

EXERCISE - 1 [A]

1. (A)
Irreversible reactions proceeds to completion while reversible reactions do not proceed to completion.
2. (C)
Equilibrium is attained when rate of forward reaction becomes equal to rate of backward reaction.
3. (D)
Equilibrium is attained when rate of forward reaction becomes equal to rate of backward reaction.
4. (D)
 $r \propto [B]^2$
5. (A)
According to law of active masses rate of reaction is directly proportional to product of active mass (molarity) raised to stoichiometric co-efficient.
6. (C)

$$K = \frac{[MX_3]^2}{[MX_2]^2 [X_2]}$$
 \Rightarrow (C)
7. (B)

$$\left(\frac{dx}{dt}\right)_{\text{net}} = 2.6 \times 10^3 \times 10^{-6} - 4.1 \times 10^{-2}$$

$$= 2.6 \times 10^{-3} - 41 \times 10^{-3} = -ve$$
 \Rightarrow (B)
8. (B)

$$N_2O_4 \rightleftharpoons 2NO_2 \quad \Delta n_g = 1$$

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

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

$$\Rightarrow T = 12.18 \text{ K}$$
9. (C)
 $x \rightarrow \Delta n_g = -1$
 $y \rightarrow \Delta n_g = 1$
 $z \rightarrow \Delta n_g = 0$

$$\frac{K_p}{K_c} = (RT)^{\Delta n_g} \quad \text{So } y > z > x$$
10. (B)

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

$$= 25.61$$

11. (B)
 $K_P = K_C (RT)^{\Delta n_g} \Rightarrow K_C = K_P (RT)^{-\Delta n_g}$
12. (D)
 $\frac{K_P}{K_C} = (RT)^{\Delta n_g} = (RT)^{-1/2}$
 \Rightarrow (D)
13. (B)
 $(\because \Delta n_g < 0)$
14. (A)
 $K_P = K_C (RT)^{\Delta n_g}$, for $K_P = K_C \Rightarrow (RT)^{\Delta n_g} = 1 \Rightarrow \Delta n_g = 0$
15. (B)
 Reversing rxn II and adding when I with get rxn III
 So $K_3 = \frac{K_1}{K_2} = 10^{-14}$
16. (D)
 For the rxn $H_2 + I_2 \rightleftharpoons 2HI$
 $r_f = 1.7 \times 10^{-18} [H_2][I_2] \Rightarrow k_f = 1.7 \times 10^{-18}$
 $r_b = 2.4 \times 10^{-21} [HI]^2 \Rightarrow k_b = 2.4 \times 10^{-21}$
 $\Rightarrow K_1 = \frac{1.7 \times 10^{-18}}{2.4 \times 10^{-21}}$
 So for reaction $\frac{1}{2}H_2 + \frac{1}{2}I_2 \rightleftharpoons HI$
 $K = \sqrt{K_1} = \sqrt{\frac{1.7 \times 10^3}{2.4}} = 26.6$
17. (B)
 Reversing Rxn 1 and adding with Rxn 2 we get the required reaction
 $K_3 = \frac{K_2}{K_1} = 1.8 \times 10^{-5}$
18. (D)
 For rxn $HI \rightleftharpoons \frac{1}{2}H_2 + \frac{1}{2}I_2$
 $K = \frac{1}{\sqrt{64}} = \frac{1}{8}$
19. (B)
 Adding all reaction we get the required reaction
 $K = K_1 K_2 K_3$
 \Rightarrow (B)
20. (A)

Reverse the second and multiply by $\frac{1}{2}$ to get 1st reaction

$$K_1 = \frac{1}{\sqrt{K_2}}$$

\Rightarrow (A)

21. (B)
Add the reactions to get required reaction

$$K = K_1 K_2$$

\Rightarrow (B)

22. (C)
Add the reactions and multiply by $\frac{1}{2}$ to get required reaction.

$$K = \sqrt{K_1 K_2}$$

\Rightarrow (C)

23. (C)
Adding the reaction will give overall reaction.
 $K = K_1 \times K_2 = 1$

24. (A)
$$K_c = 27 = \frac{[\text{H}_2]^3}{[\text{H}_2\text{O}]^3}$$
$$\Rightarrow \frac{[\text{H}_2]}{[\text{H}_2\text{O}]} = 3$$

25. (A)
 $\Delta n \neq 0$

26. (D)
All have $\Delta n = 0$

27. (D)
 $\Delta n = 0$ So no units

28. (A)
 $\Delta n = 1$
So, units are mol/L

29. (D)
 $K_p \Rightarrow \text{atm}^2 (\because \Delta n_g = 2)$

30. (C)
K remains constant

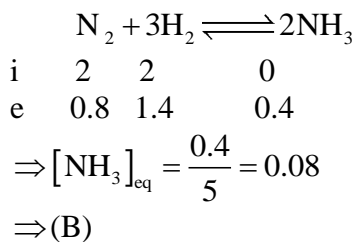
31. (B)
$$\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$$

i	1	3	0
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$$e \quad 0.5 \quad 1.5 \quad 1$$

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

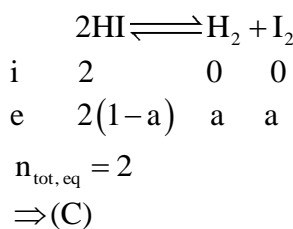
32. (B)



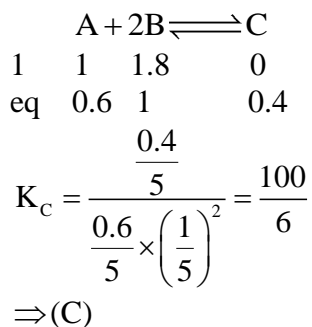
33. (B)

Small value of K indicates that at equilibrium products are much lesser than reactants so (B)

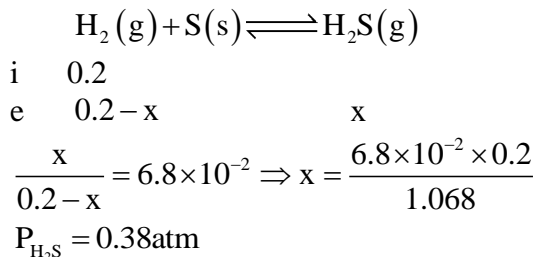
34. (C)



35. (C)



36. (B)



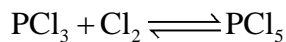
37. (C)

Higher value of K indicates more tendency to completion.

