = 2.4 \times 10^{-21} [\text{HI}]^2 \Rightarrow k_b = 2.4 \times 10^{-21}$$

$$\Rightarrow K_1 = \frac{1.7 \times 10^{-18}}{2.4 \times 10^{-21}}$$

So for reaction $\frac{1}{2}\text{H}_2 + \frac{1}{2}\text{I}_2 \rightleftharpoons \text{HI}$

$$K = \sqrt{K_1} = \sqrt{\frac{1.7 \times 10^{-18}}{2.4 \times 10^{-21}}} = 26.6$$

④

③ Reversing rxn 1 and adding with rxn 2
we get the reqd. reaction

$$K_3 = \frac{K_2}{K_1} = 1.8 \times 10^{-5} \quad \text{(B)}$$

(2)



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

$$\Rightarrow RT = 1 \quad (\because K_p = K_c \text{ \& } \Delta n_g = 1)$$

$$\Rightarrow T = 12.181K \quad (B)$$

(5) $X \rightarrow \Delta n_g = -1$

$Y \rightarrow \Delta n_g = 1$

$Z \rightarrow \Delta n_g = 0$

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

so $\Rightarrow Y > Z > X$

(C)

(6) $K_p = (3.8 \times 10^{-3}) (R \times 1000)^2$

$$= 25.61$$

(B)

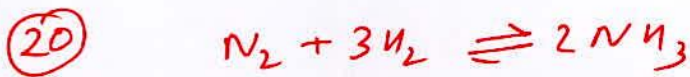
(7) $K_c = 27 = \frac{[H_2]^3}{[H_2O]^3}$

$$\Rightarrow \frac{[H_2]}{[H_2O]} = 3$$

(A)

- (8) (A) Theoretical
- (9) (C) Theory
- (10) (D) Theory
- (11) $\gamma \propto [B]^2 \Rightarrow$ (D)
- (12) (A) Theory
- (13) For rxn $H_2 \rightleftharpoons \frac{1}{2} N_2 + \frac{1}{2} I_2$
 $K = \frac{1}{\sqrt{64}} = \frac{1}{8}$ (D)
- (14) (A) $\Delta n \neq 0$
- (15) (D) All have $\Delta n = 0$
- (16) (D) $\Delta n = 0$ so no units
- (17) $K_c \Rightarrow \text{mol/L}$ (A)
- (18) $K_p \Rightarrow \text{atm}^2$ ($\because \Delta n_g = 2$) (D)
- (19) K remains constant \Rightarrow (C)

(4)

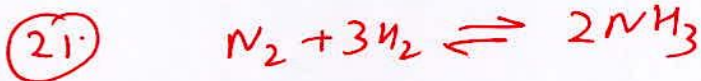


i 1 3 0

e 0.5 1.5 1

$\Rightarrow n_{tot, eq} = 3$

\Rightarrow (B)



i 2 2 0

e 0.8 1.4 0.4

$\Rightarrow [NH_3]_{eq} = \frac{0.4}{5} = 0.08$

\Rightarrow (B)

(22) $K = \frac{[m_{x_3}]^2}{[m_{x_2}]^2 [x_2]}$ \Rightarrow (C)

(23) Pressure does not effect K

\Rightarrow (D)

(24) $m_{w, eq} = \frac{122}{1 - \alpha + \frac{\alpha}{2}}$ $\approx \frac{122}{1 - \frac{1}{4}}$ $\Rightarrow 122 \times \frac{4}{3} = 163$

\Rightarrow (C)

(25) $d = \frac{D}{1 - \alpha + 2\alpha}$ $\Rightarrow \frac{D}{d} = 1 + \alpha$

\Rightarrow (A)

(26) $\frac{D}{d} = 1 + \alpha$ \Rightarrow (B)

$$\begin{aligned} (27) \quad \left(\frac{dx}{dt}\right)_{\text{net}} &= 2.6 \times 10^3 \times 10^{-6} - 4.1 \times 10^{-2} \\ &= 2.6 \times 10^{-3} - 41 \times 10^{-3} = -ve \end{aligned}$$

\Rightarrow (B)

(28) (B) Theory

$$(29) \quad \frac{K_p}{K_c} = (RT)^{\Delta n_g} = (RT)^{-1/2} \Rightarrow (D)$$

(30) (B) ($\because \Delta n_g < 0$)

(31) (A) Theory

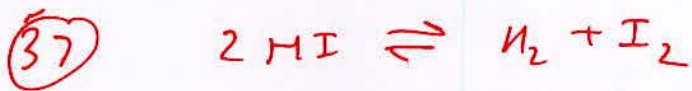
(32) (B) Theory

$$(33) \quad K = K_1 K_2 K_3 \Rightarrow (B)$$

$$(34) \quad K_1 = \frac{1}{\sqrt{K_2}} \Rightarrow (A)$$

$$(35) \quad K = K_1 K_2 \Rightarrow (B)$$

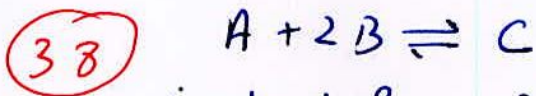
36 $K = \sqrt{K_1 K_2} \Rightarrow C$



i: 2 0 0
e: 2(1-a) a a

$\Rightarrow C$

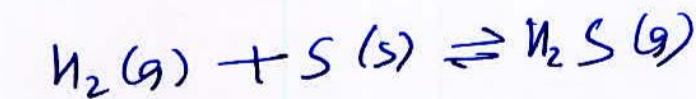
$n_{tot, eq} = 2$



i: 1 1.8 0
eq: 0.6 1 0.4

$K_c = \frac{0.4}{5} = \frac{100}{6} \Rightarrow C$
 $\frac{0.6}{5} \times \left(\frac{1}{5}\right)^2$

39



i: 0.2
e: 0.2 - x x

$\frac{x}{0.2-x} = 6.8 \times 10^{-2} \Rightarrow x = \frac{6.8 \times 10^{-2} \times 0.2}{1.068}$

$p_{H_2S} = 0.38 \text{ atm}$

B

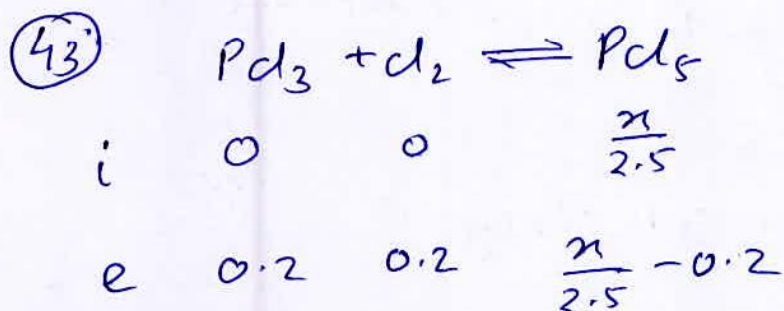
40

C

(7)

$$(41) \quad K_p = \frac{p_{SO_3}^2}{p_{SO_2}^2 p_{O_2}} \Rightarrow p_{O_2} = \frac{1}{3.5} = 0.29 \text{ atm} \quad \boxed{A}$$

$$(42) \quad K = K_1 \times K_2 = 1 \quad \Rightarrow \quad \boxed{C}$$



$$\Rightarrow \frac{\frac{x}{2.5} - 0.2}{0.2 \times 0.2} = 15$$

$$\frac{x}{2.5} = 0.6 + 0.2 = 0.8$$

 \boxed{C}

$$\Rightarrow x = 2.$$

(44) K_p never changes with pressure \boxed{A}

(45) addition of H_2O will decrease SO_3 as it will react with H_2O to form H_2SO_4 , hence the rxn will proceed in forward direction.

