# **Exercise-1**

# Section (A) : Properties of Equilibrium, Law of mass action, Equilibrium constant and its properties, Factors affecting Equilibrium constant

- 1. A chemical reaction is at equilibrium when
  - (1) Reactants are completely transformed into products
  - (2) The rates of forward and backward reactions are equal
  - (3) Formation of products is minimised
  - (4) Equal amounts of reactants and products are present
- 2. Which of the following statement is incorrect :
  - (1) At equilibrium, concentration of reactants must be equal to concentration of products.
  - (2) Equilibrium can be attained in both homogenous and heterogenous reaction.
  - (3) Approach to the equilibrium is fast in initial state but gradually it decreases.
  - (4) Equilibrium is dynamic in nature
- 3. In the given reaction  $N_2 + O_2 \rightleftharpoons 2NO$ , equilibrium means that
  - (1) Concentration of reactant is changing where as concentration of products is constant
  - (2) Concentration of all substances is constant
  - (3) Concentration of reactants is constant where as concentration of products is changing
  - (4) Concentration of all substances is changing
- 4. Rate of reaction curve for equilibrium can be like :  $[r_f = forward rate, r_b = backward rate]$



5. Rate of reaction curve for equilibrium can be like :  $[r_f = rate of forward, r_b = rate of backward]$ 



- 6. At equilibrium rate of forward reaction is proportional to active mass's of reactants with the power of their stoichiometric coefficient. This statement is known as :
  - (1) Law of mass action
- (2) Le-chatelie principle
- (3) Faraday law of electrolysis (4) Law c
  - (4) Law of constant proportion
- 7. Active mass concentration of 96 g of O2(g) contained in a 2 L vessel is -

	(1) 16 mol/L	(2) 1.5 mol/L	(3) 4 mol/L	(4) 24 mol/L
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8. In a reaction A(g) + B(g) ⇒ C(g) + D(g) the rate constant of forward & backward reactions are k<sub>1</sub> and k<sub>2</sub> respectively then the equilibrium constant (K) for reaction is expressed as –

(1) 
$$K = \frac{k_2}{k_1}$$
 (2)  $K = \frac{k_1}{k_2}$  (3)  $K = k_1 \times k_2$  (4)  $K = k_1 + k_2$ 

9.	In a chemical equilibrit constant is 1.5, the rate	um, the rate constant for e constant for the forward	the backward reaction is reaction is :	s 7.5 $\times$ 10 <sup>-4</sup> and the equilibrium
	(1) 2 × 10 <sup>−3</sup>	(2) 5 × 10 <sup>-4</sup>	(3) 1.12 × 10 <sup>−3</sup>	(4) 9.0 × 10 <sup>-4</sup>
10.	The equilibrium consta	nt for the reaction 2X(g)	$+ 2Y(g) \longrightarrow 2Z(g)$ is g	iven as :
	(1) $\frac{[2X] [2Y]}{[2Z]}$	(2) <u>[X] [Y]</u> [Z]	(3) $\frac{[Z]^2}{[X]^2 [Y]^2}$	(4) $\frac{[Z]^2}{[X] [Y]}$
11.	$N_2 + O_2 \implies 2NO.$ For (1) 0.01	this reaction $K_p = 100$ , the second secon	nen K <sub>p</sub> for reaction, 2NO (3) 10	N <sub>2</sub> + O <sub>2</sub> will be : (4) 100
12.	At a certain temperatur S(s) + 2S(s) - 2S(s) - 3S(s) What is the equilibrium $2SO_2(s) - 3S(s) -$	re, the following reactions $O_2(g) \implies SO_2(g); K$ $+ 3O_2(g) \implies 2SO_3(g)$ constant $K_c$ for the react $g) + O_2(g) \implies 2SO_3(g)$	s have the equilibrium co $K_{c1} = 5 \times 10^{52}$ ); $K_{c2} = 10^{29}$ tion at the same tempera g)	nstant as shown below : ture ?
	(1) 2.5 × 10 <sup>76</sup>	(2) $4 \times 10^{23}$	(3) 4 × 10 <sup>-77</sup>	(4) None of these
13.	Consider the two gases $SO_2(g) + {}^{1/2}O_2$ $4SO_3(g) =$ The value of the equilit	bus equilibrium involving $S_2(g) \implies SO_3(g) ; K_1 \implies 4SO_2(g) + 2O_2(g) ; K_2$ brium constant are relate	$SO_2$ and the correspondin $S_2$ d by :	ng equilibrium constant at 299 K
	(1) $K_2 = \frac{1}{(K_1)^4}$	(2) $K_2 = K_1^4$	(3) $K_2 = \left(\frac{1}{K_1}\right)$	(4) $K_2 = \frac{1}{K_1}$
14.	For the reaction A $\rightleftharpoons$ B $\rightleftharpoons$ C ; K <sub>c</sub> = 4, C $\rightleftharpoons$ K <sub>c</sub> for the reaction A $\rightleftharpoons$		(2) 24	(4) 49
	(1) 12	(2) 4/3	(3) 24	(4) 40
15.	Equilibrium constant of (a) $x \rightleftharpoons y$ $K = 10$ (b) $y \rightleftharpoons z$ $K = 2x$ (c) $P \rightleftharpoons Q$ $K = 3x$ (d) $R \rightleftharpoons S$ $K = 2x$ Initial concentration of Review the above read were of highest concer	some reaction are given -1 $\times 10^{-2}$ $\times 10^{-4}$ $\times 10^{-3}$ the reactants for each re- ction and indicate the reaction intration : -	as under ; action was taken be equ actions in which the read	al : stants and products respectively
	(1) d, c	(2) c, a	(3) a, d	(4) b, c
16.	For a reaction N <sub>2</sub> + 3H (1) Initial concentration (3) Temperature	$_2 \rightleftharpoons 2NH_3$ , the value of of the reactants	f K <sub>C</sub> depends upon : (2) Pressure (4) catalyst	
17.	The equilibrium consta (1) Depends on initial of (2) Depends on the con (3) Does not depend of (4) It is not characterist	nt in a reversible reaction concentration of the react ncentration of the produc n the initial concentration tic of the reaction.	n at a given temperature ant ts at equilibtium s	