38. (A)

$$K_p = \frac{P_{\text{SO}_3}^2}{P_{\text{SO}_2}^2 P_{\text{O}_2}} \Rightarrow P_{\text{O}_2} = \frac{1}{3.5} = 0.29 \text{ atm}$$

39. (C)



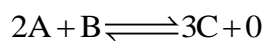
$$\begin{array}{l} \text{i} \quad 0 \quad 0 \quad \frac{x}{2.5} \\ \text{e} \quad 0.2 \quad 0.2 \quad \frac{x}{2.5} - 0.2 \end{array}$$

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

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

$$\Rightarrow x = 2$$

40. (B)

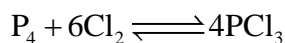


$$\begin{array}{l} \text{i} \quad 2 \quad 2 \quad 0 \quad 0 \\ \text{e} \quad 2-2x \quad 2-x \quad 3x \quad x \end{array}$$

So $[\text{B}] > [\text{A}]$

$\Rightarrow [\text{B}]$

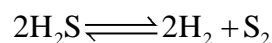
41. (C)



$$\begin{array}{l} \text{i} \quad x \quad x \quad 0 \\ \text{e} \quad x-y \quad x-6y \quad 4y \end{array}$$

So $[\text{Cl}_2] < [\text{P}_4]$

42. (B)



$$K = \frac{\left(\frac{0.2}{2}\right)^2 \left(\frac{0.8}{2}\right)}{\left(\frac{1}{2}\right)^2}$$

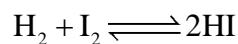
$$= 0.016$$

$\Rightarrow [\text{B}]$

43. (A)

Since K is very small reaction will proceed to negligible extent hence $[\text{I}] < [\text{I}_2]$

44. (B)



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

So rxn proceeds in forward direction

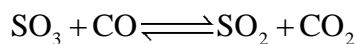
45. (D)

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

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

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

46. (D)



$$\begin{array}{l} \text{i.} \quad 2 \quad 2 \quad 2 \quad 2 \\ \text{e.} \quad 2-x \quad 2-x \quad 2+x \quad 2+x \end{array}$$

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

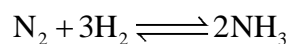
$$\Rightarrow 6+3x = 2-x$$

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

$$n_{\text{SO}_3} + n_{\text{CO}_2} = 2-x+2+x = 4$$

$$\frac{n_{\text{SO}_2}}{n_{\text{CO}}} = \frac{2+x}{2-x} = \frac{1}{3}$$

47. (D)



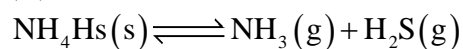
$$\begin{array}{l} \text{i.} \quad 3 \quad 10 \quad 0 \\ \text{e.} \quad 3-x \quad 10-3x \quad 2x \end{array}$$

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

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

$$K_C = \frac{\left(\frac{13/3}{4} \right)^2}{\frac{5}{4} \times \left(\frac{21}{4} \right)^3}$$

48. (C)



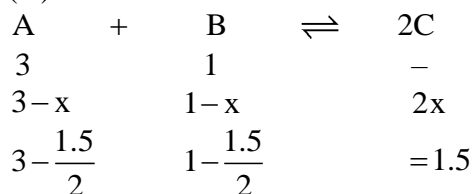
$$\begin{array}{l} \text{e} \quad \quad \quad x \quad \quad x \end{array}$$

$$2x = p \Rightarrow x = \frac{p}{2}$$

$$K_P = x^2 = \frac{p^2}{4}$$

\Rightarrow (C)

49. (D)



$$K = \frac{(1.5)^2}{0.5 \times 2.25} = 4$$

50. (C)

$$M_{w_{eq}} = \frac{122}{1-\alpha + \frac{\alpha}{2}} = \frac{122}{1-\frac{1}{4}} \Rightarrow 122 \times \frac{4}{3} = 163$$

51. (A)

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

52. (B)

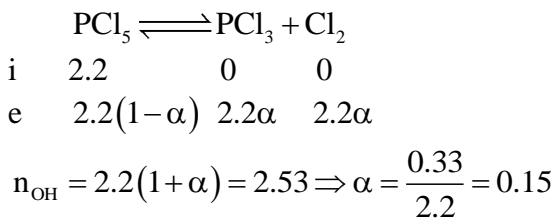
$$\frac{D}{d} = 1 + \alpha$$

\Rightarrow (B)

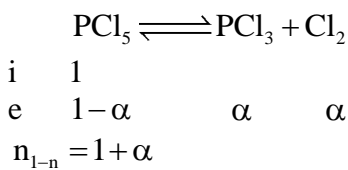
53. (A)

K_p never changes with pressure

54. (C)



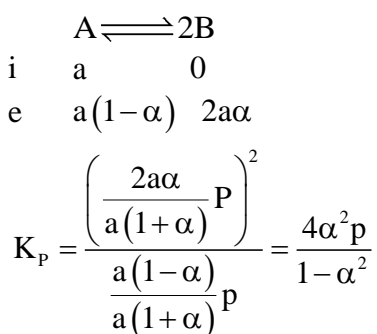
55. (B)



56. (D)

K_p will not change with volume, but α will

57. (A)



58. (C)
Exothermic reaction is favored by low T
 $\Delta n_g < 0$ is favored by high P
59. (B)
Slope = $\frac{-\Delta H}{2.303R} = 1$
 $\Rightarrow \Delta H = -4.606 \text{ cal}$
60. (B)
For I as $T \uparrow K \downarrow \Rightarrow$ exothermic
For II as $T \uparrow K \uparrow \Rightarrow$ endothermic
61. (A)
As $T \uparrow K \downarrow \Rightarrow$ exothermic
62. $T \geq \frac{50,000}{100} = 500$
SO (D)
63. (D)
At equilibrium $\Delta G = 0$
64. (B)
 $K = e^{\frac{16500}{8.314 \times 298}} = 780$
65. (A)
 $\ln k = 4 - \frac{2000}{T} = \frac{\Delta S^\circ}{R} - \frac{\Delta H^\circ}{RT}$
 $\Rightarrow \Delta S^\circ = 4R$
66. (D)
For exothermic As $T \uparrow K \downarrow$
For endothermic As $T \uparrow K \uparrow$
67. (B)
Since reaction is exothermic increase in temp will favor decomposition of N_2O_4
68. (D)
Since reaction is exothermic increase in temp will favor backward rxn hence $[NH_3]$ will decrease
69. (D)
For endothermic reaction as $T \uparrow, K \uparrow$
70. (D)