(8)

$$(46) \text{ slope} = -\frac{\Delta H}{2.303R} = 1$$

[B]

$$\Rightarrow \Delta H = -4.606 \text{ cal}$$

(47) For I As $T \uparrow$ $K \downarrow \Rightarrow$ exothermic

[B]

II As $T \uparrow$ $K \uparrow \Rightarrow$ endothermic

(48) only temperature can change K

[C]

(49) K remains unaffected if T is constant

[C]

(50) K remains unchanged on changing volume of container

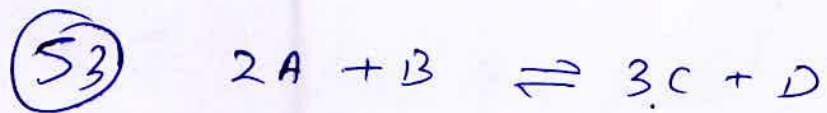
[C]

(51) $2HI \rightleftharpoons H_2 + I_2$, dissociation reaction of HI has $\Delta n_g = 0$ so change of volume of container will not have any effect.

[C]

(52) increase in P favours backward reaction if $\Delta n_g > 0$.

so [A, C]

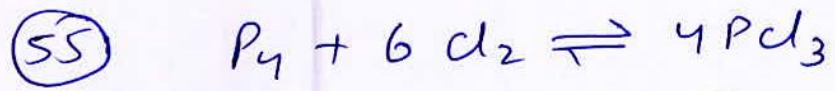


i 2 2 0 0

e $2-2x$ $2-x$ $3x$ x

so $[B] > [A] \Rightarrow [B]$

54) As $T \uparrow K \downarrow \Rightarrow$ exothermic $[A]$

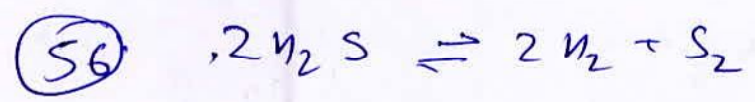


i x x 0

e $x-y$ $x-6y$ $4y$

$[C]$

so $[Cl_2] < [P_4]$



~~$K = \frac{[H_2]^2 \times [S_2]}{[H_2S]^2}$~~ $K = \frac{(0.2)^2 (0.8)}{(1)^2}$

$= 0.076 \Rightarrow [B]$

57) Since K is very small reaction will proceed to negligible extent

hence $[I] < [I_2] [A]$

58



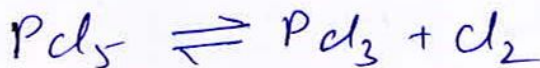
10

$$Q = \frac{\left(\frac{2 \times 10^{-2}}{2}\right)^2}{\frac{1 \times 10^{-2}}{2} \times \frac{3 \times 10^{-2}}{2}} = \frac{4}{3} < K$$

so rxn proceeds in forward direction

[B]

59



i 2.2 0 0

e 2.2(1-α) 2.2α 2.2α

[C]

$$n_{\text{tot}} = 2.2(1+\alpha) = 2.53 \Rightarrow \alpha = \frac{0.33}{2.2} = 0.15$$

60

$$K_c = \frac{[\text{SO}_2]^2 [\text{O}_2]}{[\text{SO}_3]^2} = 10 \text{ mol/L}$$

[D]

$$\Rightarrow n_{\text{O}_2} = 10 \times 10 = 100$$

$$\Rightarrow \text{no. of O}_2 \text{ molecules} = 100 N_A$$

61

$$T > \frac{50000}{100} = 500$$

so [D]

62

$$\text{At eq } \Delta G = 0 \Rightarrow [D]$$

63

$$k = e^{+\frac{16500}{8.314 \times 298}}$$

$$= 780 \Rightarrow [B]$$

(64) $\ln K = 4 - \frac{2000}{T} = \frac{\Delta S^\circ}{R} - \frac{\Delta H^\circ}{RT}$ (A)
 $\Rightarrow \Delta S^\circ = 4R$

(65) (D) Theory

(66) $K = \frac{0.3}{0.15 \times P_B} = \frac{P_C}{0.3 \times 2P_B}$ (C)
 $\Rightarrow P_C = 1.2 \text{ atm}$

(67) (A) Theory

(68) Addition of product will shift reaction backwards so $[H^+]$ will decrease (B)

(69) Since $\Delta n_g > 0$ for reaction increasing volume will favor forward reaction (C)

(70) Increasing product concentration will favor backward reaction (C)

(71) Adding Pd_s will favor forward reaction hence ch_2 will increase (B)

(72) Since $\Delta n_g = 0$ increasing pressure will have no effect. (C)

73 $\Delta n_g > 0$ so increasing pressure will shift the reaction in backward direction (B)

74 Since reaction is exothermic increase in temp. will favor ~~formation~~ decomposition of N_2O_4 (B)

75 Since reaction is exothermic increase in temp will favor backward rxn hence $[NH_3]$ will decrease (D)

76 endothermic \Rightarrow (D)

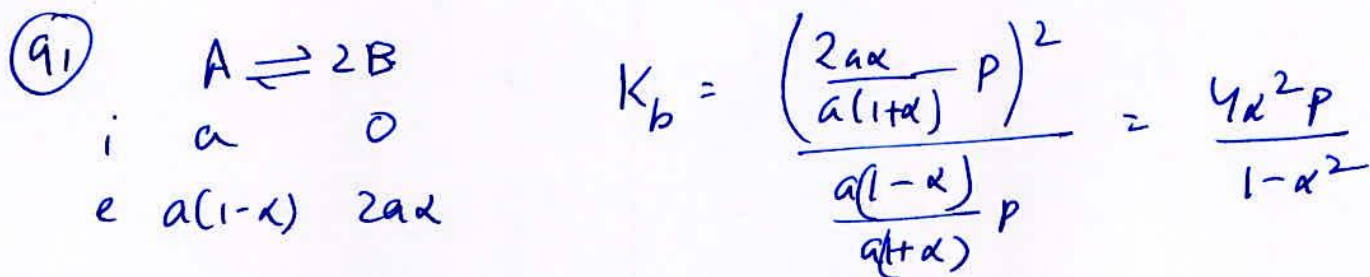
77 exothermic, $\Delta n_g < 0$
so low Temperature and high Pressure.
 \Rightarrow (C)

78 exothermic, $\Delta n_g < 0$
so low temp. & high Pressure
 \Rightarrow (D)

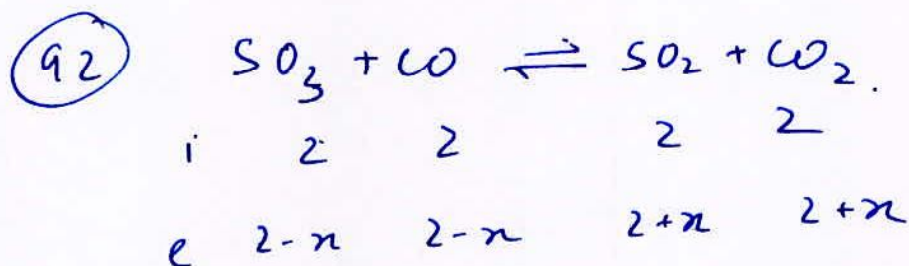
79 endothermic, $\Delta n_g < 0$
so high temp & high Pressure.
 \Rightarrow (A)

80 $Pd_5 \rightleftharpoons Pd_3 + d_2$
i 1
e $1-x \quad x \quad x$ $n_{tot} = 1 + x$ (B)

- 81) K_p can change only with temperature (D)
- 82) Adding Pd_5 will increase Cl_2 (B)
- 83) (A) Theory
- 84) K_p will not change with volume, but α will (D)
- 85) $K = \frac{P_D^2}{P_B} \Rightarrow$ so P_B is doubled so P_D will increase by factor of $\sqrt{2}$ (C)
- 86) K does not change on adding of inert (C)
- 87) removal of SO_3 will shift the reaction in forward direction (B)
- 88) Since the reaction is exothermic low temperature will favor forward rxn. (C)
- 89) Since the reaction is endothermic increasing temperature will increase P_{CO_2} (A)
- 90) Since $\Delta n_g = 0$, only temp. change will affect forward reaction (D)



(A)