- The equilibrium constant  $(K_p)$  for the reaction  $PCI_5(g) \implies PCI_3(g) + CI_2(g)$  is 16. If the volume of the 18. container is reduced to one half its original volume, the value of K<sub>n</sub> for the reaction at the same temperature will be : (1) 32 (3) 16(4) 4(2) 6419. When  $K_c >> 1$  for a chemical reaction, (1) the equilibrium would be achieved rapidly (2) the equilibrium would be achieved slowly (3) product concentrations would be much greater than reactant concentrations at equilibrium (4) reactant concentrations would be much greater then product concentrations at equilibrium. For the following gases equilibrium,  $N_2O_4$  (g)  $\implies 2NO_2$  (g),  $K_p$  is found to be equal to  $K_c$ . This is 20. attained when : (3) 1 K (1) 0°C (2) 273 K (4) 12.19 K 21. The relation between  $K_{p}$  and  $K_{c}$  in equilibrium is : (1)  $K_{n} = K_{c} (RT)^{\Delta n}$ (2)  $K_{0} = K_{0} \times RT$ (3)  $K_c = K_n (RT)^{\Delta n}$  (4)  $K_c = K_n \times \Delta n$ For which reaction at 298 K, the value of  $\frac{K_p}{K}$  will be maximum and minimum respectively : 22. (a)  $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ (b)  $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ (c)  $X(g) + Y(g) \implies 4Z(g)$ (d)  $A(g) + 3B(g) \implies 7C(g)$ (3) c,b (4) d,a (1) d,c (2) d,b 23. For which reaction is  $K_p = K_C$ : (1) 2 NOCI(g)  $\implies$  2NO(g) + CI<sub>2</sub>(g) (2)  $N_2(g) + 3H_2(g) \implies 2NH_3(g)$ (3)  $H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$  (4)  $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ 24. For hypothetical equilibrium,  $4A(g) + 5B(g) \implies 4X(g) + 6Y(g)$ The unit of  $K_c$  will be : (1) litre mole<sup>-1</sup> (3) litre mole<sup>-2</sup> (2) mole litre<sup>-1</sup> (4) mole<sup>2</sup> litre<sup>-2</sup> What is the unit of  $K_{P}$  for the reaction ? 25.  $CS_2(g) + 4H_2(g) \longrightarrow CH_4(g) + 2H_2S(g)$ (2) atm-2 (1) atm (3) atm<sup>2</sup> (4) atm-1 Section (B) : K<sub>c</sub> and K<sub>p</sub> for Homogeneous Reaction  $PCl_{5}(g) \longrightarrow PCl_{3}(g) + Cl_{2}(g)$ 1. In above reaction, at equilibrium condition mole fraction of PCI<sub>5</sub> is 0.4 and mole fraction of CI<sub>2</sub> is 0.3. Then find out mole fraction of PCl<sub>3</sub>
  - (1) 0.3 (2) 0.7 (3) 0.4 (4) 0.6
- 2. The reaction A(g) + B(g) ⊂ C(g) + D(g) is studied in a one litre vessel at 250°C. The initial concentration of A was 3n and that of B was n. When equilibrium was attained, equilibrium concentration of C was found to the equal to the equilibrium concentration of B. What is the concentration of D at equilibrium? (1) n/2 (2) (3n - 1/2) (3) (n - n/3) (4) n

3.	A certain quantity of PC 0.1 mole of PCI <sub>5</sub> 0.20 m $\longrightarrow$ PCI (a) + CI (a) is	$CI_s$ was heated in a 10 I nole of PCI <sub>3</sub> and 0.2 mole	itre vessel at 250°C. At e of $Cl_2$ ; The equilibrium	equilibrium the vessel contains constant of the reaction $\text{PCl}_{s}(g)$
	(1) 0.02	(2) 0.05	(3) 0.04	(4) 0.025
4.	For the equilibrium $N_2 = N_2$ and $H_2$ are 2M and 3 (1) 0.00358 M	+ $3H_2 \implies 2NH_3 K_c$ at 1 M respectively, then [NH (2) 0.0358 M	1000K is 2.37 × 10 <sup>-3</sup> . If f I₃] at equilibrium is : (3) 0 358 M	the equilibrium concentration of
5.	In the reaction $PCI_{5(g)} \rightleftharpoons$ The equilibrium concent is 0.5 what is the concent	$\stackrel{(L)}{\Longrightarrow} PCI_{3(g)} + CI_{2(g)}$ tration of PCI <sub>5</sub> and PCI <sub>3</sub> a intration of CI <sub>2</sub> at equilibri	are 0.4 and 0.2 mole/litre	e respectively . If the value of $K_c$
	(1) 2.0	(2) 1.5	(3) 1.0	(4) 0.5
6. 🗷	4 moles of A are mixed the reaction, $A + B =$	d with 4 moles of B, whe C + D. The equilibrium (2) 1	en 2 moles of C are form a constant is : (3)	ned at equilibrium, according to
7	(1) 4	(2) $(2)$	(J)	(4)
7.	flask. At equilibrium whi (1) [P] < [Q]	(g) 3R(g) + 3(g ich is true : (2) [P] = [Q]	(3) [Q] = [R]	(4) None of these
8.	When 3 moles of A and	1 mole of B are mixed ir	n 1 litre vessel the followi	ing reaction takes place
	$A_{(g)} + B_{(g)} \rightleftharpoons 2C_{(g)} \cdot 1.$	5 moles of C are formed	. The equilibrium constar	t for the reaction is
-	(1) 0.12	(2) 0.25	(3) 0.50	(4) 4.0
9.	$K_c = 9$ for the reaction, <i>i</i> equilibrium is :	A + B 🚝 C + D, If A a	and B are taken in equal	amounts, then ratio of C to A at
	(1) 1	(2) 0.25	(3) 0.75	(4) None of these
10.	1 mole of $N_2$ and 2 mole formed. The concentrat	es of $H_2$ are allowed to re- ion of $H_2$ in the vessel is	eact in a 1 dm³ vessel. A :	t equilibrium, 0.8 mole of $\mathrm{NH}_{_3}$ is
	(1) 0.6 mol/L	(2) 0.8 mol/L	(3) 0.2 mol/L	(4) 0.4 mol/L
11.	An equilibrium mixture f 2H S $\implies$ 2H (g) + S (g)	for the reaction		
	had 1 mol of $H_2S$ , 0.2 m (1) 0.08	, nol of H $_2$ and 0.8 mol of S (2) 0.016	$S_2$ in a 2 litre flask. The vaction (3) 0.004	alue of K <sub>c</sub> in mol lit <sup>_1</sup> is : (4) 0.160
12.	The reaction, $PCI_5 \rightleftharpoons$ mole of $PCI_5$ is there at	$PCI_3 + CI_2$ is started in equilibrium, concentratic	a five litre container by on of PCl <sub>3</sub> and $K_c$ will resp	taking one mole of $PCI_{5}$ . If 0.3 pectively be :
	(1) 0.14, <del>49</del> 150	(2) 0.12, <del>23</del> 100	(3) 0.07, <del>23</del> 100	(4) 20, <del>49</del> 150
13.	In the reaction A(g) + 2 in a 2L flask. If equilibri	$B(g) \rightleftharpoons 2C(g)$ , if 2 m ium concentration of C is	nole of A, 3.0 moles of B s 0.5 mole/L. The value	and 2.0 moles of C are placed of equilibrium constant ( $\rm K_{c}$ ) will
	(1) 0.073	(2) 0.147	(3) 0.05	(4) 0.026
14.	28 g of $N_2$ and 6 g of H	H₂ were kept at 400ºC in	1 litre vessel, the equili	brium mixture contained 17g of
	$NH_3$ . The value of $K_c$ fo (1) 7.5	r the reaction $N_2 + 3H_2 =$ (2) 0.5	→ 2NH₃ is : (3) 0.6	(4) 100

- **15.** A mixture of 0.3 mole of  $H_2$  and 0.3 mole of  $I_2$  is allowed to react in a 10 litre evacuated flask at 500°C. Equilibrium constant for the reaction  $H_2 + I_2 \implies 2HI$ , is found to be 64. The amount of unreacted  $I_2$  at equilibrium is :
  - (1) 0.15 mole (2) 0.06 mole (3) 0.03 mole (4) 0.2 mole
- **16.** At a certain temperature 50% HI is dissociated at equilibrium. The equilibrium constant for the reaction  $2HI \rightleftharpoons H_2 + I_2$  is :

**17.** 0.6 mole of NH<sub>3</sub> in a reaction vessel of 2dm<sup>3</sup> capacity was brought to equilibrium . The vessel was then found to contain 0.15 mole of H<sub>2</sub> formed by the reaction

