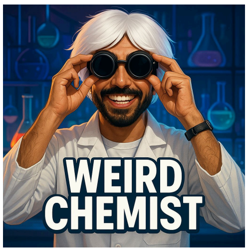

DPP-3 [K_p & K_c]

Chapter: Chemical Equilibrium

"Assignment ko time waste samajhta hai? Bhool ja result ka sapna." — Weird Chemist

Q1. For which reaction is $K_p = K_c$:-

(1) $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$
(2) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
(3) $H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$
(4) $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

Q2. In which of the following equilibrium K_c and K_p are not equal :-

(1) $2C(s) + O_2(g) \rightleftharpoons 2CO_2(g)$
(2) $2NO(g) \rightleftharpoons N_2(g) + O_2(g)$
(3) $SO_2(g) + NO_2(g) \rightleftharpoons SO_3(g) + NO(g)$
(4) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

Q3. For which of the following reaction $K_p = K_c$:-

(1) $H_2 + I_2 \rightleftharpoons 2HI$
(2) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$
(3) $2NH_3 \rightleftharpoons 3H_2 + N_2$
(4) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

Q4. For which of the following reaction value of K_p and K_c is equal :-

(1) $2NOCl \rightleftharpoons 2NO + Cl_2$
(2) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$
(3) $H_2 + Cl_2 \rightleftharpoons 2HCl$
(4) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

Q5. For the reaction $2HBr \rightleftharpoons H_2 + Br_2$ which relation is true :-

(1) $2K_p = K_c$
(2) $\frac{1}{K_p} = K_c$
(3) $K_p = K_c$
(4) None of these

Q6. For the equilibrium $CO + H_2O \rightleftharpoons CO_2 + H_2$. The relation between K_p and K_c at $25°C$ and at $100°C$ are :-

(1) $K_p = K_c$, $K_p = K_c$
(2) $K_p = K_c(RT)^{-1}$, $K_p = K_c$
(3) $K_p = K_c(RT)$, $K_p = K_c(RT)$
(4) $K_p = K_c(RT)$, $K_p = K_c$

Q7. In which of the following equilibrium equation, $K_p > K_c$:-

(1) $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$
(2) $PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$
(3) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$
(4) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

Q8. For which reaction at 298 K, the value of $\frac{K_p}{K_c}$ is maximum and minimum respectively :-

(a) $N_2O_4 \rightleftharpoons 2NO_2$
(b) $2SO_2 + O_2 \rightleftharpoons 2SO_3$
(c) $X + Y \rightleftharpoons 4Z$
(d) $A + 3B \rightleftharpoons 7C$
(1) d, c
(2) d, b
(3) c, b
(4) d, a

Q9. $\frac{K_p}{K_c}$ for following reaction will be :-

$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$

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

Q10. At 527°C, the reaction $NH_3(g) \rightleftharpoons \frac{1}{2} N_2(g) + \frac{3}{2} H_2(g)$ has $K_c = 4$ then what is the value of K_p for the same reaction :-

(1) $16 \times (800R)^2$
(2) $\left(\frac{800R}{4}\right)^{-2}$
(3) $\left(\frac{1}{4 \times 800R}\right)^2$
(4) None of these

Q11. For the equilibrium $SO_2Cl_2(l) \rightleftharpoons SO_2(g) + Cl_2(g)$, what is the temperature at which $\frac{K_p(\text{atm})}{K_c(\text{M})} = 3$:-

(1) 0.027 K
(2) 0.36 K
(3) 36.54 K
(4) 273 K

Q12. For reaction $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$, K_c at 427°C is 3×10^{-6} L mol^{-1}. The value of K_p is nearly :-

(1) 7.50×10^{-5}
(2) 2.50×10^{-5}
(3) 2.50×10^{-4}
(4) 1.75×10^{-4}

Q13. For the reversible reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ at 500°C, the value of K_p is 1.44×10^{-5} when partial pressure is measured in atmospheres. The corresponding value of K_c, with concentration in mol L^{-1} is :-

(1) $\frac{1.44 \times 10^{-5}}{(0.082 \times 500)^2}$

(2) $\dfrac{1.44\times10^{-5}}{(8.314\times773)^2}$

(3) $\dfrac{1.44\times10^{-5}}{(0.082\times773)^2}$

(4) $\dfrac{1.44\times10^{-5}}{(0.082\times773)^{-2}}$

Q14. **For the reaction $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$, if $K_p = K_c(RT)^x$ where the symbols have usual meaning then the value of x is (assuming ideality) :-**

