Self Practice Paper (SPP)

1. 1 mole of N_2 and 2 moles of H_2 are allowed to react in a 1 dm^3 vessel. At equilibrium, 0.8 mole of NH_3 is formed. The concentration of H_2 in the vessel is :

(1) 0.6 mole (2) 0.8 mole (3) 0.2 mole (4) 0.4 mole

2. For the following mechanism , $P + Q \underset{K_B}{\overset{K_A}{\rightleftharpoons}} PQ \underset{K_D}{\overset{K_C}{\rightleftharpoons}} R$ at equilibrium $\dfrac{[R]}{[P]\quad[Q]}$ is :

[k represents rate constant]

(1) $\dfrac{K_A.K_B}{K_C.K_D}$ (2) $\dfrac{K_A.K_D}{K_B.K_C}$ (3) $\dfrac{K_B.K_D}{K_A.K_C}$ (4) $\dfrac{K_A.K_C}{K_B.K_D}$

3. Select the reaction for which the equilibrium constant is written as $[MX_3]^2 = K_{eq.}[MX_2]^2[X_2]$

(1) $MX_3 \rightleftharpoons MX_2 + \frac{1}{2}X_2$ (2) $2MX_3 \rightleftharpoons 2MX_2 + X_2$

(3) $2MX_2 + X_2 \rightleftharpoons 2MX_3$ (4) $MX_2 + \frac{1}{2}X_2 \rightleftharpoons MX_3$.

4. What should be the value of K_C for the reaction $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$. If the amount are SO_3 = 48g, SO_2 = 12.8 and O_2 = 9.6 at equilibrium and the volume of the container is one litre ?

(1) 64 (2) 0.30 (3) 42 (4) 8.5

5. If 0.5 mole H_2 is reacted with 0.5 mole I_2 in a ten-litre container at 444°C and at same temperature value of equilibrium constant K_C is 49, the ratio of [HI] and $[I_2]$ will be :

(1) 7 (2) $\frac{1}{7}$ (3) $\sqrt{\frac{1}{7}}$ (4) 49

6. 4.5 moles each of hydrogen and iodine heated in a sealed ten litre vessel. At equilibrium 3 moles of HI were found. The equilibrium constant for $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ is :

(1) 1 (2) 10 (3) 5 (4) 0.33

7. In a 20 litre vessel initially each have 1 – 1 mole CO, $H_2O \rightleftharpoons CO_2$ is present, then for the equilibrium of $CO + H_2O \rightleftharpoons CO_2 + H_2$ following is true :

(1) H_2, more then 1 mole (2) CO, H_2O, H_2 less then 1 mole

(3) CO_2 & H_2O both more than 1 mole (4) All of these

8. At 1000 K, the value of K_p for the reaction :

$A(g) + 2B(g) \rightleftharpoons 3C(g) + D(g)$ is 0.05 atmosphere. The value of K_C in terms of R would be :

(1) 20000 R (2) 0.02 R (3) 5×10^{-5} R (4) $5 \times 10^{-5} \times R^{-1}$

9. In which of the following reactions is $K_p < K_c$?

(1) $CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$ (2) $CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$

(3) $2BrCl(g) \rightleftharpoons Cl_2(g) + Br_2(g)$ (4) $I_2(g) \rightleftharpoons 2I(g)$

10. K for the synthesis of HI is 50. K for dissociation of HI is

(1) 50 (2) 5 (3) 0.2 (4) 0.02

11. The equilibrium constant of the reaction $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ is 64. If the volume of the container is reduced to one fourth of its original volume, the value of the equilibrium constant will be

(1) 16 (2) 32 (3) 64 (4) 128

12. In equilibrium $CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

The equilibrium constant may change when

(1) CH_3COO^- is added (2) CH_3COOH is added

(3) Catalyst is added (4) Mixture is heated

13. $CH_3COOH(l) + C_2H_5OH(l) \rightleftharpoons CH_3COOC_2H_5(l) + H_2O(l)$ In the above reaction, one mole of each of acetic acid and alcohol are heated in the presence of little conc. H_2SO_4. On equilibrium being attained