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

- Which of the following statement is true?
- (1) 0.15 mole of the original  $NH_{3}$  had dissociated at equilibrium
- (2) 0.55 mole of ammonia is left in the vessel
- (3) At equilibrium the vessel contained 0.45 mole of  $N_2$
- (4) The concentration of NH<sub>3</sub> at equilibrium is 0.25 mole per dm<sup>3</sup>
- **18.** Equimolar concentrations of  $H_2$  and  $I_2$  are heated to equilibrium in a 2 litre flask. At equilibrium, the forward and the backward rate constants are found to be equal. What percentage of initial concentration of  $H_2$  has reacted at equilibrium for the reaction  $H_2 + I_2 \rightleftharpoons 2HI$

**19.**  $PCI_5 \implies PCI_3 + CI_2$  in the reversible reaction the moles of  $PCI_5$ ,  $PCI_3$  and  $CI_2$  are a, b and c respectively and total pressure is P then value of K<sub>n</sub> is :

(1) 
$$\frac{bc}{a}$$
.RT (2)  $\frac{b}{(a+b+c)}$ .P (3)  $\frac{bc.P}{a(a+b+c)}$  (4)  $\frac{c}{(a+b+c)}$ .P

20. For the reaction

 $A_2(g) + 3B_2 \implies 2C_2(g)$ 

the partial pressure of  $A_2$ ,  $B_2$  at equilibrium are 0.80 atm and 0.40 atm respectively. The pressure of the system is 2.80 atm. The equilibrium constant  $K_p$  will be

(1) 50 (2) 5.0 (3) 0.02 (4) 0.2

**21.** The equilibrium constant, K<sub>p</sub> for the reaction

 $2SO_2(g) + O_2(g) \implies 2SO_3(g)$ 

is 4.0 atm<sup>-1</sup> at 1000 K. What would be the partial pressure of  $O_2$  if at equilibrium the amount of  $SO_2$  and  $SO_3$  is the same ?

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(1) 16.0 atm (2) 0.25
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n (2) 0.25 atm (3) 1 atm (4) 0.75 atm

**22.** A sample of pure NO<sub>2</sub> gas heated to 1000 K decomposes :  $2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$ . The equilibrium constant K<sub>P</sub> is 100 atm. Analysis shows that the partial pressure of O<sub>2</sub> is 0.25 atm. at equilibrium. The partial pressure of NO<sub>2</sub> at equilibrium is: (1) 0.03 (2) 0.25 (3) 0.025 (4) 0.04

#### Section (C) : Reaction Quotient and Its applications

1. When two reactants, A & B are mixed to give products C & D, the reaction quotient Q, at the initial stages of the reaction :

(1) is zero	(2) decrease with time
(3) is independent of time	(4) increases with time

2. The reaction quotient Q for

 $N_2(g) + 3H_2(g) \implies 2NH_3(g)$ is given by  $Q = \frac{[NH_3]^2}{[N_2][H_2]^3}$ . The reaction will proceed in backward direction, when (4) A = 0(1)  $Q = K_{c}$ (3) Q > K<sub>c</sub> (2) Q < K<sub>c</sub> 3. A reaction mixture containing H<sub>2</sub>, N<sub>2</sub> and NH<sub>3</sub> has partial pressure 2 atm, 1 atm and 3 atm respectively at 725 K. If the value of  $K_p$  for the reaction,  $N_2 + 3H_2 \implies 2NH_3$  is  $4.28 \times 10^{-5}$  atm<sup>-2</sup> at 725 K, in which direction the net reaction will go : (1) Forward (2) Backward (3) No net reaction (4) Direction of reaction cannot be predicted 4. For the reaction,  $K_{c} = 49$ 2A + B = 3C at 298 K, A 3L vessel contains 2, 1 and 3 moles of A, B and C respectively. The reaction at the same temperature (1) must proceed in forward direction (2) must proceed in backward direction (3) must be equilibrium (4) can not be predicted 5. 2 mole each of SO $_{_3}$ , CO, SO $_{_2}$  and CO $_{_2}$  is taken in a one lit. vessel. If K $_{_{\rm C}}$  for  $SO_3(g) + CO(g) \Longrightarrow SO_2(g) + CO_2(g)$  is 1/9 then (1) total no. of moles at equilibrium are less than 8  $(2) n(SO_2) + n(CO_2) = 4$  $(3) [n(SO_{2})/n(CO)] < 1$ (4) both (2) and (3). Section (D) : Degree of dissociation and vapour density 1.  $A_3(g) \implies 3A(g)$ In the above reaction, the initial concentration of A<sub>3</sub> is "a" moles/lit. If x is degree of dissociation of A<sub>3</sub>. The total number of moles at equilibrium will be : (3)  $\left(\frac{a-ax}{2}\right)$ (1)  $a - \frac{ax}{3}$ (2)  $\frac{a}{3} - ax$ (4) a + 2ax 4 moles of PCI<sub>5</sub> are heated at constant temperature in closed container. If degree of dissociation for 2. PCl<sub>5</sub> is 0.5 calculate total number of moles at equilibrium : (1) 4.5(2) 6(3)3(4) 4The dissociation of CO<sub>2</sub> can be expressed as  $2CO_2 \rightleftharpoons 2CO + O_2$ . If the 2 moles of CO<sub>2</sub> is taken 3.> initially and 40% of the CO<sub>2</sub> is dissociated equilibrium then total number of moles at equilibrium : (1) 2.4(2) 2.0(3) 1.2In a 0.25 litre tube dissociation of 4 moles of NO is take place. If its degree of dissociation is 10%. The 4.> value of  $K_p$  for reaction 2NO  $\implies N_2 + O_2$  is : (3)  $\frac{1}{16}$ (1)  $\frac{1}{(18)^2}$ (2)  $\frac{1}{(8)^2}$ (4)  $\frac{1}{32}$ The degree of dissociation of SO<sub>3</sub> is  $\alpha$  at equilibrium pressure P<sub>0</sub>. 5.  $K_p$  for  $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$  is (1)  $[(P_0 \alpha^3)/2(1 - \alpha)^3]$ (2)  $[(P_0 \alpha^3)/(2+\alpha)(1-\alpha)^2]$ (3)  $[(P_0 \alpha^2)/2(1 - \alpha)^2]$ (4) None of these

**6.** For the dissociation reaction  $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ , the degree of dissociation ( $\alpha$ ) in terms of K<sub>p</sub> and total equilibrium pressure P is:

(1) 
$$\alpha = \sqrt{\frac{4p + K_p}{K_p}}$$
 (2)  $\alpha = \sqrt{\frac{K_p}{4p + K_p}}$  (3)  $\alpha = \sqrt{\frac{K_p}{4p}}$  (4) None of these

**7.** The degree of dissociation of  $PCI_5(g)$  obeying the equilibrium,  $PCI_5 \rightleftharpoons PCI_3 + CI_2$ , is approximately related to the presure at equilibrium by -

(1) 
$$\alpha \propto P$$
 (2)  $\alpha \propto \frac{1}{\sqrt{P}}$  (3)  $\alpha \propto \frac{1}{P^2}$  (4)  $\alpha \propto \frac{1}{P^4}$ 

8. For the reaction  $AB_{(g)} \rightleftharpoons A_{(g)} + B_{(g)}$ , AB is 33% dissociated at a total pressure of P. Therefore, P is related to  $K_{o}$  by one of the following options

(1)  $P = K_p$  (2)  $P = 3K_p$  (3)  $P = 4K_p$  (4)  $P = 8K_p$ 

- 9. Two sample of I II each of 5 gm. were taken seperately into vessels of volume 5 an 10 litres respectively at 27°C. The extent of dissociation of HI will be :
  (1) More in 5 litre vessel
  (2) More in 10 litre vessel
  (3) Equal in both vessel
  (4) None of these
- **10.** What will be the amount of dissociation, if the volume is increased 16 times of initial volume in the reaction