K_p can change only with temperature

71. (C)
Since the reaction is exothermic low temperature will favor forward rxn.
72. (A)
Since the reaction is endothermic increasing temperature will increase P_{CO_2}
73. (C)
Endothermic reaction is favored by high T
 $\Delta n_g < 0$ reaction is favored by high P
74. (D)
Pressure does not effect K
 \Rightarrow (D)
75. 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.
76. (C)
Only temperature can change K
77. (C)
K remains unaffected if T is constant
78. (C)
K remains unchanged on changing volume of container
79. (C)
 $2\text{HI} \rightleftharpoons \text{H}_2 + \text{I}_2$, dissociation reaction of HI has $\Delta n_g = 0$ so change of volume of container will not have any effect.
80. (C)
Increase in P favors backward rxn if $\Delta n_g > 0$
So (C)
81. (C)
$$K = \frac{0.3}{0.15 \times P_B} = \frac{P_C}{0.3 \times 2P_B}$$
$$\Rightarrow P_C = 1.2 \text{ atm}$$
82. (A)
Le Chatelier principle applies on disturbance on a system in equilibrium.
83. (B)
Addition of product will shift reaction backwards so $[\text{H}^+]$ will decrease
84. (C)

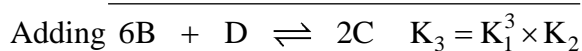
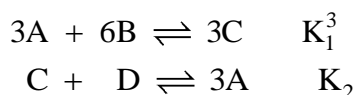
Since $\Delta n_g > 0$ for reaction increasing volume will favor forward reaction.

85. (C)
Increasing product concentration will favor backward reaction
86. (B)
Adding PCl_5 will favor forward reaction hence Cl_2 will increase
87. (C)
Since $\Delta n_g = 0$ increasing pressure will have no effect.
88. (B)
 $\Delta n_g > 0$ so increasing pressure will shift the reaction in backward direction
89. (C)
Exothermic, $\Delta n_g < 0$
So low temperature & high pressure
 \Rightarrow (C)
90. (D)
Exothermic, $\Delta n_g < 0$
So low temperature & high pressure
 \Rightarrow (D)
91. (A)
Endothermic. $\Delta n_g < 0$
So high temperature & high pressure
 \Rightarrow (A)
92. (B)
Adding N_2O_4 shift the reaction in forward direction, so concentration NO_2 will increase.
93. (A)
Catalyst does not effects equilibrium.
94. (C)
 $K = \frac{P_D^2}{P_B} \Rightarrow$ so P_B is doubled so P_D will increase by factor of $\sqrt{2}$
95. (C)
K does not changes on adding of inert
96. (B)
Removal of SO_3 will shift the reaction in forward direction
97. (D)
Since $\Delta n_g = 0$, only temp. change will effect forward reaction

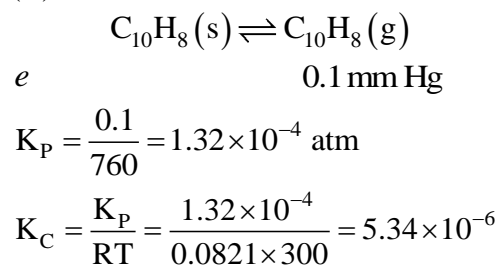
98. (D)
 CaCO_3 is solid so adding CaCO_3 will not change its active mass.
99. (A)
 $\Delta n_g > 0$ So backwards reaction is favored
100. (C)
 $\Delta n_g = 0$ will not be effected by P

EXERCISE - 1 [B]

1. (D)



2. (C)



3. (C)

Chemical equilibrium cannot be attained in open vessel.

4. (A)

K depends only on T

5. (D)

Since unit of K_p are atm so $\Delta n_g = 1$

6. (A)

For endothermic reaction as $T \uparrow K \uparrow$.

7. (C)

Since T is same, so K remains constant.

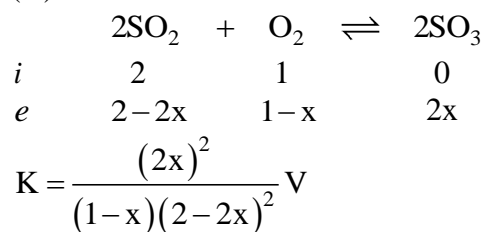
8. (A)

For vapour density to decrease, $\Delta n_g > 0$.

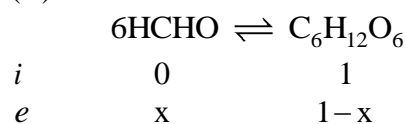
9. (D)

For oxide to be stable, K of its dissociation reaction should be least.

10. (A)



11. (B)



$$\frac{1-x}{x^6} = 6 \times 10^{22} \Rightarrow 1-x \approx 1$$

$$\text{So, } \frac{1}{x^6} = 6 \times 10^{22}$$

$$\Rightarrow x = 1.6 \times 10^{-4}$$

12. (C)

For vapour & liquid in equilibrium at boiling point, here KE is almost equal.

13. (D)

Initially only reactants are mixed so $Q = 0$, and it will increase with time.

14. (C)

$\Delta n_g > 0$ so increase in P will shift reaction in backward direction.

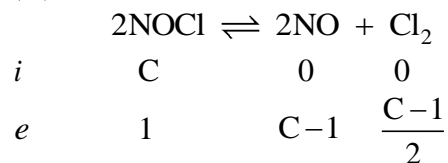
15. (C)

Addition of catalyst has no effect on K or equilibrium concentrations.

16. (B)

Lime kiln is a open vessel so $\text{CO}_2(\text{g})$ escapes out.

17. (D)



$$\frac{(C-1)^2 \left(\frac{C-1}{2} \right)}{1} = 4$$

$$\Rightarrow C-1 = 2$$

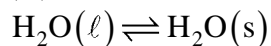
$$\Rightarrow C = 3$$

18. (A)

$$60 = \frac{92}{1+\alpha} \Rightarrow \alpha = \frac{92}{60} - 1$$

$$\Rightarrow \alpha = \frac{32}{60} = 0.5333$$

19. (D)



At -10°C reaction is spontaneous so $\Delta G^\circ < 0$

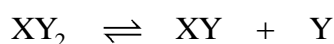
Reaction is exothermic so $\Delta H < 0$

Liquid to solid so $\Delta S < 0$.

20. (D)

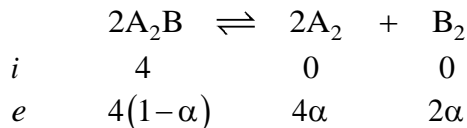
On halving the volume pressure will be doubled, and then to achieve new equilibrium reaction will decrease pressure, so at new equilibrium pressure will be less than $2P$.