(1) 1 mole of ethyl acetate is formed (2) 2 mole of ethyl acetate are formed

(3) 1/2 moles of ethyl acetate is formed (4) 2/3 moles of ethyl acetate is formed

14. In the following reaction started only with A_8,

$$2A_8(g) \rightleftharpoons 2A_3(g) + 3A_2(g) + A_4(g)$$

mole fraction of A_2 is found to 0.36 at a total pressure of 100 atm at equilibrium. The mole fraction of $A_8(g)$ at equilibrium is :

(1) 0.28 (2) 0.72 (3) 0.18 (4) None of these

15. In a 0.25 litre tube dissociation of 4 moles of NO is take place. If its degree of dissociation is 10%. The value of K_p for reaction $2NO \rightleftharpoons N_2 + O_2$ is :

(1) $\frac{1}{(18)^2}$ (2) $\frac{1}{(8)^2}$ (3) $\frac{1}{16}$ (4) $\frac{1}{32}$

16. For the given reaction at constant pressure ,

	$nA(g) \rightleftharpoons$	$A_n(g)$
Initial moles	1	0
Moles at equilibrium	$1-\alpha$	α/n

Then the correct relation between initial density (d_i) & final density (d_f) of the system is

(1) $\left[\frac{n-1}{n}\right]\left[\frac{d_f-d_i}{d_f}\right]=\alpha$ (2) $\frac{n}{n-1}\frac{[d_f-d_i]}{d_f}=\alpha$

(3) $\left[\frac{n-1}{n}\right]\left[\frac{d_i-d_f}{d_i}\right]=\alpha$ (4) $\frac{1}{(n-1)}\left[\frac{d_i-d_f}{d_i}\right]=\alpha$

17. On decomposition of NH_4HS, the following equilibrium is established :

$$NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$$

If the total pressure is P atm, then the equilibrium constant K_P is equal to

(1) P atm (2) P^2 atm^2 (3) $P^2/4$ atm^2 (4) 2P atm

18. At room temperature, the equilibrium constant for the reaction $P + Q \rightleftharpoons R + S$ was calculated to be 4.32. At 425°C the equilibrium constant became 1.24×10^{-2}. This indicates that the reaction

(1) is exothermic (2) is endothermic

(3) is difficult to predict (4) no relation between ΔH and K

19. Calculate $\Delta G°$ for conversion of oxygen to ozone $3/2\ O_2(g) \longrightarrow O_3(g)$ at 298 K, if K_p for this conversion is 2.47×10^{-29}

(1) 163 kJ mol^{-1} (2) 2.4×10^2 kJ mol^{-1} (3) 1.63 kJ mol^{-1} (4) 2.38×10^6 kJ mol^{-1}

20. For the reaction, $4\ NH_3(g) + 5\ O_2(g) \rightleftharpoons 4\ NO(g) + 6\ H_2O(\ell)$, ΔH = positive .

At equilibrium which factor will not effect the concentration of NH_3 is :

(1) change in pressure (2) change in volume (3) catalyst (4) None of these

21. The effect of adding krypton (Kr) gas on position of equilibrium, keeping the volume of the system constant is

(1) If $\Delta n = 0$, backward reaction is favoured.
(2) If, Δn = +ve, forward reaction is favoured
(3) If Δn = –ve, forward reaction is favoured
(4) No effect watever be the value of Δn

22. Le-Chatelier's principle is applicable only to a

(1) System in equilibrium
(2) Irreversible reaction
(3) Homogeneous reaction
(4) Heterogeneous reaction

23. Two solid compounds X and Y dissociates at a certain temperature as follows

$$X(s) \rightleftharpoons A(g) + 2B(g)\ ;\ K_{p1} = 9 \times 10^{-3}\ atm^3$$

$$Y(s) \rightleftharpoons 2B(g) + C(g)\ ;\ K_{p2} = 4.5 \times 10^{-3}\ atm^3$$

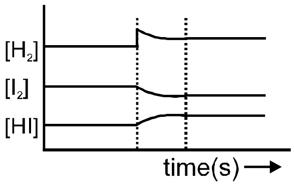
The total pressure of gases over a mixture of X and Y is :