 $PCI_5 \implies PCI_3 + CI_2$ ? (Assume dissociation is negligible)

(1) 4 (2) 
$$\frac{1}{4}$$
 (3) 2 (4)  $\frac{1}{5}$ 

- 11. The equation  $\alpha = \frac{D-d}{(n-1)d}$  correctly matched for : (1) A(g)  $\rightleftharpoons$  (n/2)B(g) + (n/3)C(g) (2) A(g)  $\rightleftharpoons$  (n/3)B(g) + (2n/3)C(g) (3) A(g)  $\rightleftharpoons$  (n/2)B(g) + (n/4)C(g) (4) A(g)  $\rightleftharpoons$  (n/2)B(g) + C(g)
- **12.** Consider the following hypothetical equilibrium  $2B(g) \rightleftharpoons B_2(g)$

If d is observed vapour density and D is theoretical vapour density, then degree of association (1) will be

(1) 
$$\alpha = 2\left(\frac{D-d}{d}\right)$$
 (2)  $\alpha = \frac{2D-d}{D}$  (3)  $\alpha = 2 - \frac{2D}{d}$  (4)  $\alpha = \frac{2D}{D-d}$ 

**13.**  $SO_3(g) \Longrightarrow SO_2(g) + \frac{1}{2} O_2(g)$ 

If observed vapour density of mixture at equilibrium is 35 then find out value of  $\alpha$ (1) 0.28 (2) 0.38 (3) 0.48 (4) 0.58

**14.** For equilibrium

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

the observed vapour density of  $N_2O_4$  is 40 at 350 K. Calculate percentage dissociation of  $N_2O_4(g)$  at 350K.

(1) 15 (2) 30 (3) 92 (4) 46

#### Section (E) : Heterogeneous Equibrium

1. How many of the following reactions are homogenous reversible reactions ?

(1)  $CH_3COOH(\ell) + C_2H_5OH(\ell) \longrightarrow CH_3COOC_2H_5(\ell) + H_2O(\ell)$ 

	(2) $C(s) + CO_2(g)$ (3) $H_2(g) + CO_2(g)$ (4) $CO(g) + CI_2(g)$ (5) $NH_4HS(s)$ (6) $CaCO_3(s)$ (7) $N_2(g) + O_2(g)$ (8) $CO_2(g) + C(s)$ (9) $SO_2(g) + NO_2(g)$ (10) (11) (12) (12) (13) (13) (14) (15) (1	$CO(g) + H_2O(g)$ $CO(g) + H_2O(g)$ $COCl_2(g)$ $(g) + H_2S(g)$ $C(s) + CO_2(g)$ $2NO(g)$ $CO(g)$ $CO(g)$ $CO(g)$		
	(10)NO(g) + $\frac{1}{2}$ Br <sub>2</sub> ( $\ell$ )	🛋 2NOBr(g)		
	(1) 4	(2) 5	(3) 6	(4) 7
2. 🖎	On decomposition of NH NH <sub>4</sub> HS(s) = If the total pressure is P (1) P atm	$H_4HS$ , the following equil $\Rightarrow$ NH <sub>3</sub> (g) + H <sub>2</sub> S (g) P atm, then the equilibrium (2) P <sup>2</sup> atm <sup>2</sup>	ibrium is established : n constant K <sub>P</sub> is equal to (3) P <sup>2</sup> / 4 atm <sup>2</sup>	(4) 2P atm
3.	For NH <sub>4</sub> HS(s) $\implies$ NH reaction mixture in equi (1) 1.44 atm <sup>2</sup>	I <sub>s</sub> (g) + H <sub>z</sub> S(g) reaction s librium is 1.2 atm at 106° (2) 0.36 atm <sup>2</sup>	tarted only with NH,HS 2C. What is the value of H (3) 0.16 atm <sup>2</sup>	(s), the observed pressure for ζ for the reaction ? (4) 3.6 atm <sup>2</sup>
4.	Partial pressure of CO equilibrium is 12 atm. Th $C(s) + CO_2(g) \Longrightarrow 2CO$ (1) 8	is twice to the partial p nen K <sub>P</sub> will be D(g) (2) 12	(3) 16	equilibrium. If total pressure at (4) 32
5.	Some solid $NH_4HS$ is p $H_2S$ when equilibrium is $NH_4HS_{(S)} \longrightarrow NH_{3(g)} +$ (1) 6.65 atm	laced in a flask containing reached $H_2S_{(g)}, K_p = 0.11$ (2) 0.665 atm	ng 0.5 atm of $NH_{3}$ , what (3) 0.0665 atm	would be pressures of $NH_{3}$ and (4) 66.5 atm
6.	What is the minimum m equilibrium in a 6.50 litre $CaCO_3(s) \longrightarrow CaO(s)$ (1) 32.5 g	mass of $CaCO_3$ (s), below e container for the reaction (s) + $CO_2$ (g), $K_c = 0.05$ m (2) 24.6 g	v which it decomposes c on : ole/litre (3) 40.9 g	ompletely, required to establish (4) 8.0 gm
Sectio	on (F) : Thermodyna	mics of Equilibrium		
1.≿	The correct relationship constant K is : $(1) - \Delta G^{\circ} = RT \ln K$	o between free energy c (2) ∆G = RT In K	hange in a reaction and $(3) - \Delta G = RT \ln K$	the corresponding equilibrium (4) $\Delta G^{\circ} = RT \ln K$
2.≥	In an equilibrium reaction (1) 0	on for which $\Delta G^{\circ} = 0$ , the (2) 1	value of equilibrium con (3) 2	stant K = is (4) 10
3.ര	The effect of temperatu	re on equilibrium constar	nt is expressed as $(T_2 > T_2)$	Γ <sub>1</sub> )

$$\log K_{2} / \log K_{1} = \frac{-\Delta H}{2.303 R} \left[ \frac{1}{T_{2}} - \frac{1}{T_{1}} \right].$$
 For endothermic reaction false statement is  
(1)  $\left[ \frac{1}{T_{2}} - \frac{1}{T_{1}} \right]$  = positive (2)  $\Delta H$  = positive

(3)  $\log K_2 > \log K_1$ (4)  $K_2 > K_1$ 

For a reversible reaction  $aA + bB \implies cC + dD$ ; the variation of K with temperature is given by 4.