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

(2) 1

(3) -1

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

Q15. **For the reaction $CuSO_4{\cdot}5H_2O(s) \rightleftharpoons CuSO_4{\cdot}3H_2O(s) + 2H_2O(g)$ Which one is correct representation :-**

(1) $K_p = p^2_{H_2O}$

(2) $K_c = [H_2O]^2$

(3) $K_p = K_c(RT)^2$

(4) All

Q16. $\log\dfrac{K_p}{K_c} + \log RT = 0$ **is true relationship for the following reaction :-**

(1) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

(2) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

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

(4) (2) and (3) both

Q17. **Assertion :- For the reaction $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$, $K_p = K_c$.**

Reason :- K_p of all gaseous reactions is equal to K_c.

(1) A

(2) B

(3) C

(4) D

Q18. **Assertion :- $K_p = K_c$ for all reactions.**

Reason :- At constant temperature, the pressure of the gas is proportional to the concentration.

(1) A

(2) B

(3) C

(4) D

Q19. **STATEMENT-1 : For a given reaction at fixed temperatures, equilibrium constants K_p and K_c are related as $K_p = K_c(RT)^{\Delta n}$.**

and

STATEMENT-2 : Δn = No. of moles of products − No. of moles of reactants.

(1) Statement-1 is true, Statement-2 is true and Statement-2 is the correct explanation of Statement-1.

(2) Statement-1 is true, Statement-2 is true but Statement-2 is not the correct explanation of Statement-1.

(3) Statement-1 is true, Statement-2 is false.
(4) Statement-1 is false, Statement-2 is true.

Q20. Match Column-I with Column-II.

Column-I	Column-II
(A) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$	(p) $\Delta n_g > 0$
(B) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$	(q) $K_p < K_c$
(C) $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$	(r) K_p not defined
(D) $CH_3COOC_2H_5(l) + H_2O(l) \rightleftharpoons CH_3COOH(l) + C_2H_5OH(l)$	(s) $K_p > K_c$

(assume temperature = 25°C)

Q21. At 1000 K, the value of K_p for the reaction : A(g) + 2B(g) $\rightleftharpoons$ 3C(g) + D(g) is 0.05 atm. The value of K_c in terms of R would be :-
(1) 20000 R
(2) 0.02 R
(3) $5 \times 10^{-5} R$
(4) $5 \times 10^{-5} \times R^{-1}$

Q22. For the reaction $C(s) + CO_2(g) \rightleftharpoons 2CO(g)$ the partial pressure of CO and CO_2 are 2.0 and 4.0 atm respectively at equilibrium. The K_p for the reaction is :-
(1) 0.5
(2) 4.0
(3) 8.0
(4) 1

Q23. Two moles of gas A_2 are mixed with two moles of gas B_2 in a flask of volume 1 lit. If at equilibrium 0.5 moles of A_2 are obtained then find out K_p for reaction $A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$:-
(1) 12
(2) 9
(3) 4
(4) 36

JEE

Q24. **At $527°C$, the reaction given below has $K_c = 4$:**
$NH_3(g) \rightleftharpoons \frac{1}{2}N_2(g) + \frac{3}{2}H_2(g)$
What is the K_p for the reaction?
(A) $16 \times (800\,R)^2$
(B) $\left(\frac{800\,R}{4}\right)^{-2}$
(C) $4 \times 800\,R$
(D) None of these

Q25. **The value of K_p for the reaction, $2H_2O(g) + 2Cl_2(g) \rightleftharpoons 4HCl(g) + O_2(g)$ is 0.03 atm at $427°C$, when the partial pressures are expressed in atmosphere. Then the value of K_c for the same reaction is:**
(A) 5.23×10^{-4}
(B) 7.34×10^{-4}
(C) 3.2×10^{-3}
(D) 5.43×10^{-6}

Q26. $\log\left(\frac{K_p}{K_c}\right) + \log RT = 0$ **is a relationship for the reaction:**
(A) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$
(B) $2SO_2 + O_2 \rightleftharpoons 2SO_3$
(C) $H_2 + I_2 \rightleftharpoons 2HI$
(D) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