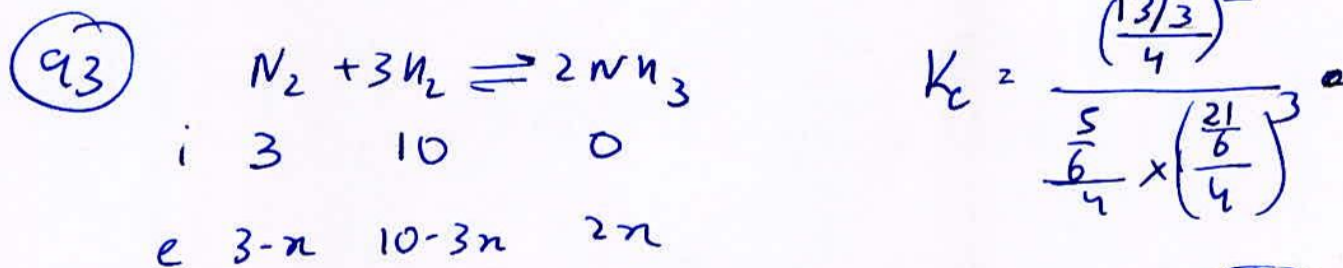
$$\left(\frac{2+x}{2-x}\right)^2 = \frac{1}{9} \Rightarrow \frac{2+x}{2-x} = \frac{1}{3}$$

$$\Rightarrow 6 + 3x = 2 - x$$

$$4 = -4x \Rightarrow x = -1$$

$$n_{SO_3} + n_{CO_2} = 2 - x + 2 + x = 4$$

$$\frac{n_{SO_2}}{n_{CO}} = \frac{2+x}{2-x} = \frac{1}{3}$$

 \Rightarrow (D)

$$\frac{13-2x}{13} = \frac{2}{3} \Rightarrow 39 - 6x = 26$$

$$\Rightarrow x = \frac{13}{6}$$

 \Rightarrow (D)

HOME ASSIGNMENT - 1

1. (B) $K_3 = \frac{K_1}{K_2} = 10^{-14}$

2. (D) $K_{eq} = \frac{K_f}{K_b} = \frac{1.7 \times 10^{-18}}{\sqrt{2.4 \times 10^{-21}}} = \sqrt{708} = 26.6$

3. (D) $K_1 \times K_2 = K_3$

4. (B) $\frac{K_2}{K_1} = K_3$

5. (C) $K_p = [P_{C_{10}H_8}] = \frac{0.1 \text{ atm}}{760} = 1.32 \times 10^{-4}$

$$K_c = \frac{K_p}{(RT)^{\Delta n_g}} = 5.34 \times 10^{-6}$$

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

$$(RT)^1 = 1$$

$$T = \frac{1}{R} = \frac{1}{0.082} = 12.18 \text{ K}$$

7. (C) $\frac{K_p}{K_c} = (RT)^{\Delta n_g} \quad X < Z < Y$

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

9. (A) $K_c = 27 = \frac{(H)^3}{(H_2O)^3}$

10. (A) THEORETICAL

11. (C) BASICS OF CHAPTER

12. (C) conc of CO_2 is const. in open atm.

13 D) Eq. Is DYNAMIC

14 D) $K_p \propto (P)^2$

15 A)

16 A), ~~B~~ BASICS

17) D) $64 = \frac{(HI)^2}{(H_2)(I_2)} \quad \therefore \frac{(H_2)^{1/2} (I_2)^{1/2}}{(HI)} = \frac{1}{8}$

18 D), A) K_p 's units $\propto \Delta n_g$
For D) $\Delta n_g = 1$ For A) $\Delta n_g = 1$

19 A)

20 D)

21 D)

22 A) $K_c = \frac{(P)^7 (Q)^6}{(B)^5 (A)^7}$

23 D)

24 A) Forward reaction is more favoured for endothermic.

25 C) Unit of K_p does not exist here

26 C) K_{eq} does not change on concentration change.

27 B) 0.5 mole H_2 remains 1.5 mole H_2 remains

1 mole NH_3 formed.

\therefore Final mole left = 3

28 B) 0.6 mole H_2 used, 0.4 mole NH_3 formed.

\therefore Concentration = 0.08

29 C)

30) ~~WRONG QUESTION~~ for gaseous reaction unit of K_p (atm)^{Δn_g}

30) D) Eq. const will remain unchanged.

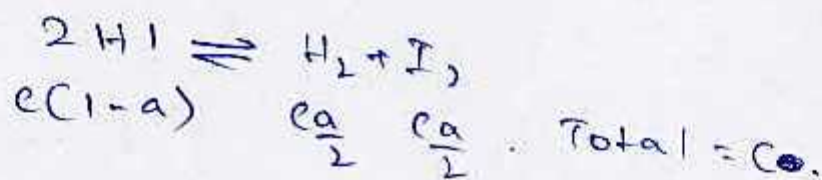
HA-2

- 1) (C) $MM_{\text{Theoretical}} = MM_{\text{observed}} \left(1 - \frac{\alpha}{2}\right)$
- 2) (A) $D = d(1 + \alpha)$
- 3) (B) $\frac{D}{d} = 1 + \alpha$
- 4) (A) $V \cdot P_{\text{obs}}$ is smaller when products are more.
- 5) (B) At eq., $\frac{dx}{dt} = 0$.
 $K_{\text{eq}} < Q$
- 6) (B) $K_p = K_c (RT)^{\Delta n}$
- 7) (D) $(RT)^{\Delta n}$, $\Delta n = \frac{-1}{2}$
- 8) (B) $\Delta n < 0$.
- 9) (A) $\Delta n = 0$.
- 10) (B)
- 11) (B)
- 12) (A) $K_2 = \frac{1}{K_1^2}$
- 13) (B)
- *14) (D) $(2\text{NO} \rightleftharpoons \text{N}_2 + \text{O}_2, K_c = 10^{35})$
Stability \uparrow as $K_c \downarrow$.

15) (C)

$$\sqrt{K_1 K_2}$$

16) (C)

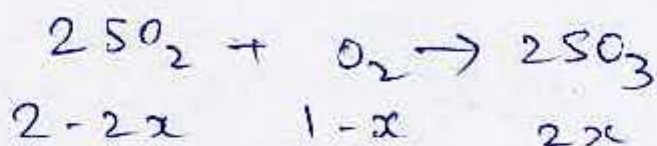


17) (C)

$$K_c = \frac{0.4}{0.6} \times 25 = \frac{50}{3} \sim 17.$$

$c = 2$

18) (A)



19) (B)



~~$0.2x$~~
Find pressures of each and calculate.

20) (B)



$$K_c = \frac{1-x}{(6x)^6} = 6 \times 10^{22} = \frac{1}{(6x)^6}$$

Calculate approximately.

21) (C)

As $K_p \uparrow$, tendency of completion of rxn. increases.

22) (A)

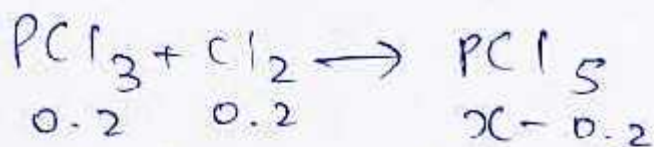
$$K_p = \frac{[P_{SO_3}]^2}{[P_{SO_2}]^2 \times [P_{O_2}]}$$

23) (C)

$$K_1 = 10^{-2}, K_2 = 10^2$$

$$\text{Eq. Const.} = K_1 K_2 = 1.$$

24) (C)



Use K_c equation and find x .