21. (B)



$$\begin{array}{r}
 i \quad 600 \quad 0 \quad 0 \\
 e \quad 600 - P \quad P \quad P \\
 600 - P = 800 \\
 P = 200 \\
 K_P = \frac{200 \times 200}{400} = 100
 \end{array}$$

22. (A)



$$K_P = \frac{\frac{2\alpha}{4+2\alpha} \times \left(\frac{4\alpha}{4+2\alpha}\right)^2}{\left(\frac{4(1-\alpha)}{4+2\alpha}\right)^2} P$$

$$\text{So, } \frac{2\alpha}{4+2\alpha} \times \alpha^2 = (1-\alpha)^2 \quad (\because K_P = P)$$

$$2\alpha^3 = (1+\alpha^2-2\alpha)(4+2\alpha)$$

$$2\alpha^2 = 4 + 4\alpha^2 - 8\alpha + 2\alpha + 2\alpha^3 - 4\alpha^2$$

$$6\alpha = 4 \Rightarrow \alpha = \frac{2}{3}$$

23. (D)

Le Chatelier's principle can't be applied if all reactions & products are solids.

24. (B)

Adding HCl will increase H^+ concentration
So reaction will be shifted backward.

25. (C)

$\Delta n_g > 0$, So (C).

26. (B)

For endothermic as $T \uparrow K \uparrow$, So (B)

27. (C)

For endothermic as $T \uparrow K \uparrow$, So (C)

28. (B)

Exothermic will be favoured by low T
 $\Delta n_g < 0$ will be favoured by high P

29. (A)

$$\Delta n_g > 0$$

Adding inert at constant P will shift reaction in forward direction.

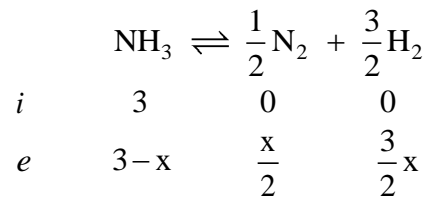
30. (D)

Addition of catalyst does not affect equilibrium concentrations.

31. (C)

$$2.9 \times 10^{-2} = \frac{\alpha^2}{1 - \alpha^2} \times 1$$
$$\Rightarrow \alpha = 0.17$$

32. (C)



$$\frac{\frac{3}{2}x}{4+x} = \frac{1}{2}$$

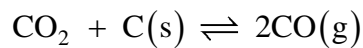
$$3x = 4 + x$$

$$x = 2$$

$$K_C = \frac{\left(\frac{3}{V}\right)^{3/2} \left(\frac{1}{V}\right)^{1/2}}{\frac{1}{V}}$$

$$K_C \times V = 3^{3/2}$$

33. (A)



<i>i</i>	0.5
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<i>e</i>	0.5 - P
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$$0.5 + P = 0.8 \Rightarrow P = 0.3$$

$$K_P = \frac{(0.6)^2}{0.2} = 1.8$$

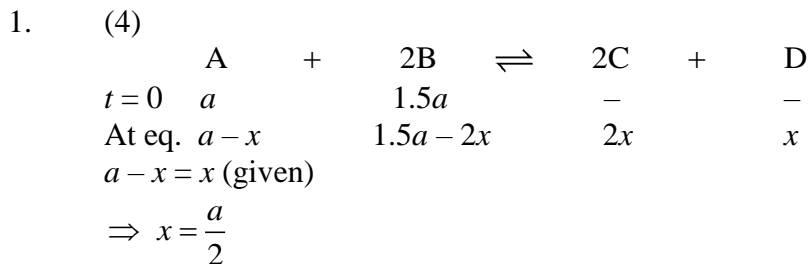
34. (D)

When ice and water are in equilibrium then $G_{\text{ice}} = G_{\text{water}} \neq 0$

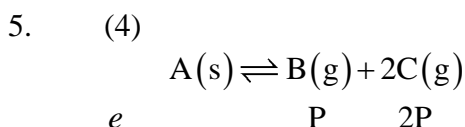
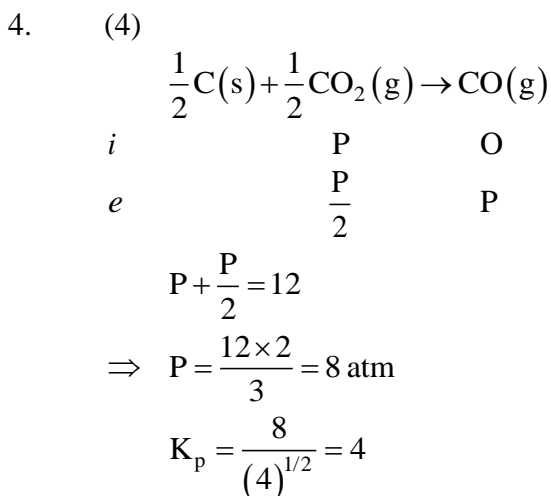
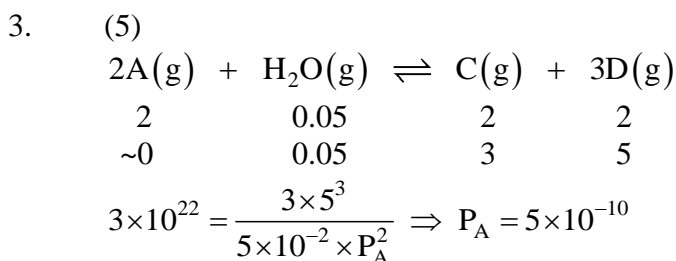
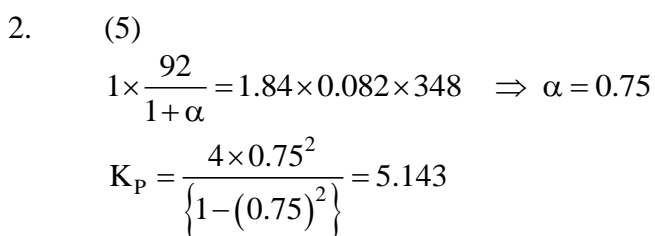
35. (C)

Since, $\Delta n_g > 0$ increasing pressure will shift reaction in backwards direction.