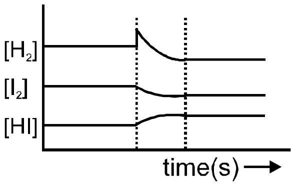
(1) 4.5 atm (2) 0.45 atm (3) 0.6 atm (4) None of these

24. The value of ΔG^o for the phosphorylation of glucose in glycolysis is 15 kJ/mole. Find the value of K_c at 300 K.

(1) e^6 (2) $10^{-\frac{6}{2.303}}$ (3) $\frac{1}{e^{-6}}$ (4) $10^{\frac{2.303}{6}}$

25. H_2 & I_2 are inequilibrium with HI in a closed container if H_2 is added in the container than which of the following is correct at new equilibrium $H_2 + I_2 \rightleftharpoons 2HI$

(1)


(2)


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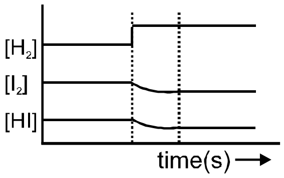

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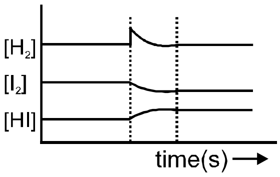
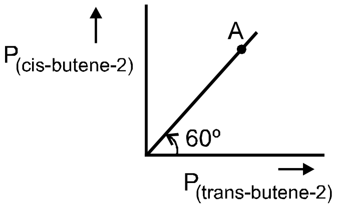


26. For the following isomerisation reaction

cis-butene-2 $\rightleftharpoons$ trans-butene-2 $K_P = 1.732$



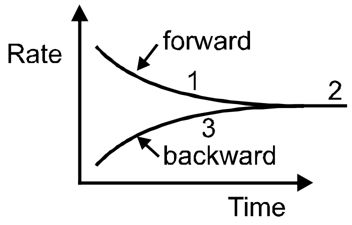
Which of the following statement is true at point 'A' ?

(1) $Q > K_P$ (2) $Q < K_P$ (3) Q = K = 1 (4) Q = K = 1.732

27. In the reaction

$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

a graph in plotted to show the variation of rate of forward and backward reactions against time. Which of the following is correct ?



	Q > K	Q = K	Q < K
(1)	3	2	1
(2)	1	2	3
(3)	2	3	1
(4)	2	1	3

28. For the reaction : $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
The backward reaction at constant temperature is favoured by
(1) introducing chlorine gas at constant volume (2) introducing an inert gas at constant pressure
(3) increasing the volume of the container (4) introducing PCl_5 at constant volume

29. Which of the following affects the value of equilibrium constant of a reaction ?
(1) Change in temperature (2) Addtion of catalyst
(3) Change in concentration of the reactants (4) Change in pressure

30. If a reaction vessel at 400ºC is charged with equimolar mixture of CO and steam such that $P_{CO} = P_{H_2O}$ = 4 bar what will be that partial pressure of H_2 at equilibrium
$CO_{if} + H_2O \rightleftharpoons CO_2 + H_2$ Kp = 9
(1) 0.3 bar (2) 0.4 bar (3) 0.2 bar (4) 0.1 bar

31. In chemical reaction $A \rightleftharpoons B$, the system will be known in equilibrium when
(1) A completely changes to B
(2) 50% of A changes to B
(3) The rates of change of A to B and B to A on both the sides are same
(4) Only 10% of A changes to B

32. Which of the following is **not** a general characteristic of equilibria involving physical processes ?
(1) Equilibrium is possible only in a closed system at a given temperature.
(2) All measurable properties of the system remain constant.
(3) All the physical processes stop at equilibrium.
(4) The opposing processes occur at the same rate and there is dynamic but stable condition.