25) (C)

26) (A)

27) (D)

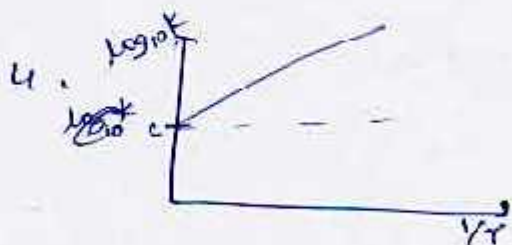
~~28) (A) Stability increases with decreasing K .~~

HOME ASSIGNMENT - III

1. $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$
 Rxn proceeds forward, if $Q < K_{eq}$
 \Rightarrow If H_2O is added
 SO_2 will change to H_2SO_4 .
 \Rightarrow Active mass of SO_2 will decrease, and
 rxn will proceed in forward dirn
 \Rightarrow (A)

2. $H_2O(l) \rightleftharpoons H_2O(g)$
 Increase in pressure \Rightarrow increases boiling pt
 \Downarrow
 rxn shifts in dirn of less gaseous moles
 \Downarrow
 more $H_2O(l)$ is formed.
 \Rightarrow (C)

3. $2A(g) + B(g) \rightleftharpoons C(g) + D(g)$ $\Delta H^\circ = +ve$
 Addition of catalysts doesn't affect K_c .
 \Rightarrow (C)



$$\log_{10} K = \frac{1}{T} + c$$

$$\Delta H \quad \Delta G^\circ = -RT \ln K$$

$$\Delta H^\circ - T \Delta S^\circ = -RT \ln K$$

$$\Rightarrow \ln K = \Delta H \frac{\Delta S^\circ}{R} - \frac{\Delta H^\circ}{RT}$$

$$\Rightarrow \log_{10} K = \frac{\Delta S^\circ}{2.303R} - \frac{\Delta H^\circ}{2.303RT}$$

comparing

$$\frac{1}{T} = \frac{-\Delta H^\circ}{2.303R} \times$$

$$\Rightarrow \Delta H^\circ = -2.303R = -4.606 \text{ cal}$$

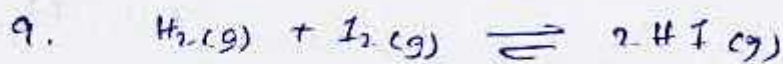
~~...~~ \Rightarrow (B)

5. I: K_{eq} dec. with inc. in temp \Rightarrow exothermic
 II: K_{eq} inc. with inc. in temp. \Rightarrow endothermic.
 \Rightarrow (B)

6. (B) [due to CO_2 escaping
 $Q < K_p \Rightarrow R_x^n$ goes forward]

7. (C)

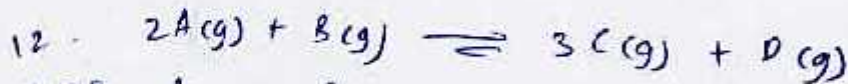
8. Equilibrium const. is independent of concentration
 \Rightarrow (C)



~~$K_c = \frac{[HI]^2}{[H_2][I_2]}$~~ $\Rightarrow \Delta n_g = 0$.
 Reducing volume to half, equilibrium const. will stay unchanged \Rightarrow (C).

10. (C) [$\Delta n_g = 0$]

11. Increase in pressure $\Rightarrow R_x^n$ proceeds in dirⁿ of less no. of gaseous moles.
 \Rightarrow (A), (C)



$t=0$ 2 2

$t=t_{eq}$ $2-2x$ $2-x$ $3x$ x .

$n > 0$

$\Rightarrow 2-2x < 2-x$

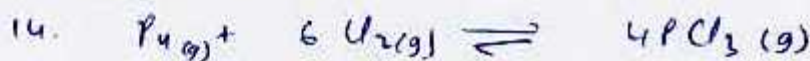
$\Rightarrow [A] < [B] \Rightarrow$ (B)

13. k at 298 K = 2.85^5

k at 698 K = 1.4×10^{-2}

k dec. with inc. in temp. \Rightarrow Exothermic.
 \Rightarrow (A)

~~14. $Pu(g) + 6Cl_2(g) \rightleftharpoons 4PCl_3(g)$~~



$t=0$ a a

$t=t_{eq}$ $a-x$ $a-6x$ $4x$.

$\Rightarrow [Cl_2] < [Pu] \Rightarrow$ (C)



$$\frac{a-2x}{4} = 1$$

$$\Rightarrow a-2x = 4$$

~~$$K_c = \frac{(2x/4)^2 (x/4)}{(a-2x/4)^2}$$~~

$$K_c = \frac{(2x/4)^2 (x/4)}{(a-2x/4)^2}$$

$$\Rightarrow 4 = \left(\frac{x}{2}\right)^2 \left(\frac{x}{4}\right)$$

$$= \frac{x^3}{16}$$

$$\Rightarrow x^3 = 64 \Rightarrow x = 4$$

$$\Rightarrow a = 2x + 4 = 12$$

$$\Rightarrow [\text{NOCl}] = \frac{12}{4^2} = 3 \text{ M} \Rightarrow \underline{\underline{(D)}}$$



~~$t=0$~~

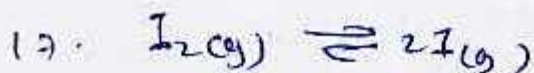
$t=t_{eq}$	1	0.2	0.8
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$$K_c = \frac{[\text{H}_2]^2 [\text{S}_2]}{[\text{H}_2\text{S}]^2} = \frac{(0.2)^2 (0.8)}{(1)^2}$$

$$= \frac{(0.01)(0.4)4}{1}$$

$$= (1.6)(0.01)$$

$$= 0.016 \Rightarrow \underline{\underline{(B)}}$$



$t=0$ 1

0

$t=t_{eq}$ $1-x$

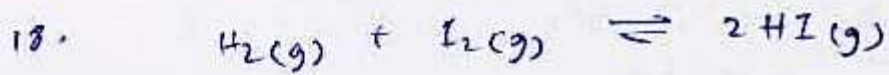
$2x$

$$K_c = 37.6 \times 10^{-6} \text{ @ } 1000 \text{ K}$$

$$K_c = \frac{(2x)^2}{1-x} = \frac{4x^2}{1-x} = 37.6 \times 10^{-6}$$

$$\Rightarrow x < 1$$

$$\Rightarrow [I] < [I_2] \Rightarrow \underline{\underline{(A)}}$$



$K_c = 50.5$

$Q = \frac{(10^{-2})^2 \times 4}{(3 \times 10^{-4})} = \frac{10^{-4} \times 4}{3 \times 10^{-4}}$

$\therefore Q < K_c \Rightarrow$ Rxn proceeds in fwd. dirⁿ.

\Rightarrow (B)



$t=0 \quad 2.2$

0

0

$t=t_{eq} \quad 2-2n$

n

n

$2.2 + n = 2.53$

$\therefore n = 0.33$

\Rightarrow degree of dissociation = $\frac{0.33}{2.2} = \frac{3}{20}$

= 0.15 \Rightarrow (C)



$t=0 \quad a$

0

$t=t_{eq} \quad a-n$

$2n$

$VP = 30 \Rightarrow MM = 60.$

~~$(46)(2n)$~~ $\frac{(46)(2n) + 92(a-n)}{a+n} = 60$

$\Rightarrow 42a = 60a + 60n$

$\Rightarrow 32a = 60n$

\Rightarrow degree of dissociation

= $\frac{n}{a} = \frac{32}{60} = 53.3\%$

\Rightarrow (A)



~~$t=0$~~

$K_c = 10 M = \frac{[O_2][SO_2]^2}{[SO_3]^2}$

Given:-
 $[SO_2] = [SO_3]$

$\therefore K_c = [O_2]$

$\Rightarrow [O_2] = 10 M$

$\Rightarrow n_{O_2} = 100 \text{ moles}$

\Rightarrow no. of molecules = $100 N_A$
 \Rightarrow (D)

HOME ASSIGNMENT - IV

1.) (D) $\Delta H^\circ = T\Delta S^\circ$ $T = \frac{\Delta H^\circ}{\Delta S^\circ} = 500\text{K}$ $T_{\min} > T$