EXERCISE - 1 [C]



$$K_C = \frac{a^2 \times \frac{a}{2}}{\frac{a}{2} \times \left(\frac{a}{2}\right)^2} = 4$$



$$(P)(2P)^2 = 32$$

$$\Rightarrow P = 2$$

6. (1)

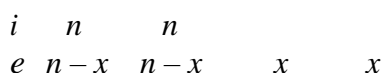
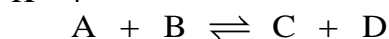
$$K_c = \frac{2/5}{2/5} = 1$$

7. (2)

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

$$\ln K = \frac{-830}{-2 \times 300} = \frac{83}{60}$$

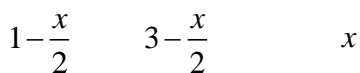
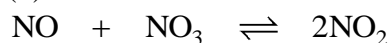
$$K = 4$$



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

$$\Rightarrow \frac{x}{n-x} = 2$$

8. (4)



$$K = \frac{x^2}{\left(1-\frac{x}{2}\right)\left(3-\frac{x}{2}\right)} \Rightarrow K = \frac{4x^2}{(3-x)^2}$$

Equating the two K $x = \frac{3}{2}$ and then $K = 4$.

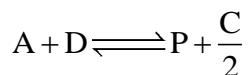
9. (2)

$$K_p = K_x (RT)^{\Delta n} = K_c (RT)^2$$

$$\Rightarrow \Delta n = 2$$

10. (3)

For the reactions,



$$K = \frac{6}{\sqrt{4}} = 3$$

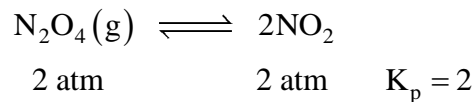
11. (9)

$$\log K = \frac{\Delta S^\circ}{2.3R} - \frac{\Delta H^\circ}{2.3RT}$$

$$\Rightarrow \frac{\Delta S^\circ}{2.3R} = 0.47$$

$$\text{Hence } \Delta S^\circ = 0.47 \times 2.3 \times 8.3 = 9$$

12. (2)



$$\frac{2}{x} - p = 0.85 \qquad \frac{2}{x} + 2p$$

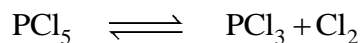
$$K_p = 2 = \frac{\left(\frac{2}{x} + 2p\right)^2}{0.85}$$

$$\Rightarrow \frac{2}{x} + 2p = 1.3 \qquad \dots(\text{i})$$

$$\text{and } \frac{2}{x} - p = 0.85 \qquad \dots(\text{ii})$$

Eliminating p from equation (i) and (ii) gives $x = 2$.

13. (2)



$$\text{Eqn-1 : } \quad n \qquad \qquad n \quad n$$

$$K_c = \frac{n}{V} \qquad \dots(\text{i})$$

$$\text{Eqn-2 : } \quad n + m \qquad \quad n - m \quad n + \frac{20}{3} - m$$

$$K_c = \frac{\left(n - m + \frac{20}{3}\right)(n - m)}{(n + m)2V} \qquad \dots(\text{iv})$$

Also since volume is doubled, moles will also be doubled

$$\Rightarrow 3n + \frac{20}{3} - m = 6n \text{ or } \frac{20}{3} - m = 3n \qquad \dots(\text{iii})$$

From (i) (ii) and (iii), $n = 2$

14. (12)

$$K_c = \frac{x}{2(2)^2} = \frac{1}{2}$$

$$\Rightarrow x = 4 \text{ mol AB}_2 \text{ present.}$$

Now let y mol of AB_2 is added.

$$K_c = \frac{1}{2} = \frac{4 + y}{2(2 + 2)^2}$$

$$\Rightarrow y = 12$$

15. (1)

$$\Delta G^\circ = -RT \ln K = 0$$

$$\Rightarrow K = 1$$

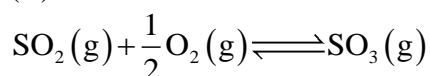
1. (D)

To calculate the value of K_4 in the given equation we should apply:

$$\text{eq.}(2) + \text{eqn.}(3) \times 3 - \text{eqn.}(1)$$

$$\text{Hence, } K_4 = \frac{K_2 K_3^3}{K_1}$$

2. (B)



$$K_p = K_c (\text{RT})^x$$

Where $x = \Delta n_g =$ number of gaseous moles in product – number of gaseous moles in reactants

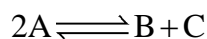
$$= 1 - \left(1 + \frac{1}{2}\right) = 1 - \frac{3}{2} = -\frac{1}{2}$$

3. (D)

On adding inert gas at constant volume, the total pressure of the system is increased, but the concentration of each reactant and product remains the same. Hence, there is no effect on the state of equilibrium.

4. (D)

$$\Delta G^\circ = 2494.2\text{J}$$



$$[\text{A}] = \frac{1}{2}, [\text{B}] = 2, [\text{C}] = \frac{1}{2}$$

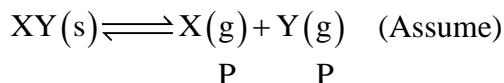
$$Q = \frac{[\text{B}][\text{C}]}{[\text{A}]^2} = \frac{2 \times 1/2}{\left(\frac{1}{2}\right)^2} = 4$$

$$\Delta G^\circ = -2.303\text{RT} \log K_c$$

$$2494.2\text{J} = -2.303 \times (8.314\text{J} / \text{K} / \text{mol}) \times (300\text{K}) \log K_c$$

$$\Rightarrow \log K_c = -0.4341 \Rightarrow K_c = 0.37; \therefore Q > K_c$$

5. (A)



$$P \quad P$$

At eqm, Total pressure = $2p = 10\text{bar}$

$$\therefore p = 5; \text{ Now } K_p = (P_x)(P_y) = P^2 = 25$$

6. (C)

$$\text{Given, } \Delta H^\circ = -29.8\text{kJ mol}^{-1}$$

$$\Delta S^\circ = 0.1\text{kJ K}^{-1}$$

From the equation

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ = -29.8 - (298 \times (-0.100))$$
$$= -29.8 + 29.8 = 0$$

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

$$0 = -2.303RT \log K_{\text{eq}} \quad \therefore K = 1$$

7. (D)
- | | |
|--|-------------------------|
| Perturbation | Shifts reaction towards |
| Removal of CO | Left |
| Removal of CO ₂ | Right |
| Addition of CO ₂ | Left |
| Addition of Fe ₂ O ₃ | No change |
- (This is a solid compound.
Its concentration has no effect
on the equilibrium)

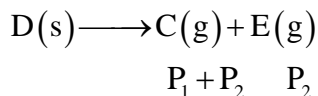
8. (B)
- As volume \uparrow pressure \downarrow , reaction proceeds in that direction where the number of moles of gases increases.