33. The equilibrium constant for the reaction : $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ at 2000 K is 4×10^4 In presence of a catalyst the equilibrium is established ten times faster at the same temperature. What is the value of equilibrium constant in presence of catalyst : -
(1) 40×10^{-4} (2) 4×10^{-4} (3) 4×10^4 (4) None

34. The decomposition of N_2O_4 to NO_2 is carried out at 280 K in chloroform. When equilibrium has been established, 0.2 mol of N_2O_4 and 2×10^{-3} mol of NO_2 are present in 2 litre solution. The equilibrium constant for reaction $N_2O_4 \rightleftharpoons 2NO_2$ is
(1) 1×10^{-2} (2) 2×10^{-3} (3) 1×10^{-5} (4) 2×10^{-5}

35. In a reaction $A_{(g)} + 2B_{(g)} \rightleftharpoons 2C_{(g)}$, 2 moles of 'A', 3 moles of 'B' and 1 mole of 'C' are placed in a 2 L flask and the equilibrium concentration of 'C' is 1 mol/L. The equilibrium constant (K_C) for the reaction is
(1) 0.33 lit/mol (2) 1.33 lit/mol (3) 1.66 lit/mol (4) 0.66 lit/mol

36. The equilibrium constant of the reaction $SO_2(g) + \frac{1}{2} O_2(g) \rightleftharpoons SO_3(g)$ is 4×10^{-3} atm$^{-1/2}$. The equilibrium constant of the reaction $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ would be :

(1) 250 atm (2) 6.25×10^3 atm (3) 0.25×10^4 atm (4) 6.25×10^4 atm

37. Find out $\ln K_{eq}$ for the formation of NO_2 from NO and O_2 at 298 K

$$NO_{(g)} + \frac{1}{2} O_2 \rightleftharpoons NO_2\ g$$

Given : $\Delta G_f^\circ (NO_2) = 52.0$ KJ/mole

$\Delta G_f^\circ (NO) = 87.0$ KJ/mole

$\Delta G_f^\circ (O_2) = 0$ KJ/mole

(1) $\frac{35 \times 10^3}{8.314 \times 298}$ (2) $-\frac{35 \times 10^3}{8.314 \times 298}$ (3) $\frac{35 \times 10^3}{2.303 \times 8.314 \times 298}$ (4) $\frac{35 \times 10^3}{2 \times 298}$

38. Which statement for equilibrium constant is true for the reaction $A + B \rightleftharpoons C$

(1) Not changes with temperature (2) Changes when catalyst is added

(3) Increases with temperature (4) Changes with temperature

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

(1) 53.3 % (2) 106.6% (3) 26.7% (4) none

40. Pure ammonia is placed in a vessel at a temperature where its dissociation constant (α) is appreciable. At equilibrium :

(1) K_p does not change significantly with pressure.

(2) α does not change with pressure.

(3) concentration of NH_3 does not change with pressure.

(4) concentration of hydrogen is less than that of nitrogen

41. In a container equilibrium $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ is attained at 25°C. The total equilibrium pressure in container is 380 torr. If equilibrium constant of above equilibrium is 0.667 atm, then degree of dissociation of N_2O_4 at this temperature will be :

(1) $\frac{1}{3}$ (2) $\frac{1}{2}$ (3) $\frac{2}{3}$ (4) $\frac{1}{4}$

42. In which of the following system, doubling the volume of the container cause a shift to the right

(1) $H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$ (2) $2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g)$

(3) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ (4) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

43. Which of the following options will be correct for the stage of half completion of the reaction A B.

(1) $\Delta G^0 = 0$ (2) $\Delta G^0 > 0$ (3) $\Delta G^0 < 0$ (4) $\Delta G^0 = -RT \ln 2$

44. For the equilibrium $2NO_2(g) \rightleftharpoons N_2O_4(g) + 14.6$ kcal the increase in temperature would

(1) Favour the formation of N_2O_4 (2) Favour the decomposition of N_2O_4

(3) Not alter the equilibrium (4) Stop the reaction

45. Given the following reaction at equilibrium

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

Some inert gas at constant pressure is added to the system. Predict which of the following facts will be produced.

(1) More $NH_3(g)$ is produced (2) Less $NH_3(g)$ is produced

(3) No affect on the equilibrium (4) K_p of the reaction is decreased

SPP Answers

1.	(2)	**2.**	(4)	**3.**	(3)	**4.**	(2)	**5.**	(1)	**6.**	(1)	**7.**	(2)
8.	(4)	**9.**	(1)	**10.**	(4)	**11.**	(3)	**12.**	(4)	**13.**	(4)	**14.**	(1)
15.	(1)	**16.**	(2)	**17.**	(3)	**18.**	(1)	**19.**	(1)	**20.**	(3)	**21.**	(4)
22.	(1)	**23.**	(2)	**24.**	(2)	**25.**	(1)	**26.**	(4)	**27.**	(1)	**28.**	(1)
29.	(1)	**30.**	(1)	**31.**	(3)	**32.**	(3)	**33.**	(3)	**34.**	(3)	**35.**	(2)
36.	(4)	**37.**	(1)	**38.**	(4)	**39.**	(1)	**40.**	(1)	**41.**	(2)	**42.**	(4)
43.	(1)	**44.**	(2)	**45.**	(2)								

SPP Solutions

1.