2.) (D) At equilibrium, $\Delta G = 0$

3.) (B) $\Delta G^\circ = -2.303RT \log K$
 $K = 7.80 \times 10^2$

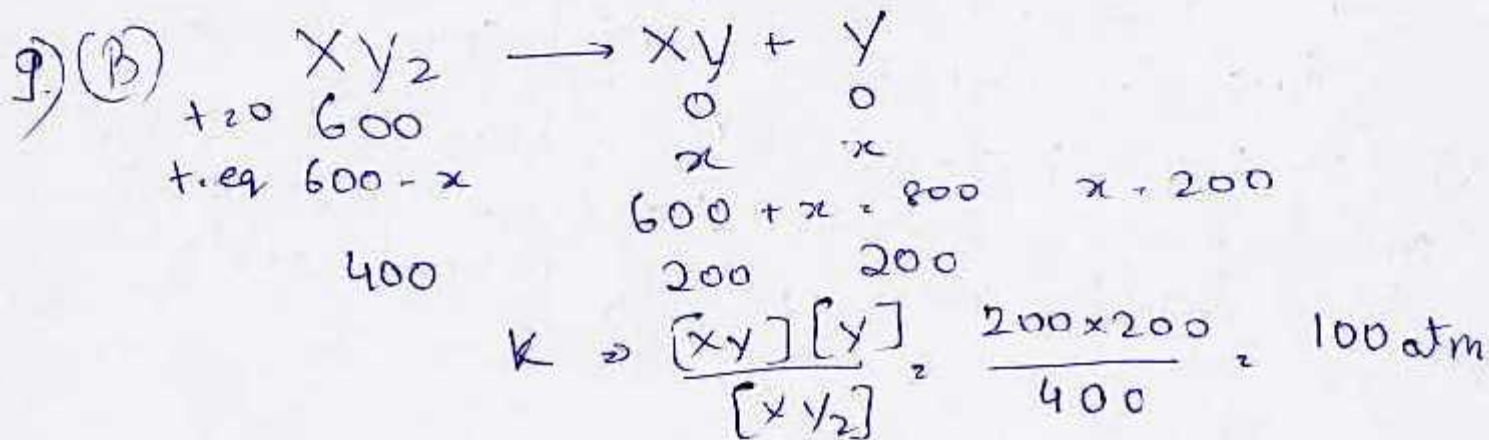
4.) (D) $\Delta G = -ve$ (Reaction is spontaneous)
 $\Delta H = -ve$ (Energy is released during freezing)
 $\Delta S = -ve$ (Liquid changes to solid)

5.) (A) $\log_e K = \frac{\Delta S^\circ}{R} - \frac{\Delta H^\circ}{RT}$

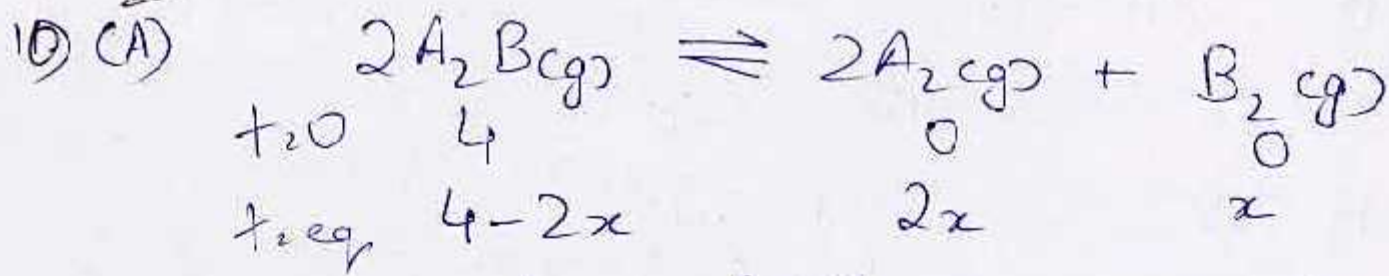
6.) (D) Increase in temperature increases equilibrium constant if reaction is endothermic and vice-versa.

7.) (D) Decrease in volume favours reaction to the side having less no. of gaseous moles.

8.) (C) Equate $\frac{[P_c]}{[P_B][P_A]} = \frac{[P_c]'}{[P_B]'[P_A]'}$
 $[P_c]' = 1.20 \text{ atm}$



10.) ~~(C) [theoretical]~~



$$K_c \Rightarrow \frac{\left(\frac{2x}{V}\right)^2 \cdot \frac{x}{V}}{\left(\frac{4-2x}{V}\right)^2} \Rightarrow \frac{4x^3}{(4-2x)^2} \times \frac{1}{V}$$

$$K_p = K_c (RT)^{\Delta n} \Rightarrow \frac{4x^3}{(4-2x)^2} \times \frac{RT}{V} = \frac{(\text{Total moles}) RT}{V}$$

$$\frac{4x^3}{(4-2x)^2} \Rightarrow x + 4$$

From calculation $x = 4/3$

$$x = \frac{2x}{4} \Rightarrow \frac{2 \times 4/3}{4} = \frac{2}{3}$$

17.) (A) System in equilibrium

12.) (D) No equilibrium exists in the reaction

13.) (B) According to Le-Chatelier's principle
Reaction will go in backward direction

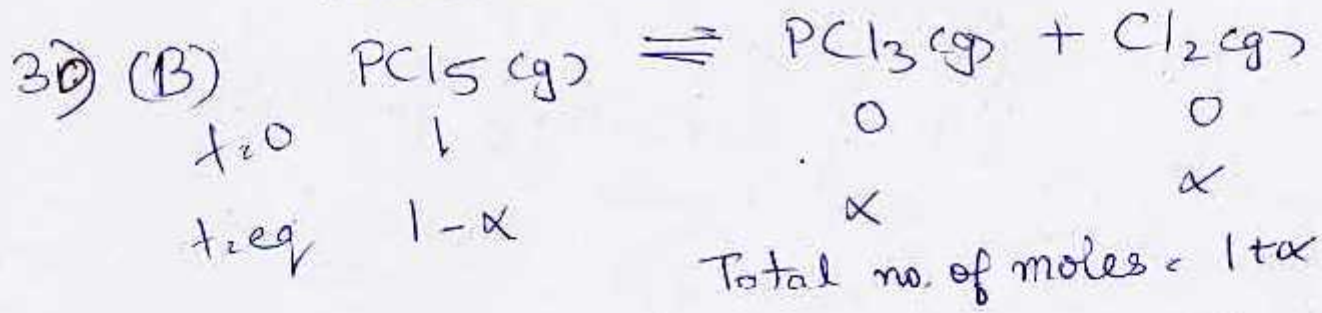
14.) (B) According to Le-Chatelier's principle
Reaction will go in backward direction
due to increase in $[H^+]$ concentration.

15.) (C) Le-Chatelier's Principle states that
on increasing volume reaction goes ~~to~~ to
side having more no. of gaseous moles.

- 17) (C) Le-Chatelier's Principle.
- 18) (B) Adding PCl_5 will favour the forward reaction.
- 19) (C) No effect $\Delta n_g = 0$
No effect of increasing pressure or volume.
- 20) (C) Low pressure favours ^{forward} reaction having $\Delta n_g > 0$
- 21) (B) Increasing pressure will favour the backward reaction as $\Delta n_g > 0$ for the reaction.
- 22) (B) Increasing temperature favours endothermic reaction and vice-versa.
Given reaction is exothermic.
- 23) (D) Same as above.
- 24) (B) Increase of temperature favours endothermic reaction.
- 25) (D) Same as above.
- 26) (C) Only C option is endothermic.
- 27) (C) High Pressure and Low temperature favours the reaction.
- 28) (B) $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$ $\Delta n_g = -ve$
 $\Delta H = -ve$
Reaction is favoured by low temperature and high pressure.

28) (D) low temperature, high pressure.

29) (A) Le-Chatelier's Principle
Reaction is endothermic



31) (D) Equilibrium constant depends only on temperature.

32) (B) Le-Chatelier's Principle.

33) (A) temperature affects equilibrium constant. $\Delta n_g < 0$

34) (D) $K_p \Rightarrow \frac{4P\alpha^2}{1-\alpha}$ P is initial pressure of N_2O_4

Volume reduces Pressure increases
 α changes.

35) (C) $K \Rightarrow \frac{[D]^2}{[B]}$ [B] doubles
[D] becomes $\sqrt{2}$ times

~~37) (C) Same as above~~

38) (A) Adding inert gas at constant pressure increases volume reaction goes towards more no. of gaseous moles.

39) (C) Rem Equilibrium constant remains unchanged.

40.) (D) Addition of catalyst only increases rate of reaction.