9. (A)
- We know that, $K_p = K_c \cdot (RT)^{\Delta n_g}$
- \therefore If $\Delta n_g \neq 0$ then $K_p \neq K_c$
- Now, $2C(s) + O_2(g) \rightleftharpoons 2CO(g)$
- $$\Delta n_g = +1 \Rightarrow K_p = K_c (RT)^1$$
- Hence, $K_p \neq K_c$

10. (C)
- Given, $S + O_2 \rightleftharpoons SO_2$ (i); $K_1 = 10^{52}$
- $2S + 3O_2 \rightleftharpoons 2SO_3$ (ii); $K_2 = 10^{129}$
- $2SO_2 + O_2 \rightleftharpoons 2SO_3$ (iii); $K = ?$
- To get equation (iii) follow (ii) $-2(i)$,
- $$2S + 3O_2 \rightarrow 2SO_3 \quad K_2 = 10^{129}$$
- $$-(2S + 2O_2 \rightarrow 2SO_2 \quad K_1 = 10^{104})$$
- $$O_2 \rightarrow 2SO_3 - 2SO_2 \quad K = 10^{129-104}$$
- Or $2SO_2 + O_2 \rightarrow 2SO_3 \quad K = 10^{25}$

11. (B)
- $$A(s) \longrightarrow B(g) + C(g)$$
- $$P_1 \quad P_1 + P_2$$
- $$K_{P_1} = P_B \times P_C$$

$$P_1(P_1 + P_2) = x \quad \dots\dots(i)$$



$$K_{P_1} = P_C \times P_E$$

$$(P_1 + P_2)P_2 = y \quad \dots\dots(ii)$$

Adding (i) and (ii)

$$\therefore P_1(P_1 + P_2) + P_2(P_1 + P_2) = x + y$$

$$\Rightarrow (P_1 + P_2)(P_1 + P_2) = (P_1 + P_2)^2 = x + y$$

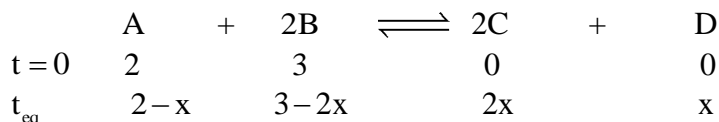
$$\Rightarrow P_1 + P_2 = \sqrt{x + y}$$

$$\therefore \text{Total pressure } (P_T) = P_C + P_B + P_E$$

$$(P_1 + P_2) + P_1 + P_2 = 2(P_1 + P_2)$$

$$P_T = 2(\sqrt{x + y})$$

12. (A)

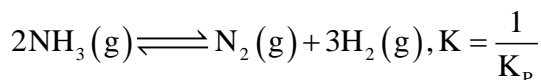


Given, 3 - 2x = 2 - x

$$\Rightarrow x = 1 \therefore [C] = 2, [D] = 1, [A] = 1, B = 1$$

$$\therefore K_c = \left\{ \frac{2^2 \times 1}{1^2 \times 1} \right\} = 4$$

13. (A)



$$\therefore K = \frac{1}{K_p} = \frac{P_{N_2} (P_{H_2})^3}{(P_{NH_3})^2} \quad \dots\dots(i)$$

$$\Rightarrow P_{\text{total}}(P) = P_{N_2} + P_{H_2} + P_{NH_3}$$

$$\approx P_{N_2} + P_{H_2} \quad (\because P_{NH_3} \ll P_{\text{total}})$$

Now,

$$\text{Partial pressure of } N_2 = \text{mole fraction of } N_2 \times P = \frac{1}{4}P;$$

$$\text{Partial pressure of } H_2 = \frac{3}{4}P$$

$$\text{From eq(i), } \frac{1}{K_p} = \frac{\left(\frac{1}{4}P\right)\left(\frac{3}{4}P\right)^3}{(P_{NH_3})^2}$$

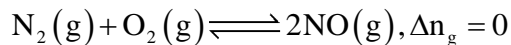
$$P_{\text{NH}_3} = \frac{3^{3/2} \cdot P^2 \cdot K_p^{1/2}}{16}$$

14. (B)

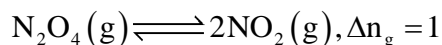
$$K_p = K_c (RT)^{\Delta n_g}$$

Δn_g = No. of gaseous moles of products – No. of gaseous moles of reactants

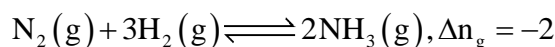
$$\frac{K_p}{K_c} = (RT)^{\Delta n_g}$$



$$\frac{K_p}{K_c} = (24.62 \text{ dm}^3 \text{ atm mol}^{-1})^0 = 1$$



$$\frac{K_p}{K_c} = 24.62 \text{ dm}^3 \text{ atm mol}^{-1}$$



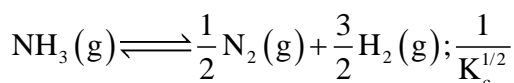
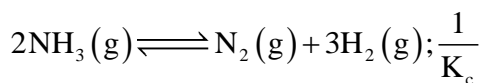
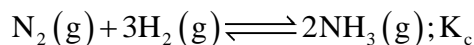
$$\frac{K_p}{K_c} = (24.62 \text{ dm}^3 \text{ atm mol}^{-1})^{-2} = 1.65 \times 10^{-3} \text{ dm}^{-6} \text{ atm}^{-2} \text{ mol}^2$$

15. (C)

$$K_p = K_c (RT)^{\Delta n_g} = K_c (RT)^{1-3/2} = K_c (RT)^{-1/2}$$

$$\Rightarrow K_c = K_p (RT)^{1/2}$$

16. (D)

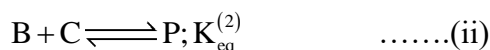
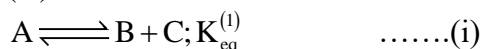


$$\frac{1}{K_c^{1/2}} = \frac{1}{(64)^{1/2}} = \frac{1}{8}$$

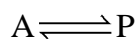
17. (B)

At equilibrium, rate of forward reaction = Rate of backward reaction.