 $\log \frac{K_2}{K_1} = \frac{-\Delta H^\circ}{2.303R} \left| \frac{1}{T_2} - \frac{1}{T_1} \right|$ then, (1)  $K_2 > K_1$  $T_2 > T_1$  for an endothermic change if if  $T_2 > T_1$  for an endothermic change (2)  $K_2 < K_1$ (3)  $K_2 > K_1$  $T_2 > T_1$  for an exothermic change if (4) All are correct

- The equilibrium constant for the reaction  $Br_2 \implies 2Br$  at 500 K and 700 K are 1 × 10<sup>-10</sup> and 1 × 10<sup>-5</sup> 5.>> respectively. The reaction is : (1) Endothermic (2) Exothermic (3) Fast (4) Slow
- 6. The standard state gibbs free energy change for the given isomerization reaction cis-2-pentene trans-2-pentene is -3.62kJ/mol at 400 K. If more trans-2-pentene is added to the reaction vessel, then
  - (1) More cis-2-pentene is formed
  - (2) Equilibrium is shifted in the forward direction
  - (3) Equilibrium remains unaffected
  - (4) Additional trans-2-pentene is formed
- 7.2 An exothermic reaction is represented by the graph :



An endothermic reaction is represented by the graph : 8.2



#### Section (G) : Le-chatelier's principle

- 1. For the reaction  $CO(g) + H_2O(g) \implies CO_2(g) + H_2(g)$  at a given temperature the equilibrium amount of  $CO_{2}(g)$  can be increased by :
  - (1) adding a suitable catalyst
- (2) adding an inert gas
- (3) decreasing the volume of container
- (4) increasing the amount of CO(g)
- Given the following reaction at equilibrium  $N_2(g) + 3H_2(g) \implies 2NH_3(g)$ . Some inert gas at constant 2.2 pressure is added to the system. Predict which of the following facts will be affected. (1) More NH<sub>3</sub>(g) is produced
  - (3) No affect on the equilibrium
- (2) Less NH<sub>3</sub>(g) is produced
  - (4)  $K_{p}$  of the reaction is decreased
- 3. Introduction of inert gas (at the same temperature) will affect the equilibrium if :
  - (1) volume is constant and  $\Delta n_{a} \neq 0$
- (2) pressure is constant and  $\Delta n_{d} \neq 0$
- (3) volume is constant and  $\Delta n_{a} = 0$ (4) pressure is constant and  $\Delta n_a = 0$

**4.** In the following reversible reaction

 $2SO_2 + O_2 \implies 2SO_3 + Q$  cal

Most suitable condition for the higher production of  $\mathrm{SO}_{\scriptscriptstyle 3}$  is

- (1) High temperature and high pressure
- (2) High temperature and low pressure
- (3) Low temperature and high pressure
- (4) Low temperature and low pressure
- 5. In the formation of SO<sub>3</sub> by contact process  $(2SO_2 + O_2 \implies 2SO_3 + Q \text{ cal})$  the conditions used are
  - (1) Catalyst, optimum temperature and higher concentration of reactants
  - (2) Catalyst, optimum temperature and lower concentration of reactants
  - (3) Catalyst, high temperature and higher concentration of reactants
  - (4) Catalyst, low temperature and lower concentration of reactants
- 6. Consider the reactions

(i)  $PCl_{_{5}}(g) \Longrightarrow PCl_{_{3}}(g) + Cl_{_{2}}(g)$ 

(ii)  $N_2O_4(g) \Longrightarrow 2NO_2(g)$ 

The addition of an inert gas at constant volume

- (1) will increase the dissociation of  $PCI_5$  as well as  $N_2O_4$
- (2) will reduce the dissociation of  $PCI_5$  as well as  $N_2O_4$
- (3) will increase the dissociation of  $PCI_{5}$  and step up the formation of  $NO_{2}$ 
  - (4) will not disturb the equilibrium of the reactions
- 7. Vapour density of equilibrium  $PCI_5(g) \Longrightarrow PCI_3(g) + CI_2(g)$  is decreased by
  - (1) increasing temperature (2) decreasing volume
  - (3) increasing pressure (4) decreasing temperature
- For the reaction : PCl<sub>5</sub>(g) → PCl<sub>3</sub>(g) + Cl<sub>2</sub>(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  $PCI_{5}$  at constant volume
- **9.** Which of the following reaction will shift in backward direction. When the respective change is made at equilibrium:

$(1) N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$	increase in pressure at eq.
(2) $H_2O(s) \rightleftharpoons H_2O(\ell)$	addition of inert gas at constant volume
(3) $PCI_5(g) \Longrightarrow PCI_3(g) + CI_2(g)$	addition of inert gas at constant pressure
$(4) \operatorname{CO}_2(g) + \operatorname{CaO}(s) \rightleftharpoons \operatorname{CaCO}_3$	increase in temperature

**10.** If the volume of the reaction flask is reduced to half of its initial value and temperature is kept constant then in which of the following cases the position of equilibrium will not shift ? (1)  $CO(g) + H_2O(g) \implies CO_2(g) + H_2(g)$  (2)  $I_2(g) \implies 2I(g)$ 

_	-	-	—	
(3) $NH_4HS(s) \implies NH_3(g) +$	⊦ H₂S(g)		(4) 2NOCI(g)	$2NO(g) + Cl_2(g)$

11. The dissociation of phosgene, which occurs according to the reaction

 $\text{COCl}_2(g) \rightleftharpoons \text{CO}(g) + \text{Cl}_2(g)$ 

(1) Adding Cl<sub>2</sub> to the system

Is an endothermic process. Which of the following will increase the degree of dissociation of COCI<sub>2</sub>?

- (2) Adding helium to the system at constant pressure
- (3) Decreasing the temperature of the system (4) Increasing total pressure

**12.** For the reaction,  $\frac{1}{2} N_2(g) + \frac{1}{2} O_2(g) \rightleftharpoons NO(g)$ 

If pressure is increased by reducing the volume of the container then :

- (1) Degree of dissociation at equilibrium will change.
- (2) Concentration of all the component at equilibrium will change.
- (3) Concentration of all the component at equilibrium will remain same
- (4) Equilibrium will shift in the forward direction

#### **13.** At constant temperature, the equilibrium constant ( $K_p$ ) for the decomposition reaction $N_2O_4 \implies 2NO_2$

is expressed by  $K_P = \frac{(4x^2 P)}{(1-x^2)}$ , where P = pressure, x = extent of decomposition. Which one of the

following statements is true ? (1)  $K_{P}$  increases with increase of P

- (2)  $K_{P}$  increases with increase of x
- (3)  $K_{p}$  increases with decrease of x (4)  $K_{p}$  remains constant with change in P and x
- 14. Consider the following equilibrium in a closed container

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

At a fixed temperature, the volume of the reaction container is halved. For this change, which of the following statements holds true regarding the equilibrium constant ( $K_p$ ) and degree of dissociation (1)?

- (1) neither  $K_{P}$  nor  $\alpha$  changes (2) both  $K_{P}$  and  $\alpha$  change
- (3)  $K_P$  changes, but  $\alpha$  does not change (4)  $K_P$  does not change but  $\alpha$  changes
- **15.** When hydrogen molecules decomposed into its atoms which conditions give maximum yield of hydrogen atoms ?
  - (1) High temperature and low pressure
  - (3) High temperature and high pressure
- (2) Low temperature and high pressure
- (4) Low temperature and low pressure

(2) potential energy

(4) none of these.

#### Section (H) : Physical Equiibrium

- **1.** A liquid is in equilibrium with its vapour at its boiling point . On the average the molecules in the two phases have equal :
  - (1) inter molecular forces
  - (3) kinetic energy
- 2.  $Au(s) \Longrightarrow Au(\ell)$ 
  - Above equilibrium is favoured at :
  - (1) High pressure low temperature(2) High pressure high temperature(3) Low pressure, high temperature(4) Low pressure, low temperature
- A gas 'X' when dissolved in water heat is evolved. Then solublity of 'X' will increase :
   (1) Low pressure, high temperature
   (2) Low pressure, low temperature
   (3) high pressure, high temperature
   (4) high pressure, low temperature
- **4.** For an equilibrium  $H_2O(s) \Longrightarrow H_2O(\ell)$  which of the following statements is true.
  - (1) The pressure changes do not affect the equilibrium
  - (2) More of ice melts if pressure on the system is increased
  - (3) More of liquid freezes if pressure on the system is increased
  - (4) The degree of advancement of the reaction do not depend on pressure.
- 5. When the pressure is applied over system ice  $\implies$  water what will happen
  - (1) More water will form