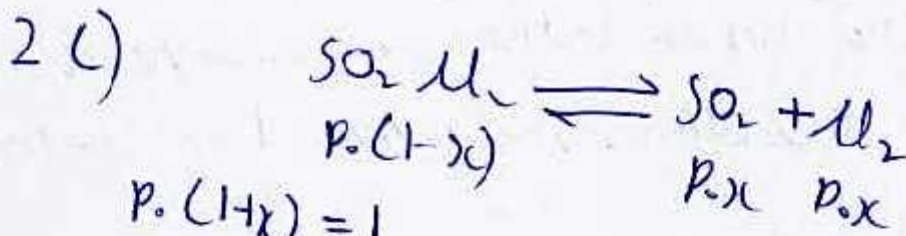
39.) (B) ~~an~~ Decreasing conc. of SO_3 will favour forward reaction.

42.) ~~(B)~~ (C) Exothermic reactions are favoured by decreasing temperature.

41.) (A) Endothermic reactions are favoured by increasing temperature thus pressure of CO_2 increases.

HOME ASSIGNMENT - V

1 D) K_{eq} is affected by change in temp



$P_0(1+x) = 1$

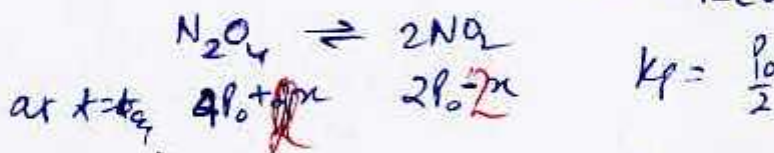
$P_0 = \frac{1}{1+x}$

$2.9 \times 10^{-2} = \frac{(SO_2)(N_2)}{(SO_2 + N_2)} = \frac{P_0 x^2}{1-x} = \frac{x^2}{1-x^2}$

$x^2 = 2.9 \times 10^{-2}$

$x = 1.7 \times 10^{-1} = 17\%$

3 (A) LONG QUESTION (CALCULATE SINCERELY)



$K_p = \frac{(P_{NO_2})^2}{P_{N_2O_4}} = \frac{(2P_0 - 2x)^2}{4P_0 + 2x} = \frac{P_0}{2}$, $x = \left(\frac{12 - \sqrt{161}}{16}\right)P_0$

Total pressure = $6P_0 + x = \left(\frac{79 + \sqrt{161}}{16}\right)P_0$

4 (A)



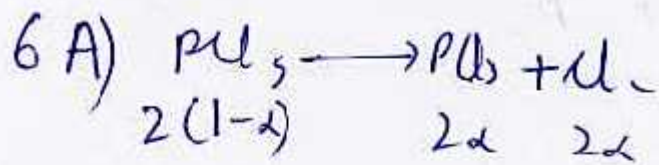
On Addition of Cl_2 , K_c remain same

$$\frac{(5-x)(2-x)}{20(1+x)} = \frac{3}{10}$$

$(10 - 7x + x^2) = 6 + 6x$

$x^2 - 13x + 4 = 0$
 $x = \frac{13 \pm \sqrt{153}}{2} = \frac{13 - \sqrt{153}}{2}$
 Mole of $PCl_5 = 1+x = \frac{15 - \sqrt{153}}{2}$
 $x_{PCl_5} = \frac{15 - \sqrt{153}}{2(3 + \sqrt{153})}$

5c) Consider cases of 0% and 100% dissociation
 If the given value lies in between, answer is possible.
 For C at 100% dissociation, molar mass will be 103.



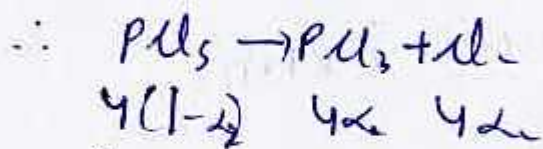
$$\frac{2\alpha}{2(1-\alpha)+1} = \frac{1}{7}$$

$$14\alpha = 3 + 2\alpha$$

$$12\alpha = 3$$

$$\alpha = \frac{1}{4}$$

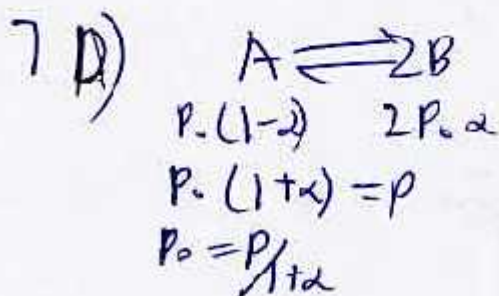
$$K = \frac{\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)}{\left(\frac{3}{2}\right)\left(150\right)} = \frac{1}{600}$$



$$\frac{16\alpha_2^2}{4(1-\alpha_2)} = \frac{1}{900}$$

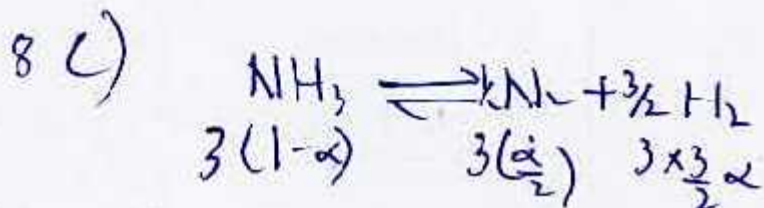
$$\alpha_2 = \frac{1}{60}$$

$\alpha \approx 1.67\%$



$$K_p = \frac{4P_0\alpha^2}{P_0(1-\alpha)}$$

$$K_p = \frac{4P\alpha^2}{1-\alpha^2}$$



$$\frac{\frac{9}{2}\alpha}{4+3\alpha} = \frac{1}{K}$$

$$9\alpha = 4 + 3\alpha$$

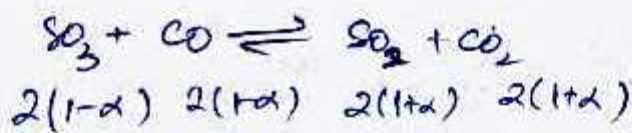
$$6\alpha = 4$$

$$\alpha = \frac{2}{3}$$

$$\therefore K_c = \frac{(\text{H}_2)^{3/2} \times (\text{N}_2)^{1/2}}{\frac{\text{NH}_3}{V}}$$

$$K_c \times V = \frac{3^{3/2} \cdot V}{1} = \underline{\underline{3\sqrt{3}}}$$

9 (D)



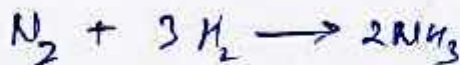
$$\frac{1+\alpha}{1-\alpha} = \frac{1}{3}$$

$$3+3\alpha = 1-\alpha$$

$$4\alpha = -2$$

$$\alpha = -\frac{1}{2}$$

10 (D)



$$\text{at } t=0 \quad 3 \quad 10 \quad 0 \quad \equiv \quad 13$$

$$\text{at } t=t \quad 3-x \quad 10-3x \quad 2x \quad \equiv \quad 13-2x$$

$$(13-2x) = \frac{2}{3}(13)$$

$$39-6x = 26$$

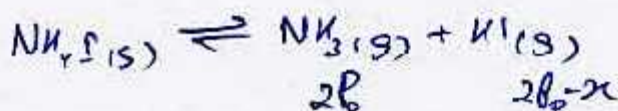
$$x = \frac{13}{6}$$

$$K_c = \frac{\left(\frac{13}{3 \times 4}\right)^2}{\left(\frac{3-13}{4 \times 6}\right)\left(\frac{10-\frac{13}{2}}{4}\right)^2}$$

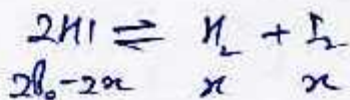
11. (B)

$$K_p = \left(\frac{P_{\text{H}_2\text{O}}}{P_{\text{H}_2}}\right)^2 = \frac{9}{4} = 2.25$$

12. (C)



$$K_p = 4P_0^2$$



$$\text{Total } f = 2b-2x+x+x+b\text{NH}_3$$

$$P_{\text{NH}_3} = 3P_0$$

$$K_p = 4P_0^2 = 3P_0^2 (2P_0 - 2x)$$

$$2P_0 - 2x = \frac{4P_0}{3}$$

$$x = P_0 - \frac{2P_0}{3} = \frac{P_0}{3}$$

$$K_p = \frac{2P_0^2 x^2}{(2P_0 - 2x)^2} = \frac{1}{16}$$

13. (B)

$$K_p = (P_{NH_3})^2 (P_{CO_2})$$

$$\left. \begin{array}{l} (P_{CO_2}) = P \\ P_{NH_3} = 2P \end{array} \right\} 4P^3 = 2.9 \times 10^{-5}$$

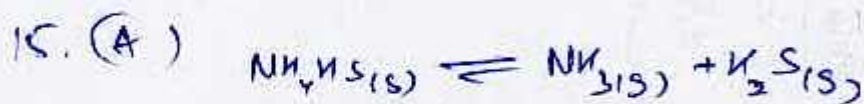
$$P^3 = \frac{2.9}{4} \times 10^{-6}$$

$$P = \sqrt[3]{0.725 \times 10^{-6}} = 0.0194 \text{ atm}$$

$$\text{Total pressure} = 3P$$

$$= 0.0582 \text{ atm}$$

14. (D)



at
eq.