Q27. **How many of the following reactions are homogenous reversible reactions?**
1) $CH_3COOH(\ell) + C_2H_5OH(\ell) \rightleftharpoons CH_3COOC_2H_5(\ell) + H_2O(\ell)$
2) $H_2(g) + CO_2(g) \rightleftharpoons CO(g) + H_2O(g)$
3) $CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$
4) $NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$
5) $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$
6) $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$
7) $CO_2(g) + C(s) \rightleftharpoons 2CO(g)$
8) $2SO_2(g) + NO_2(g) \rightleftharpoons SO_3(g) + NO(g)$
9) $NO(g) + \frac{1}{2}Br_2(\ell) \rightleftharpoons 2NOBr(g)$

(How many of the above are homogenous reversible reactions?)

Q28. **For the reversible reaction, $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ at $500°C$, the value of K_p is 1.44×10^{-5} when partial pressure is measured in atmospheres. The corresponding value of K_c, with concentration in mole litre^{-1}, is:**
(A) $\frac{1.44 \times 10^{-5}}{(0.082 \times 500)^{-2}}$
(B) $\frac{1.44 \times 10^{-5}}{(8.314 \times 773)^{-2}}$
(C) $\frac{1.44 \times 10^{-5}}{(0.082 \times 773)^{2}}$
(D) $\frac{1.44 \times 10^{-5}}{(0.082 \times 773)^{-2}}$ *[JEE 2000, 1/35]*

Q29. **For the reaction $CO(g) + \frac{1}{2}O_2(g) \rightleftharpoons CO_2(g)$, K_c/K_p is: *[AIEEE 2002, 3/225]***

(1) RT
(2) $(RT)^{-1}$
(3) $(RT)^{-1/2}$
(4) $(RT)^{1/2}$

Q30. **For the reaction, $CO(g)+Cl_2(g) \rightleftharpoons COCl_2(g)$, K_p/K_c is equal to: *[AIEEE 2004, 3/225]***

(1) $\frac{1}{RT}$
(2) 1.0
(3) $\sqrt{RT}$
(4) RT

Q31. **For the reaction $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$, if $K_p = K_c(RT)^x$ where the symbols have usual meaning, then the value of x is: (assuming ideality) *[JEE(Main) 2014, 4/120]***

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

Q32. **The values of K_p/K_c for the following reactions at 300 K are, respectively: (At 300 K, $RT = 24.62$ dm^3 atm mol^{-1}) *[JEE(Main) 2019 Online (10-01-19), 4/120]***

(i) $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$
(ii) $2N_2O(g) \rightleftharpoons 2N_2(g) + O_2(g)$
(iii) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

(1) $1,\ 4.1 \times 10^{-2}$ dm^3 atm^{-1}mol, 606 dm^6 atm^{2}mol^{-2}
(2) $1,\ 24.62$ dm^3 atm mol^{-1}, 1.65×10^{-3} dm^6 atm^{-2}mol^{-2}
(3) 24.62 dm^3 atm mol^{-1}, 606.0 dm^6 atm^{2}mol^{-2}, 1.65×10^{-3} dm^6 atm^{-2}mol^{-2}
(4) 24.62 dm^3 atm mol^{-1}, 606.0 dm^6 atm^{2}mol^{-2}, 1.65×10^{-3} dm^6 atm^{-2}mol^{-2}

Q33. **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) $5 \times 10^{-5}\,R$
(4) $5 \times 10^{-5}\,R^{-1}$

Q34. **In which of the following reactions is $K_p < K_c$?**

(1) $CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$
(2) $2BrCl(g) \rightleftharpoons Cl_2(g) + Br_2(g)$
(3) $CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$
(4) $I_2(g) \rightleftharpoons 2I(g)$

Q35. **For the reversible reaction, $A + B \rightleftharpoons C$, the specific reaction rates for forward and reverse reactions are 1.25×10^{-3} and 2.75×10^{-5} respectively. The equilibrium constant for the reaction is: *[NSEC-2002]***

(A) 45.45
(B) 0.022
(C) 2.20
(D) 0.4545

Q36. **The equilibrium constant for the gaseous reaction $H_2 + Cl_2 \rightleftharpoons 2HCl$ is given by** ***[NSEC-2002]***