- (2) More ice will form
- (3) There will be no effect over equilibrium
- (4) Water will decompose in H<sub>2</sub> and O<sub>2</sub>

(4)  $\sqrt{\frac{1}{\kappa}} + 1$ 

## Exercise-2

- 1. Which of the following is incorrect about the chemical equilibrium ?
  - (1)  $(\Delta G)_{TP} = 0$
  - (2) Equilibrium constant is independent of initial concentration of reactants
  - (3) Achievment of equilibrium is an sponteneous process.
  - (4) Reaction stops at equilibrium
- 2. The equilibrium concentration of B that is [B]<sub>eq</sub>, for the reversible reaction A = B can be evaluated by the expression:

(1) 
$$K_{C}[A]_{e}^{-1}$$
 (2)  $\frac{k_{f}}{k_{b}} [A]_{e}^{-1}$  (3)  $k_{f}k_{b}^{-1}[A]_{e}$  (4)  $k_{f}k_{b}[A]^{-1}$ 

- **3.** For a reaction  $N_2 + 3H_2 \rightleftharpoons 2NH_3$ , the value of  $K_c$  does not depends upon : (a) Initial concentration of the reactants (b) Pressure (c) Temperature (d) Presence of catalyst (1) Only c (2) a,b,c (3) a,b,d (4) a,b,c,d
- 4. The equilibrium constant for 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
- **5.** For  $N_2 + 3H_2$  2NH<sub>3</sub> equilibrium constant is K then equilibrium constant for  $2N_2 + 6H_2 \implies 4NH_3$ :

(1) 
$$\sqrt{K}$$
 (2)  $K^2$  (3)  $\frac{K}{2}$ 

**6.** Equilibrium constant for following reactions respectively  $K_1$ ,  $K_2$  and  $K_3$ 

$$N_{2} + 3H_{2} \rightleftharpoons 2NH_{3} \qquad K_{1}$$

$$N_{2} + O_{2} \rightleftharpoons 2NO \qquad K_{2}$$

$$H_{2} + \frac{1}{2} O_{2} \rightleftharpoons H_{2}O \qquad K_{3}$$

$$2NH_3 + \frac{5}{2}O_2 \Longrightarrow 2NO + 3H_2O$$
  $K_4$ 

Which of the following relation is incorrect.

(1) 
$$K_1 = \frac{K_2 \times (K_3)^3}{K_4}$$
 (2)  $K_4 = K_1 \times K_2 / (K_3)^3$  (3)  $K_2 = \frac{K_4 \times K_1}{(K_3)^3}$  (4)  $K_4 = \frac{K_2 \times (K_3)^3}{K_1}$ 

- 7. The yield of the product will be higher if the value of K for the reaction is (1)  $1 \times 10^{-15}$  (2)  $1 \times 10^{-12}$  (3)  $5 \times 10^{8}$
- 9. The equilibrium constant of the reaction  $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$  is  $4 \times 10^{-3}$  atm<sup>-1/2</sup>. The equilibrium constant of the reaction  $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$  would be : (1) 250 atm (2)  $4 \times 10^3$  atm (3)  $0.25 \times 10^4$  atm (4)  $6.25 \times 10^4$  atm
- **10.** For the reaction

$$CuSO_4.5H_2O(s) \rightleftharpoons CuSO_4.3H_2O(s) + 2H_2O(g)$$
  
Which one is correct representation :

12.

(1) 
$$K_P = (P_{H_2O})^2$$
 (2)  $K_C = [H_2O]^2$  (3)  $K_P = K_C(RT)^2$  (4) All

11. The following pictures represents the equilibrium state for three different reactions of the type



**13.** 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)  $5 \times 10^{-5} \times R^{-1}$ 
**14.** The  $K_p/K_c$  ratio for the reaction  $4NH_3(g) + 7O_2(g) \rightleftharpoons 4 NO(g) + 6 H_2O(g)$ , at  $127^{\circ}C$  is

 (1) 0.0301
 (2) 0.0831
 (3) 1.0001
 (4) 33.26

**15.** The figure show the change in concentration of species A and B as a fuctional of time . The equilibrium constant  $K_c$  for the reaction A(g)  $\implies$  2B (g) is :



**16.** The equilibrium  $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$  is estabilished in a reaction vessel of 2.5 L capacity. The amounts of  $N_2$  and  $O_2$  taken at the start were respectively 2 moles and 4 moles. Half a mole of nitrogen has been used up at equilibrium. The molar concentration of nitric oxide is : (1) 0.2 (2) 0.4 (3) 0.6 (4) 0.1

17.	In the reaction, $N_2 + O$ equilibrium, the initial c (1) 0.75 mol/litre, 0.55 (3) 0.25 mole/litre, 0.50	$P_2 \rightleftharpoons 2NO$ , the moles/li oncentration of N <sub>2</sub> and O mole/litre mole/ litre	tre of $N_2$ , $O_2$ and NO res <sup>2</sup> will be respectively if in (2) 0.50 mole/litre, 0.75 (4) 0.25 mole/litre, 1.0 r	spectively 0.25, 0.05 and 1.0 at itially only $N_2$ and $O_2$ are taken : mole/litre mole/litre
18.	'a' moles of $PCI_5$ , unde equilibrium is 0.25 and t	rgoes, thermal dissociation he total pressure is 2.0 atr	on as : $PCI_5 \implies PCI_3 +$ mosphere. The partial pres	$Cl_2$ , the mole fraction of $PCl_3$ at ssure of $Cl_2$ at equilibrium is : (4) None
	(1) 2.5	(2) 1.0	(3) 0.5	(4) NOTE
19.	2 mol of $N_2$ is mixed w NH <sub>3</sub> at equilibrium, the (1) 4/27	with 6 mol of $H_2$ in a closs value of $K_c$ for the reaction (2) 27/4	ed vessel of 1L capacity on, $N_2(g) + 3H_2(g) \rightleftharpoons 2$ (3) 1/27	<ul> <li>If 50% of N<sub>2</sub> is converted into 2NH<sub>3</sub>(g) is</li> <li>(4) 27</li> </ul>
20.	For the reaction, $N_2O_5$	g) 🛁 2NO₂(g) + 1/2 O	g(g), calculate the mole	fraction of $N_2O_5(g)$ decomposed
	at a constant volume & 960 mm Hg. Assume io	k temperature, if the initiated by the second se	al pressure is 600 mm H	g & the pressure at any time is
	(1) 0.4	(2) 0.5	(3) 0.2	(4) 0.8
21.	For the reaction $A_2(g) + 2B_2 \implies 2C_2(g)$ the partial pressure of a system is 2.80 atm. The	g) A <sub>2</sub> , B <sub>2</sub> at equilibrium are ( e equilibrium constant K <sub>p</sub>	0.80 atm and 0.40 atm re will be	espectively. The pressure of the
	(1) 20	(2) 5.0	(3) 0.02	(4) 0.2
22.	A reaction mixture con at 725 K. If the value of direction the net reaction	taining $H_2$ , $N_2$ and $NH_3$ h f $K_p$ for the reaction, $N_2$ -	as partial pressure 2 atr - $3H_2 \implies 2NH_3$ is 4.28	n, 1 atm and 3 atm respectively $3 \times 10^{-5}$ atm <sup>-2</sup> at 725 K, in which
	(1) Forward	, , , , , , , , , , , , , , , , , , ,	(2) Backward	