2 1.5

$$K_p = 3 \text{ atm}^2$$

In vessel V_1

$$P_{NH_3} = \sqrt{3} \text{ atm}$$

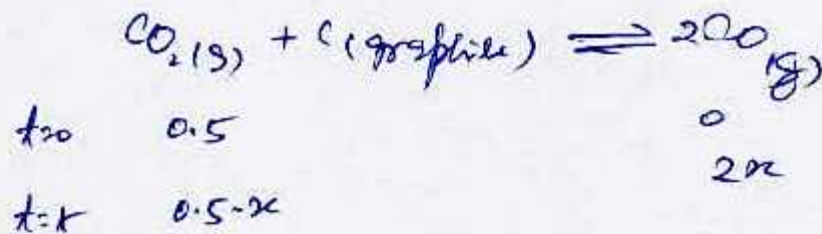
$$P_{H_2S} = \sqrt{3} \text{ atm}$$

$$\text{Total pressure, } P_0 = 2\sqrt{3} \text{ atm}$$

$$\left| \frac{W_{NH_3}}{W_{H_2S}} = \frac{2 \times 17}{1.5 \times 32} = \frac{21}{8}$$

16 ~~(D)~~

(A)

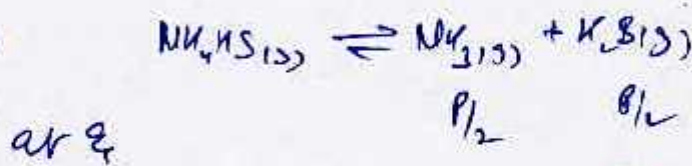


$$\text{Total } P = 0.5 + x = 0.8$$

$$x = 0.3$$

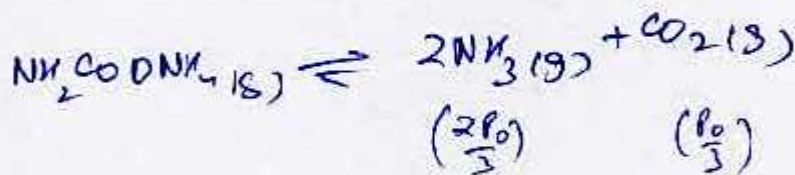
$$K_p = \frac{(0.6)^2}{(0.2)} = \text{Ans } 1.8$$

17. (C)



$$K_p = \left(\frac{P}{2}\right)\left(\frac{P}{2}\right) = \frac{P^2}{4}$$

18. (C)



$$K_p = \left(\frac{2P_0}{3}\right)^2 \left(\frac{P_0}{3}\right) = \frac{4P_0^3}{27}$$

on decreasing pressure or increasing volume reaction will go in forward reaction

19. (C)

20. (A) Le chatelier principle

~~21. (A)~~

~~22. (C) As ΔH is 2 kJ~~

~~23. (C)~~

21. volume dec. \Rightarrow H_2O conc. will inc.
[Le Chatelier]

\Rightarrow (A)

22. (C) [$\Delta n_g = 0$]

23. $\Delta H = +ve.$

\Rightarrow K inc. with inc. in temp.

~~\Rightarrow low temp.~~ \Rightarrow (C).

24. exothermic rxn

\Rightarrow K inc. with dec. in temp.

\Rightarrow low temp., high pressure \Rightarrow (C)

25. High temp \Rightarrow Endothermic rxn.

High pressure \Rightarrow less ~~gas~~ gaseous moles in
fwd dirn.

\Rightarrow (C).

26. $[\text{H}^+]$ will dec. ~~\Rightarrow low temp.~~ \Rightarrow (B)

27. (B)

28. D) G can never be 0

29. C) Le Chatelier principle

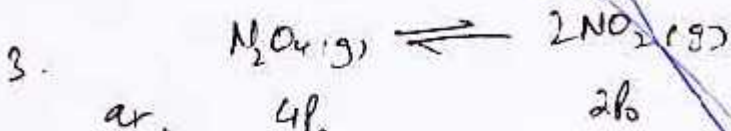
30. D)

GET EQUIPPED FOR IIT-JEE

Fill in the blank

1. K_p is independent of total pressure, it depends only on temperature.

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



at
equilⁿ

$$4P_0$$

$$2P_0$$

$$K_p = \frac{(2P_0)^2}{4P_0} = P_0$$

on doubling
volume

$$2P_0 - x$$

$$P_0 + 2x$$

$$\frac{(P_0 + 2x)^2}{2P_0 - x} = P_0$$

$$4x^2 + 4P_0x + P_0^2 = 2P_0^2 - P_0x$$

$$4x^2 + 5P_0x - P_0^2 = 0$$

$$x = \frac{-5P_0 + \sqrt{41}P_0^2}{8}$$

$$\text{Pressure due to } P_{\text{NO}_2} = P_0 + 2 \left(\frac{-5 + \sqrt{41}}{8} \right) P_0$$

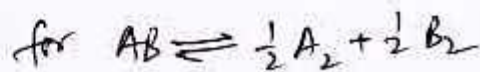
$$P_{\text{NO}_2} = \left(\frac{\sqrt{41} - 1}{4} \right) P_0$$

$$m=4, n=1$$

It is correct

True & False

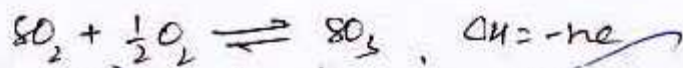
1. False



$$K_p = \frac{1}{\sqrt{K}}$$

ONLY SINGLE CHOICE CORRECT

1. (B)

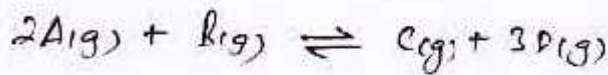


~~Reaction is favoured at high pressure and at low temperature.~~

2. 2(D)

~~Kp depends only on temperature.~~

3. (A)

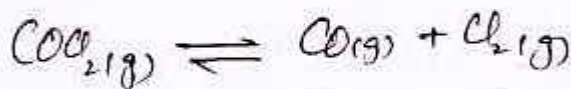


at t=0	1.5	2.5	0.5	0
at t=t _{eq}	0.5	2	1	1.5

$$K_{eq} = \frac{(1)(1.5)^3}{(0.5)^2(2)} = 6.75 \text{ M}$$

31
H.A.S
(C)

~~5(B)~~



at t=0	4	0	0
at t=t _{eq}	4-x'	x'	x'
	2	2	2
	2+y	2+x-y	2-y
	2.5	1.5+x	1.5

$$\frac{x'}{20} = 0.1$$

$$x' = 2$$

$$K_{eq} = 0.1$$

$$K_{eq} = 0.1 = \frac{(1.5)(1.5+x)}{(2.5)(4)}$$

$$10 = 2.25 + 1.5x$$

$$x = 5.167$$

$$\frac{2+y}{40} = \frac{1}{10}$$

$$\frac{2+y}{10} = \frac{1}{4}$$

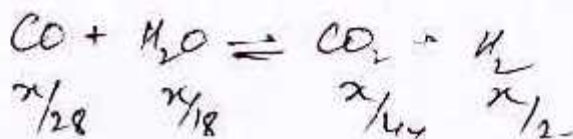
$$4+2y = 5$$

$$y = 0.5$$

32
H.A.S

33
H.A.S

4. (D)



and since molar ratio at t=0 & 3t=0 is same in molar, it is already at eq. at t=0.