	N_2 +	$3H_2$ ⇌	$2\,NH_3$
t = 0	1 mole	2 mole	0
t = eq	1–x	2–3x	2x = 0.8

x = 0.4

mole of $N_2 = 0.6$

mole of $H_2 = 0.8$

2. $$\frac{K_A}{K_B} = \frac{[PQ]}{[P]\ [Q]} \quad \text{..... (i)}$$

$$\frac{K_C}{K_D} = \frac{[R]}{[PQ]} \quad \text{..... (ii)}$$

On multiply equation (i) and (ii) we get

$$\frac{K_A.K_C}{K_B.K_D} = \frac{[R]}{[P]\ [Q]}$$

4. $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

$$K_C = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$$ Concentration in gram mole/litre, therefore

$$[SO_3] = \frac{48}{80\times1}$$ (Where 80 is molecular weight of SO_3)

$$[SO_2] = \frac{128}{64\times1}$$ (Where 64 is molecular weight of SO_2)

$$[O_2] = \frac{9.6}{32\times1}$$ (Where 32 is molecular weight of O_2)

$$\text{Thus, } K_C = \frac{\left(\frac{48}{80}\right)^2}{\left(\frac{12.8}{64}\right)^2\left(\frac{9.6}{32}\right)} = 0.30$$

5. $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

$$K_C = \frac{[HI]^2}{[H_2][I_2]}$$ if $[H_2] = [I_2]$

$$K_C = \frac{[HI]^2}{[I_2]^2}$$ $[HI]^2 = K_C \times [I_2]^2$

$$\text{or } \frac{[HI]^2}{[I_2]^2} = K_C \quad \text{or} \quad \frac{[HI]}{[I_2]} = \sqrt{K_C} = \sqrt{49} = 7$$

6.

	$H_2(g) + I_2(g)$	$\rightleftharpoons$	$2HI(g)$
t = 0	4.5	4.5	0
t = teq.	4.5 – x	4.5 – x	2x
put	x = 1.5		
	4.5 – 1.5	4.5 – 1.5	2 × 1.5 = 3
	↓	↓	↓
	3	3	3

$$K_C = \frac{(3)^2}{3\times 3} = 1$$

7.

	$Co + H_2O$	$\rightleftharpoons CO_2$	+	H_2
t = 0	1	1	1	0
t = teq	1 – x	1 – x	1 + x	x

at equilibrium, only CO_2 has (1 + x) moles.

8. $K_p = K_c\,(RT)^{\Delta n}$, $\Delta n = 4 - 3 = 1$

$0.05 = K_c\, R \times 1000$

$K_c = 5 \times 10^{-5} \times R^{-1}$

14.

	$2A_8$	$2\,A_3$	+	$3\,A_2$	+	A_4
t = 0	2	0		0		0
$t = t_{eq}$	$2 - 2\alpha$	2α		3α		α

$n_T = 2 + 4\alpha$

given mole fraction of A_2 is = 0.36.

$$0.36 = \frac{3\alpha}{2+4\alpha}$$

$\alpha = 0.46$

Mole fraction of A_8 $= \dfrac{2-2\alpha}{2+4\alpha} = \dfrac{2-2\times 0.46}{2+4\times 0.46} = 0.28$

15.

	$2NO$	$\rightleftharpoons N_2$	+ O_2	$\alpha = 10\%$
t = 0	4 – .4	.2	.2	
	3.6	0.2	0.2	

$\Delta n = 0$,

$\therefore K_P = K_C$, $\quad K_C = \dfrac{(.2/V)^2}{(3.6/V)^2} = \dfrac{4}{36\times 36}$

16. Total moles at equilibrium $= 1 - \alpha + \alpha/n = 1 + \left[\dfrac{1}{n} - 1\right]\alpha$

So using $\dfrac{d_i}{d_f} = 1 + \left[\dfrac{1}{n} - 1\right]\alpha$.