(3) No net reaction

(4) Direction of reaction cannot be predicted

23.	At 445° C, K <sub>c</sub> for the fol $2HI(g) \Longrightarrow H_2(g) + I_2(g)$ A mixture of H <sub>2</sub> , I <sub>2</sub> and H $[HI] = 2.0M, [H_2] = 0.50$ Q <sub>c</sub> is: (1) Q = K : the system	lowing reaction is 0.020. ) HI in a vessel at 445° C H M and $[I_2] = 0.10M$ . The	has the following concent e statement that is true co	ration : oncerning the reaction quotient,
	(1) $Q_c = K_c$ , the system (2) $Q_c$ less than $K_c$ ; mo (3) $Q_c$ less than $K_c$ ; mo (4) $Q_c$ is greater than $K_c$	re $H_2$ and $I_2$ will be produced re HI will be produced ; more $H_2$ and $I_2$ will be p	uced produced	
24.≿	5 moles of $SO_2$ and 5 m stage, 60% $SO_2$ is used (1) 3.9	noles of O <sub>2</sub> are allowed t I up. The total number of (2) 10.5	o react to form $SO_3$ in a of moles of $SO_2$ , $O_2$ and $SO_3$ (3) 8.5	closed vessel. At the equilibrium O <sub>3</sub> in the vessel now is : (4) 10.0
25.≿	The extent of dissociation pressure at which this second (1) 0.123	ion of PCl <sub>5</sub> at a certain t substance is half dissocia (2) 0.246	emperature is 20 % at or ated at the same tempera (3) 0.826	ne atm pressure . Calculate the ature. (4) 0.111
26. 🖎	In a container equilibriu is attained at 25°C. Th above equilibrium is 0.6	m $N_2O_4(g)$ total equilibrium pres 667 atm, then degree of	$2NO_2$ (g) soure in container is 380 dissociation of $N_2O_4$ at th	torr. If equilibrium constant of is temperature will be
	(1) $\frac{1}{3}$	(2) $\frac{1}{2}$	(3) $\frac{2}{3}$	(4) $\frac{1}{4}$
27.	The vapour density of temperature is :	$N_2O_4$ at a certain tem	perature is 30.67. The	% dissociation of $N_2O_4$ at this
	(1) 50	(2) 20	(3) 70	(4) 10
28.≿	Vapour density of PCl <sub>5</sub> degree of dissociation of	is 104.16 but when he of PCI <sub>5</sub> at this temperatu	ated to 230°C its vapour re will be :	density is reduced to 62 The
	(1) 6.8 %	(2) 68%	(3) 46%	(4) 64%
29.2	For the reaction $N_2O_4(g$ then the sequence of o	$\Rightarrow 2NO_2(g), \text{ if percentions}$	entage dissociation of N <sub>2</sub> s will be :	O <sub>4</sub> are 20%, 45%, 65% & 80%,
	(1) $d_{20} > d_{45} > d_{65} > d_{80}$	(2) $d_{80} > d_{65} > d_{45} > d_{20}$	(3) $d_{20} = d_{45} = d_{65} = d_{80}$	(4) $(d_{20} = d_{45}) > (d_{65} = d_{80})$
30.	The degree of dissociate $PCI_5 \implies PCI_3 + CI_2$ Assuming ideal behavior Calculate the density of	tion is 0.5 at 800 K and 2 our of all the gases. f equilibrium mixture at 8	2 atm for the gaseous rea 300 K and 2 atm.	action
	(1) 4.232 g/L	(2) 6.4 g/L	(3) 8.4 g/L	(4) 2.2 g/L
31.	For the reaction C(s) + respectively at equilibrin	$CO_2(g) \rightleftharpoons 2CO(g)$ th um. The K <sub>P</sub> for the reaction	ne partial pressure of CC ion is :	and CO <sub>2</sub> are 2.0 and 4.0 atm.
	(1) 0.5	(2) 4.0	(3) 8.0	(4) 1
32.	In the reaction C(s) + C then $K_p$ will be :	$CO_2(g) \rightleftharpoons 2CO(g), t$	he equilibrium pressure	is 12 atm. If 50% of $CO_2$ reacts
	(1) 12 atm	(2) 16 atm	(3) 20 atm	(4) 24 atm
33.	A 10 L container at 300	) K contains CO, gas at	t pressure of 0.2 atm and	d an excess solid CaO (neglect

the volume of solid CaO). The volume of container is now decreased by moving the movable piston

fitted in the container. What will be the maximum volume of container when pressure of CO<sub>2</sub> attains its maximum value given that  $CaCO_3$  (s)  $\subset$  CaO(s) + CO<sub>2</sub>(g) K<sub>p</sub> = 0.800 atm (1) 5 L (2) 2.5 L (3) 1 L (4) The information is insufficient. 34. Calculate the partial pressure of carbon monoxide from the following data  $CaCO_{3}(s) \xrightarrow{\Delta} CaO(s) + CO_{2} \uparrow$ ,  $K_{n} = 8 \times 10^{-2}$  $CO_{2}(g) + C(s) = 2CO(g), K_{0} = 2$ (1) 0.2(2) 0.4(3) 1.6 (4) 4If standard heat of dissociation of PCI<sub>5</sub> is 230 cal then slope of the graph of logk vs  $\frac{1}{\tau}$  is : 35. (2) - 50 (3) 10 (1) + 50(4) None 36. Calculate  $\Delta G^{0}$  for conversion of oxygen to ozone 3/2  $O_{2(0)} \rightarrow O_{3(0)}$  at 298 K, if K<sub>0</sub> for this conversion is 2.47 × 10<sup>-29</sup> ? (2) 2.4 × 10<sup>2</sup> kJmol<sup>-1</sup> (1) 163 kJmol-1 (3) 1.63 kJmol<sup>-1</sup> (4) 2.38 × 10<sup>6</sup> kJmol<sup>-1</sup> 37. The standard free energy change of a reaction is △G°=-115 kJ at 298 K. Find log K<sub>o</sub> (R = 8.314 JK<sup>-</sup> <sup>1</sup>mol<sup>-1</sup>) (3) 2.016(1) 20.16(2) 2.303(4) 13.83 The equilibrium,  $SO_2CI_2(g) \implies SO_2(g) + CI_2(g)$  is attained at 25°C in a closed container and an inert 38. gas, helium, is introduced. Which of the following statement(s) is/are correct. (1) Concentrations of SO<sub>2</sub>, Cl<sub>2</sub> and SO<sub>2</sub>Cl<sub>2</sub> are changed (2) No effect on equilibrium (3) Concentration of SO<sub>2</sub> is reduced (4) K<sub>p</sub> of reaction is increasing 39. A reaction in equilibrium is represented by the following equation - $2A(s) + 3B(g) \implies 3C(g) + D(g) + O_{2}$  if the pressure on the system is reduced to half of its original value (1) The amounts of C and D decreases (2) The amounts of C and D increases (3) The amount of B and D decreases (4) All the amounts remain constant Consider the following two equilibria simultaneously established in a rigid vessel at a particular 40.2 temperature:  $NH_2COONH_4(s) \implies 2NH_3(g) + CO_2(g)$  $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ Now, on adding some amount of NH<sub>3</sub> to the reaction vessel, the orignal equilibrium is disturbed and a new equilibrium state is obtained. On comparing the following at the initial & final equilibrium states, select the CORRECT statement (s) : (1) Nothing can be said about the number of moles of CO<sub>2</sub> gas in reaction vessel. (2) Nothing can be said about the number of moles of NH<sub>3</sub> gas in reaction vessel. (3) Number of moles of NH<sub>3</sub> gas would have definitely increased. (4) Number of moles of CaCO<sub>3</sub> solid would have definitely decreased. 41. A liquid is in equilibrium with its vapour at its boiling point. On the average the molecules in the two phases have equal : (1) inter molecular forces (2) potential energy (3) kinetic energy (4) none of these. 42.> For the equilibrium reaction,  $H_2O(I) \rightleftharpoons H_2O(g)$ . What happens, if pressure is applied :