(A) $K = \frac{[H_2][Cl_2]}{[HCl]^2}$

(B) $K = \frac{[H_2][Cl_2]}{2[HCl]}$

(C) $K = \frac{[HCl]^2}{[H_2][Cl_2]}$

(D) $K = \frac{2[HCl]}{[H_2][Cl_2]}$

Q37. **For the reaction $4NH_3(g)+7O_2(g) \rightleftharpoons 4NO_2(g)+6H_2O(g)$, K_p is related to K_c by** ***[NSEC-2005]***

(A) $K_p = K_c(RT)$

(B) $K_p = K_c$

(C) $K_p = K_c(RT)^3$

(D) $K_p = K_c(RT)^{-1}$

Q38. **For the reaction $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$,**

(A) $K_p = K_c$

(B) $K_p > K_c$

(C) $K_p < K_c$

(D) $K_p = \sqrt{K_p}$

[NSEC-2009]

Q39. **For the reaction $PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$, K_c is 26 at 250°C. K_p at the same temperature is ($R = 8.314$ J K^{-1}mol^{-1})** ***[NSEC-2011]***

(A) 4.6×10^{-3}

(B) 5.7×10^{-3}

(C) 6.0×10^{-3}

(D) 8.3×10^{-3}

Q40. **In which of the following reactions is $K_p > K_c$?** ***[NSEC-2012]***

(A) $H_2 + I_2 \rightleftharpoons 2HI$

(B) $2SO_3 \rightleftharpoons 2SO_2 + O_2$

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

(D) $PCl_3 + Cl_2 \rightleftharpoons PCl_5$

Q41. **The K_p/K_c ratio for the reaction $4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$ at 127°C is:** ***[NSEC-2013]***

(A) 0.0301

(B) 0.0831

(C) 1.0001

(D) 33.26

Q42. **K_p for the reaction given below is 1.36 at 499 K. Which of the following equations can be used to calculate K_c for this reaction?** ***[NSEC-2013]***

$N_2O_5(g) \rightleftharpoons N_2O_3(g) + O_2(g)$

(A) $K_c = \frac{[0.0821] \times [499]}{1.36}$

(B) $K_c = \frac{[1.36] \times (0.0821)}{[499]}$

(C) $K_c = \dfrac{1.36}{(0.0821) \times (499)}$

(D) $K_c = \dfrac{(1.36) \times (499)}{[0.0821]}$

Q43. For the following gaseous equilibrium, $N_2O_4(g) \rightleftharpoons 2NO_2(g)$, K_p is found to be equal to K_c. This is attained when:

(A) 0°C

(B) 273 K

(C) 1 K

(D) 12.19 K

Q44. Consider the following reversible gaseous reactions (at 298 K):

(a) $N_2O_4 \rightleftharpoons 2NO_2$

(b) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

(c) $2HI \rightleftharpoons H_2 + I_2$

(d) X + Y $\rightleftharpoons$ 4Z

Highest and lowest value of $\dfrac{K_p}{K_c}$ will be shown by the equilibrium:

(A) d, b

(B) a, c

(C) a, b

(D) b, c

Q45. The vapour pressure of water at 27°C is 0.2463 atm. Calculate the values of K_p and K_c at 27°C for the equilibrium $H_2O(l) \rightleftharpoons H_2O(g)$.

Q46. For the reaction, $2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$, ($K_c = 1.8 \times 10^{-6}$ at 184°C) ($R = 0.0831$ kJ/(mol · K)). When K_p and K_c are compared at 184°C it is found that :

(1) Whether K_p is greater than, less than or equal to K_c depends upon the total gas pressure

(2) $K_p = K_c$

(3) K_p is less than K_c

(4) K_p is greater than K_c

Q47. Reaction $CO(g) + \frac{1}{2} O_2(g) \rightleftharpoons CO_2(g)$. The value of $\dfrac{K_p}{K_c}$ is :- [AIEEE–2002]

(1) $\dfrac{1}{RT}$

(2) $\sqrt{RT}$

(3) $\dfrac{1}{\sqrt{RT}}$

(4) RT

Q48. For the reaction $CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$, the $\dfrac{K_p}{K_c}$ is equal to :- [AIEEE–2004]

(1) $\dfrac{1}{RT}$

(2) RT

(3) $\sqrt{RT}$

(4) 1.0

Q49. For the reaction $2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$ ($K_c = 1.8 \times 10^{-6}$ at 184°C) ($R = 0.831$ kJ/(mol · K)). When K_p and K_c are compared at 184°C it is found that : [AIEEE–2005]