ONE OR MORE than one Choice Correct

1. (A, B, C, D) Le Chatelier's principle
2. (C, D) NaNO_3 & NaNO_2 both are solid.
3. (C) No change in the position of equilibrium on addition of He at constant volume
4. (C, D, E) Le Chatelier's principle
5. (D) On addition of reactant reaction will go in forward direction
6. (A, B, C) Chemical equilibrium is example of dynamic equilⁿ.
7. (C, D) $\text{AB}_2(\text{g}) \rightleftharpoons \text{AB}(\text{g}) + \text{B}(\text{g})$

$$\alpha = \sqrt{\frac{K_p}{K_p + P}}$$

8. (A, C) On increasing pressure, reaction will shift towards less no. of gaseous molecules.
9. (C, D) $2\text{CO} + \text{O}_2 \rightleftharpoons 2\text{CO}_2 + \text{heat}$
Le Chatelier's principle.
10. (C, D)

COMPREHENSION TYPE

[A] 1. (c)

$$K_{eq} = \frac{K_f}{K_b} = 10$$

$$\frac{(P_{H_2})^4}{(P_{H_2O})^4} = 10$$

$$(P_{H_2O}) = (P_{H_2}) (10)^{-1/4}$$

$$(P_{H_2O}) = (P_{H_2}) \times 10^{-0.25}$$

2. (A)

$$\Delta G^\circ = -2.303 RT \log K_{eq}$$

$$= -2.303 \times 8.314 \times 400 \times \log 10$$

$$= -7657 \text{ J/K}$$

3. (c)

As Δn_g is zero.

4. (D)

K_c is independent of volume.

5. (B)

As given reaction is exothermic.

[B]

$$\log K_p = \frac{\Delta S^\circ}{2.303R} - \frac{\Delta H^\circ}{2.303R} \left(\frac{1}{T} \right)$$

1. (B)

$$\text{As slope} = - \frac{\Delta H^\circ}{2.303R}$$

for line (2) ΔH° is positive

2. (B)

for exothermic reaction K_p decreases with increase in temperature.

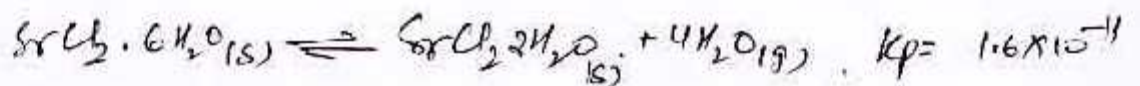
3. (c)

$$\Delta H = E_{af} - E_{ab} = -ve$$

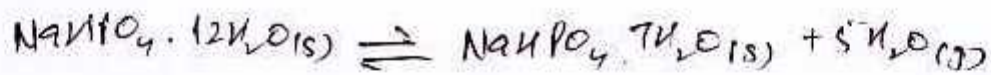
4. (c)

$$K_p = K_c (RT)^{\Delta n_g} \quad | \quad E_{ab} > E_{af}$$

FCJ

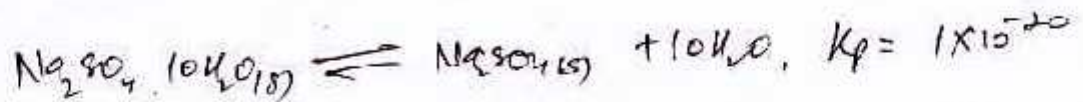


$$(P_{\text{H}_2\text{O}}) = 2 \times 10^{-3} \text{ atm}$$



$$K_p = 2.43 \times 10^{-13}$$

$$(P_{\text{H}_2\text{O}}) = 3 \times 10^{-3} \text{ atm}$$



$$(P_{\text{H}_2\text{O}}) = 1 \times 10^{-2} \text{ atm}$$

1. (A)

2. ~~(A)~~ K_p of 2nd reaction is minimum.

3. (D) Relative humidity = $\frac{10^{-2}}{\frac{15.2}{760}} \times 100 = 50\%$

4. (A)

5. (D) Molar ratio is same as partial pressure ratio.

[D]

$$K_c = \frac{\left(\frac{n_c}{V}\right)^c \left(\frac{n_d}{V}\right)^d}{\left(\frac{n_A}{V}\right)^a \left(\frac{n_B}{V}\right)^b} \quad K_p = \frac{\left(\frac{n_c R T}{V}\right)^c \left(\frac{n_d R T}{V}\right)^d}{\left(\frac{n_A R T}{V}\right)^a \left(\frac{n_B R T}{V}\right)^b} = K_c (R T)^{\Delta n_g}$$

$$K_x = \frac{(n_c)^c (n_d)^d}{(n_A)^a (n_B)^b} \times (\Sigma n)^{a+b-c-d}$$

$$= K_c (V)^{\Delta n_g} / (\Sigma n)^{\Delta n_g} = K_c \left(\frac{V}{n}\right)^{\Delta n_g}$$

$$K_x = K_c \left(\frac{R T}{P}\right)^{\Delta n_g} \Rightarrow \boxed{K_c = K_x \left(\frac{P}{R T}\right)^{\Delta n_g}}$$

$$1. (B) \quad K_p = K_c (RT)^{\Delta n_g} = K_x (P)^{\Delta n_g}$$

$$2. (C) \quad \Delta n_g = 1$$

$$K_p = K_x (P)$$

$$\text{If } P > 1 \text{ atm, } K_p > K_x$$

$$3. (C)$$

$$\Delta n_g = -1$$

$$K_c = K_x \left(\frac{P}{RT} \right)^{-1}$$

$$K_c = K_x (RT/P)$$

[E.]

$$\ln K = 2 - \frac{10500}{T} = \frac{\Delta S^\circ}{R} - \frac{\Delta H^\circ}{R} \left(\frac{1}{T} \right)$$

$$1. (A) \quad \Delta S^\circ = 2R$$

$$2. (B)$$

$$3. (B) \quad \log K_2 = \frac{\Delta S^\circ}{2.303R} - \frac{\Delta H^\circ}{2.303R} \left(\frac{1}{T} \right)$$

$$\text{Slope} = - \frac{\Delta H^\circ}{2.303R} = 1$$

$$\Delta H^\circ = -2.303R$$

$$= -2.303 \times 8.314$$

$$= -19.147$$

$$4. \quad \log \left(\frac{4}{1} \right) = \frac{\Delta H^\circ}{2.303R} \left(\frac{1}{300} - \frac{1}{520} \right)$$

$$\Delta H^\circ = 13.31 \text{ kcal/mole}$$

for reverse reaction, $\Delta H^\circ = -13.31 \text{ kcal/mole}$

MATCH THE COLUMN

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

If $\Delta n_g > 0$, $\frac{K_p}{K_c} > 1$

$\Delta n_g < 0$, $\frac{K_p}{K_c} < 1$

$(A-p)(B-r)(C-q)(D-s)$

2. Unit of $K_p = (\text{atm})^{\Delta n_g}$

$(A-r)(B-q)(C-p)(D-s)$

3. $(A-p)(B-s)(C-q)(D-r)$

4. $\log\left(\frac{K_2}{K_1}\right) = \frac{\Delta H^\circ}{2.303R} \left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

$(A-p)(B-r)(C-s)(D-q)$

5. Le-Chatelier principle.

$(A-r)(B-q)(C-p)(D-s)$

ASSERTION & REASONS

1. ~~(D)~~ Statement 1 is wrong.

2. (A) On applying pressure reaction will shift towards more density.

3. (D) Statement 1 is wrong.

4. ~~(B) Both statements are correct~~

5. (A)
$$Q_p = \frac{(P_B)(P_C)}{(P_A)} = \frac{(9)(9)}{9} = 9$$

$Q_p > K_p$. (Reaction will go in backward direction)

6. (C) only statement 2 is wrong.

7. (A)

8. (D) If $Q_p < K_p$ reaction will move towards forward direction

9. (B) for $H_2(g) + \frac{1}{2} I_2(g) \rightleftharpoons 2HI(g)$

$$\Delta n_g = 0$$

10. (A)