17. $P_{NH_3} = P_{H_2S} = \dfrac{P}{2}$ Hence $K_p = P_{NH_3} \times P_{H_2S} = \dfrac{P}{2} \times \dfrac{P}{2} = \dfrac{P^2}{4}$

18. At room temperature, K = 4.32
and at 425°C, equilibrium constant become 1.24×10^{-4} i.e. it is decreases with increase in temperature. So, it is exothermic reaction.

20. Catalyst can't disturb the state of the equilibrium.

23. Let x is partial pressure of A and y is partial pressure of C when both equilibrium simultaneously established in a vessel

$$X(s) \rightleftharpoons \underset{x}{A(g)} + \underset{(2x + 2y)\ ;}{2B(g)}$$

$$Y(s) \rightleftharpoons \underset{y}{C(g)} + \underset{(2y + 2x)\ ;}{2B(g)}$$

$$= \quad \frac{K_{P_1}}{K_{P_2}} \Rightarrow \frac{x}{y}\ x = 2y$$

$$K_{P_1} = x(2x + 2y)^2$$

$\Rightarrow$ $x = 0.1$ atm;

$\therefore$ $y = 0.05$ atm

Total pressure of gases = $P_A + P_B + P_C$

$= 3(x + y)$

$= 0.45$ atm.

24. $\Delta G^o = - RT \ln K_{eq}$

$$15000 = -\frac{25}{3} \times 300 \ln K_{eq}$$

$$\ln K_{eq} = -\frac{15000}{2500} = 6$$

$\ln K_{eq} = -6$

$K_{eq} = e^{-6}$

26. AT point A, $Q = \tan 60^oC$

$Q = 1.732$

$\therefore$ $Q = K = 1.732$

28. According to $K_P = \dfrac{P_{PCl_3\ (g)} \times P_{Cl_2\ (g)}}{P_{PCl_5\ (g)}} = \dfrac{(n_{PCl_3\ (g)})_{eq.} \times (n_{Cl_2\ (g)})_{eq.}}{V \times (n_{PCl_5\ (g)})_{eq.}}$

and on adding inert gas at constant pressure effect on equilibrium will be similar to as if volume of container has been increased.

30. $CO + H_2O \rightleftharpoons CO_2 + H_2$

0.4 0.4

0.4 – x 0.4 – x x x

$$\frac{x}{0.4 - x} = 3$$

$1.2 - 3x = x$

$1.2 = 4x$

$$x = \frac{1.2}{4} = 0.3$$

$x = 0.3$

33. 4×10^4, Since Equilibrium const. is temp. dependent only.

37. $NO + \frac{1}{2}O_2 \rightleftharpoons NO_2$

$\Delta G^{\circ}_{R\times H} = 52 - 87 = -35$ kJ

$\Delta G^{o} = -RT\ln K_{eq}$

$\ln K_{eq} = \frac{35000}{8.314 \times 298}$.

39. $\alpha = \frac{D - d}{d} = \frac{46 - 30}{30} = 0.533 = 53.3\%$

40. K_P depends only on temperature so α will change on changing pressure and $P_{H_2} > P_{N_2}$.

41. $K_P = 0.667 \text{ atm} = \frac{2}{3} \text{ atm} = \frac{4\alpha^2}{1-\alpha^2} . P = \frac{4\alpha^2}{1-\alpha^2} . \frac{1}{2}$

so, $\frac{4\alpha^2}{1-\alpha^2} = \frac{4}{3}$ $\Rightarrow$ $3\alpha^2 = 1 - \alpha^2$

so, $\alpha^2 = \frac{1}{4}$ $\Rightarrow$ $\alpha = \frac{1}{2}$

43. (i) $\Delta G^0 = 0$

Justification : $\Delta G^0 = -RT \ln K$

At the stage of half completion of reaction [A] = [B], Therefore, K = 1. Thus, $\Delta G^0 = 0$