(1) K_p is less than K_c

(2) K_p is greater than K_c

(3) Whether K_p is greater than, less than or equal to K_c depends upon the total gas pressure

(4) $K_p = K_c$

Q50. For the reaction $SO_2(g) + \frac{1}{2} O_2(g) \rightleftharpoons SO_3(g)$, if $K_p = K_c(RT)^x$ where the symbols have usual meaning then the value of x is : (assuming ideality) [JEE-MAINS–14]

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

(2) 1

(3) -1

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

Q51. The value of K_p/K_c for the following reactions at 300 K are, respectively :
(At 300 K, $RT = 24.62$ dm^3 atm mol^{-1}) [JEE–MAINS (Jan)–19]

$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$

$N_2O_4(g) \rightleftharpoons 2NO_2(g)$

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

(1) 24.62 dm^3 atm mol^{-1}, 606.0 dm^6 atm^2 mol^{-2}, 1.65×10^{-3} dm^{-6} atm^{-2} mol^{-2}

(2) 1, 4.1×10^{-2} dm^{-3} atm^{-1} mol, 606.0 dm^6 atm^2 mol^{-2}

(3) 1, 24.62 dm^3 atm mol^{-1}, 606.0 dm^6 atm^2 mol^{-2}

(4) 1, 24.62 dm^3 atm mol^{-1}, 1.65×10^{-3} dm^{-6} atm^{-2} mol^{-2}

Q52. In which one of the following equilibria, $K_p \neq K_c$? [JEE–MAINS (Apr.)–19]

(1) $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$

(2) $NO_2(g) + SO_2(g) \rightleftharpoons NO(g) + SO_3(g)$

(3) $2C(s) + O_2(g) \rightleftharpoons 2CO(g)$

(4) $2NO(g) \rightleftharpoons N_2(g) + O_2(g)$

Q53. For the reversible reaction : $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ at 500°C. The value of K_p is 1.44×10^{-5}, when partial pressure is measured in atmospheres. The corresponding value of K_c, with concentration in mol L^{-1} is : [JEE–2000]

(A) $\frac{1.44 \times 10^{-5}}{(0.082 \times 500)^2}$

(B) $\frac{1.44 \times 10^{-5}}{(8.314 \times 773)^2}$

(C) $\frac{1.44 \times 10^{-5}}{(0.082 \times 500)^2}$

(D) $\frac{1.44 \times 10^{-5}}{(0.082 \times 773)^{-2}}$

Q54. For the following gaseous equilibrium : $N_2O_4(g) \rightleftharpoons 2NO_2(g)$, K_p is found to be equal to K_c. This is attained when temperature is :-

(A) 0°C

(B) 273 K

(C) 1 K

(D) 12.19 K

Q55. For the reaction; $2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$, $K_c = 1.8 \times 10^{-6}$ at 184°C and $R = 0.083$ J K^{-1}mol^{-1}. When K_p and K_c are compared at 184°C, it is found that :

(A) $K_p > K_c$

(B) $K_p < K_c$

(C) $K_p = K_c$

(D) $K_p \geq K_c$ depends upon pressure of gases

Q56. **For the reversible reaction : $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ at $500°C$. The value of K_p is 1.44×10^{-5}, when partial pressure is measured in atmospheres. The corresponding value of K_c, with concentration in mol L^{-1} is :**

(A) $\dfrac{1.44 \times 10^{-5}}{(0.082 \times 500)^2}$

(B) $\dfrac{1.44 \times 10^{-5}}{(8.314 \times 773)^2}$

(C) $\dfrac{1.44 \times 10^{-5}}{(0.082 \times 500)^2}$

(D) $\dfrac{1.44 \times 10^{-5}}{(0.082 \times 773)^{-2}}$

Q57. **Q.3 Find relationship between K_p and K_c :**

(a) $2NH_3(g) + 3CuO(s) \rightleftharpoons 3H_2O(g) + N_2(g) + 3Cu(s)$

(b) $2Cu(NO_3)_2(s) \rightleftharpoons 2CuO(s) + 4NO_2(g) + O_2(g)$

(c) $CH_4(g) + 2H_2S(g) \rightleftharpoons CS_2(g) + 4H_2(g)$

(d) $3Fe(s) + 4H_2O(g) \rightleftharpoons Fe_3O_4(s) + 4H_2(g)$