18. (D)



On adding equations(i) and (ii), we get



$$K_{\text{eq}}(\text{overall}) = K_{\text{eq}}^{(1)} \cdot K_{\text{eq}}^{(2)}$$

19. (D)
Equilibrium constant

$$K_c = \frac{[B]}{[A]} = \frac{11}{6} \approx 2$$

20. (C)
 $\Delta G^\circ = -RT \ln K, T_1 = 25^\circ\text{C}, K_1 = 10$

$$\Delta G^\circ \text{ at } T_1 = -8.314 \times 298 \times 2.303 \times \log 10 = -5.71 \text{ kJ/mol}$$

$$\Delta G^\circ \text{ at } T_2 = -8.314 \times 373 \times 2.303 \times \log(100)$$

$$= -14.29 \text{ kJ/mol}$$

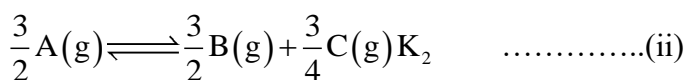
$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ \Rightarrow -5.71 = \Delta H^\circ - 298(\Delta S^\circ) \text{ and } -14.29 = \Delta H^\circ - 373(\Delta S^\circ)$$

$$\Delta H^\circ = 28.4 \text{ kJ/mol}$$

21. (A)
Reaction at equilibrium, $\text{N}_2\text{O}_4 \rightleftharpoons 2\text{NO}_2$. According to Le chatelier's principle.

(A) addition of an inert gas at constant pressure will increase volume or decrease moles per unit volume. Thus equilibrium shifts towards more number of molecules.

22. (C)
 $2\text{A}(\text{g}) \rightleftharpoons 2\text{B}(\text{g}) + \text{C}(\text{g}) K_1 \dots\dots\dots(\text{i})$



eq. (ii) is $\frac{3}{4}$ times of equation (i), hence, $K_2 = (K_1)^{\frac{3}{4}}$

23. (A)
 $\text{PCl}_5 = 5$ moles; $\text{Ar} = 4$ mole

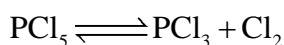
$$P_{\text{Total}} = \frac{9 \times 0.082 \times 610}{100} = 4.5 \text{ atm}$$

$$P_y = X_y P_T$$

\swarrow Total pressure
 \searrow mole fraction of y

$$X_{\text{PCl}_5} = \frac{5}{9}; X_{\text{Ar}} = \frac{4}{9}$$

$$P_{\text{PCl}_5} = \frac{5 \times 4.5}{9} = 2.5 \text{ atm}; P_{\text{Ar}} = \frac{4 \times 4.5}{9} = 2 \text{ atm}$$



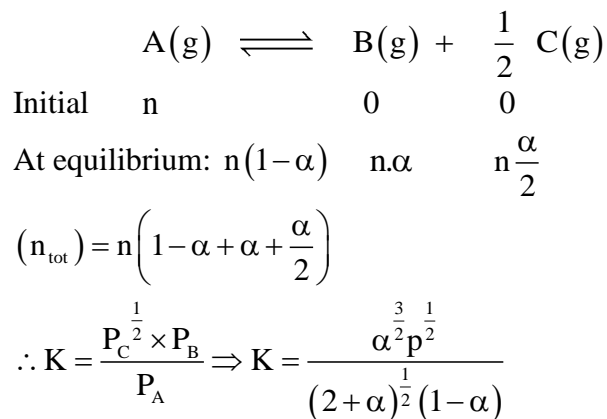
$$2.5 - P \qquad P \qquad P$$

$$P_{\text{total}} = 2.5 - P + P + P + P_{\text{Ar}} = 6 \text{ atm}$$

$$P = 1.5 \text{ atm}$$

$$K_p = \frac{1.5 \times 1.5}{1} = 2.25$$

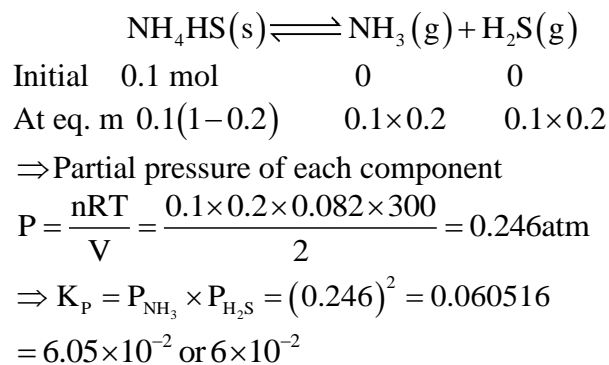
24. (B)



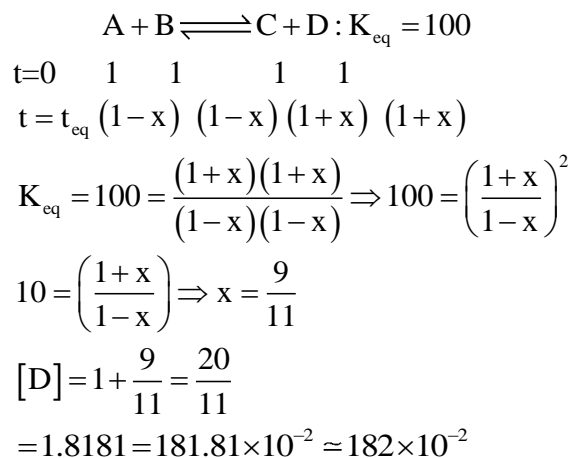
25. (6)

$$\text{Moles of NH}_4\text{HS initially taken} = \frac{5.1 \text{ g}}{51 \text{ g/mol}} = 0.1 \text{ mol}$$

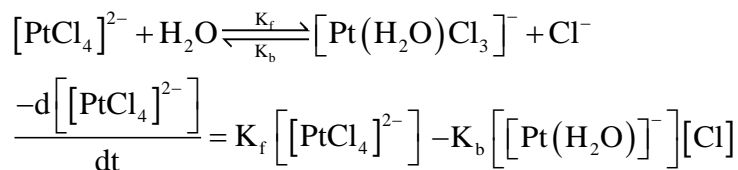
Volume of vessel = 2L



26. (182)



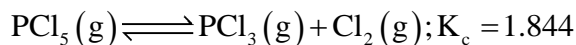
27. (0.02)



Comparing this equation with the given one:

$$\Rightarrow K_{eq} = \frac{K_f}{K_b} = \frac{4.8 \times 10^{-5}}{2.4 \times 10^{-3}} = 0.02$$

28. (1400)



$$t = 0 \quad 3 \text{ moles} \quad \quad 0 \quad \quad 0$$

$$t = \infty \quad (3-x) \quad \quad x \quad \quad x$$

$$\Rightarrow \frac{[\text{PCl}_3][\text{Cl}_2]}{[\text{PCl}_5]} = \frac{x^2}{3-x} = 1.844$$

$$\Rightarrow x^2 + 1.844x - 5.532 = 0$$

$$x = \frac{-b \pm \sqrt{D}}{2a} = \frac{-1.844 + \sqrt{(1.844)^2 + 4 \times 5.532}}{2} \cong 1.604$$

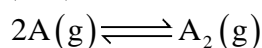
$$\Rightarrow \text{Moles of } \text{PCl}_5 = 3 - 1.604 \cong 1.396 \cong 1.4 \cong 1400 \times 10^{-3}$$

29. (16)

$$K_p = (P_{\text{O}_2})^{1/2}$$

$$4 = (P_{\text{O}_2})^{1/2} \Rightarrow P_{\text{O}_2} = 16$$

30. (166)



For homogenous gas phase reaction, $K_{th} = K_p$

$$\Delta G^\circ = -RT \ln K_p$$

$$\Rightarrow 25.2 \times 10^3 = -8.3 \times 400 \times 2.3 \log K_p$$

$$\log K_p = \frac{-25.2 \times 10^3}{8.3 \times 400 \times 2.3} \Rightarrow \log K_p = -3.3$$

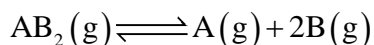
$$K_p = \text{antilog}(-3.3)$$

$$K_p = 10^{-3.3}; K_p = 10^{-3} \cdot 10^{-0.3}$$

$$K_p = 0.501 \times 10^{-3} = 5 \times 10^{-4} \therefore K_p = K_c (RT)^{-1}$$

$$\therefore K_c = 5 \times 10^{-4} \times 8.3 \times 400 = 1.66 = 166 \times 10^{-2}$$

31. (72)



$$t = 0 \quad 1 \quad \quad - \quad \quad -$$

$$t = \text{eq}^m \quad 1-\alpha \quad \quad \alpha \quad \quad 2\alpha$$

\therefore No. of moles at equilibrium

$$= 1 + 2\alpha = \frac{PV}{RT} = \frac{1.9 \times 25}{0.082 \times 300} \approx 1.93$$

$$\therefore \alpha = 0.465$$

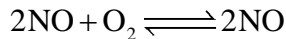
$$\therefore P_{AB_2} = \frac{1-\alpha}{1+2\alpha} \times P_T = \frac{1-0.465}{1+2 \times 0.465} \times 1.9 \approx 0.53 \text{ atm}$$

$$P_A = \frac{\alpha}{1+2\alpha} \times P_T = \frac{0.465}{1.93} \times 1.9 \approx 0.46 \text{ atm}$$

$$P_B = \frac{2\alpha}{1+2\alpha} \times P_T = \frac{2 \times 0.465}{1.93} \times 1.9 \approx 0.91 \text{ atm}$$

$$K_P = \frac{P_A \cdot (P_B)^2}{P_{AB_2}} = \frac{0.46 \times (0.91)^2}{0.53} \approx 0.72 \approx 72 \times 10^{-2}$$

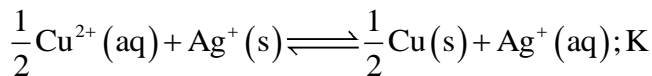
32. (2)



Initial:	2	1	-
Change:	$2-2x$	$1-x$	$2x$
Equilibrium:	1.2	0.6	0.8

$$K_P = \frac{\left(\frac{0.8}{2.6}\right)^2}{\left(\frac{1.2}{2.6}\right)^2 \left(\frac{0.6}{2.6}\right)} = 1.925$$

33. (2)



$$K = \frac{1}{\sqrt{2 \times 10^{15}}} = 2.23 \times 10^{-8}$$

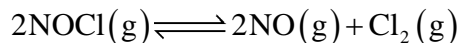
34. (29)

$$\text{moles of water} = \frac{0.90}{18}$$

By ideal gas equation $PV = nRT$

$$V = \frac{nRT}{P} = \frac{0.90 \times 0.82 \times 300 \times 760}{18 \times 32} = 29.21 \approx 29$$

35. (125)



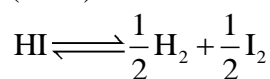
$t=0$	2M	-	-
$t=t_{eq}$	$(2-x)M$	xM	$\frac{x}{2}M$

$$\therefore x = 0.4M$$

$$\therefore [NOCl]_{eq} = 2.0 - 0.4 = 1.6M; [Cl_2]_{eq} = 0.2M$$

$$\Rightarrow K_c = \frac{[NO]^2 [Cl_2]}{[NOCl]^2} = \frac{[0.4]^2 [0.2]}{[1.6]^2} = 125 \times 10^4$$

36. (2735)



$$t_i \quad 1$$

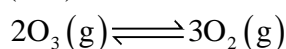
$$t_{\text{eq}} \quad 1 - 0.4 \quad \frac{0.4}{2} \quad \frac{0.4}{2}$$

$$K_p = \frac{(0.2)^{\frac{1}{2}}(0.2)^{\frac{1}{2}}}{1 - 0.4} = \frac{0.2}{0.6} = \frac{1}{3}$$

$$\Delta G = \Delta G^\circ + RT \ln K = 0 \quad [\because \text{at Equilibrium } \Delta G = 0]$$

$$\Delta G^\circ = -RT \ln K = -8.31 \times 300 \times 2.3 \times \log\left(\frac{1}{3}\right) = 2735 \text{ J/mol}$$

37. (747)



$$t = 0 \quad 2 \quad 0$$

$$t = \text{eq.} \quad 2 - 1 = 1 \quad 3/2$$

Total moles at equilibrium = $1 + 3/2 = 5/2$

Total pressure = 1 atm (given)

Partial pressure = moles fraction \times total pressure

$$P_{\text{O}_3} = \frac{1}{5/2} \times 1 = \frac{2}{5}; P_{\text{O}_2} = \frac{3/2}{5/2} \times 1 = \frac{3}{5}$$

$$K_p = \frac{(P_{\text{O}_2})^3}{(P_{\text{O}_3})^2} = \frac{(3/5)^3}{(2/5)^2} = 1.35$$

Free energy change,

$$\Delta G = -RT \ln K_p = -8.3 \times 300 \times \ln 1.35 = -747 \text{ J mol}^{-1}$$

38. (1107)

Given: 2 mole of N_2 gas was present as inert gas. Equilibrium pressure = 2.46 atm



$$t = 0 \quad 5 \quad 0 \quad 0$$

$$t = \text{Eq}^m \quad 5 - x \quad x \quad x$$

From ideal gas equation, $PV = nRT$

$$2.46 \times 200 = (5 - x + x + x + 2) \times 0.082 \times 600 \Rightarrow x = 3$$

$$K_p = \frac{\left(\frac{3}{10} \times 2.46\right) \left(\frac{3}{10} \times 2.46\right)}{\left(\frac{2}{10} \times 2.46\right)} = 1.107 = 1107 \times 10^{-3}$$