- (1) More water evaporates
- (3) No effect on boiling point

- (2) The boiling point of water is increased
- (4) None of the above

43.> On cooling of following system at equilibrium  $CO_2(s) \rightleftharpoons CO_2(g)$ 

- (1) There is no effect on the equilibrium state
- (3) More gas solidifies

**Exercise-3** 

## PART - I : NEET / AIPMT QUESTION (PREVIOUS YEARS )



- (2) More gas is formed (4) None of above

7.	In the two gaseous rea	ctions (i) and (ii) at 250%	С	[AIPI	MT 1994, 2005]
	(i) NO (g) + $\frac{1}{2}$ O <sub>2</sub>	$_{2}(g) \rightleftharpoons NO_{2}(g),$	K <sub>1</sub>		
	(ii) $2NO_2$ (g) $\rightleftharpoons$ The equilibrium consta	2NO (g) + $O_2$ (g), nts $K_1$ and $K_2$ are related	K <sub>2</sub> l as :		
	(1) $K_2 = \frac{1}{K_1}$	(2) $K_2 = K_1^{1/2}$	(3) $K_2 = \frac{1}{K_1^2}$	(4) $K_2 = K_1^2$	
8.	For the reaction, $CH_4$ + Which of the following $(1)$ At equilibrium, the c	$2O_2(g) \rightleftharpoons CO_2(g) +$ statements is not true ? concentrations of $CO_2(g)$	2 $H_2O(\ell)$ , $\Delta_rH = -170.4$ ) and $H_2O(\ell)$ are not equ	8 kJ mol⁻¹ ıal.	[AIPMT 2006]
	(2) The equilibrium con	istant for the reaction is g	given by $K_p = \frac{[CO_2]}{[CH_4]}$	2]	
	(3) Addition of $CH_4$ (g) (4) The reaction is exore	or $O_{2}^{2}$ (g) at equilibrium withermic.	vill cause a shift to the rig	lht.	
9.	The value of the equilit	prium constant of the rea	ction		
	HI (g) $\rightleftharpoons \frac{1}{2}$	$H_2(g) + \frac{1}{2} I_2(g)$ is 8.0			[AIPMT 2008]
	The equilibrium consta $H_2(g) + I_2(g) \neq$ (1) 1/16	nt of the reaction $\Rightarrow$ 2HI (g) will be	(3) 16	(4) 1/8	
10	If concentration of OH-	ions in the reaction	(3) 10	(4) 1/0	
	$Fe(OH)_3(s) \Leftarrow$	$\Rightarrow$ Fe <sup>3+</sup> (aq) + 3OH <sup>-</sup> (aq)			[AIPMT 2008]
	is decreased by $\frac{1}{4}$ time	es, then equilibrium cond	centration of Fe3+ will incr	ease by	
	(1) 8 times	(2) 16 times	(3) 64 times	(4) 4 times	
11.	The value of $K_{P_1}$ and $F$	$K_{P_2}$ for the reactions			[AIPMT 2008]
	$X \rightleftharpoons Y + Z$ and $A \rightleftharpoons 2B$ are in the ratio of 9 : equilibrium (1) and (2)	: (1) (2) 1. If the degree of dis are in the ratio	sociation of X and A b	e equal, then to	otal pressure at
	(1) 3 : 1	(2) 1 : 9	(3) 36 : 1	(4) 1 : 1	
12.	The dissociation equilit $2AB_2(g) \rightleftharpoons$ The degree of dissociation	prium of a gas $AB_2$ can b 2 AB(g) + B <sub>2</sub> (g) ation is 'x' and it is sma	e represented as Il compared to 1. The ex	xpression relatin	[AIPMT 2008] g the degree of
	(1) (2 $K_p/P$ )	(2) $2K_p/P$ ) <sup>1/3</sup>	(3) $(2 \text{ K}_{p}/\text{P})^{1/2}$	(4) (K <sub>p</sub> /P)	
13.	The dissociation consta The equilibrium consta (1) 3.0 × 10⁵	ant for acetic acid and H nt for the equilibrium, CN (2) 3.0 × 10 <sup>-5</sup>	HCN at 25⁰C are 1.5 × 1 √- + CH₃COOH ⇐━━━ HC (3) 3.0 × 10 <sup>_4</sup>	0 <sup>-5</sup> and 4.5 × 10 <sup>-</sup> N + CH₂COO <sup>-</sup> (4) 3.0 × 10⁴	<sup>-10</sup> , respectively. [AIPMT 2009]
14.	The reaction, $2A_{(g)}$ + is begun with the con- reached, the concentra constant for this reaction (1) [(0.75) <sup>3</sup> (0.25)] ÷ [(1 (3) [(0.75) <sup>3</sup> (0.25)] ÷ [(0.25)] +	$B_{(g)} \longrightarrow 3C_{(g)} + D_{(g)}$ centrations of A and B ation of D is measured on is given by the expres $.00)^2 (1.00)$ ] $0.50)^2 (0.25)$ ]	both at an initial value and found to be 0.25 M sion : (2) $[(0.75)^3 (0.25)] \div [(0)(0.25)]$	of 1.00 M. Whe /. The value for ).50) <sup>2</sup> (0.75)] ).75) <sup>2</sup> (0.25)]	n equilibrium is the equilibrium [AIPMT 2010]

15.	Match	List I (Equations List I Equations	) with List II(Typ	oes of pr	ocesses) and se List II	lect the correc	ct option.	[AIPMT 2010]
	(a)	$K_{n} > Q$		(i)	Non-spontaneo	us		
	(b) (c)	$\Delta G^{\circ} > - RT In$ $K_{p} = Q$	Q	(ii) (iii)	Equilibrium Spontaneous a	nd endotherm	lic	
	(d)	$T > \frac{\Delta H}{\Delta S}$		(iv)	Spontaneous			
	(1) a - (3) a -	(i), b - (ii), c - (iii) (iv), (b -(i), c - (ii	), d - (iv) ), d - (iii)		(2) a - (iii), b - (i (4) a - (ii), b - (i)	v), c - (ii), d - ( ), c - (iv), d - (i	(i) ii)	
16.	In whic (1) 2N( (3) H <sub>2</sub> (g	th of the followin $D(g) \rightleftharpoons N_2(g)$ $g) + I_2(g) \rightleftharpoons$	g equilibrium K <sub>c</sub> a ı) + O <sub>2</sub> (g) 2HI(g)	and $K_p$ a	re not equal? (2) SO <sub>2</sub> (g) + NC (4) 2C(s) + O <sub>2</sub> (g	$D_2(g) \Longrightarrow S$ $g) \Longrightarrow 2CO$	O <sub>3</sub> (g) + N0 9 <sub>2</sub> (g)	<b>[AIPMT 2010]</b> D(g)
17.	For the $K_2$ for t $O_2(q)$ ?	e reaction N <sub>2</sub> (g) - the reaction 2NC	$+ O_2(g) \rightleftharpoons 2h$ $D(g) + O_2(g) \rightleftharpoons$	$NO(g), th \geq 2NO_2$	ne equilibrium co <u>,(g)</u> . What is K fo	nstant is K <sub>1</sub> . T or the reaction	he equilib nNO₂(g) ∹	rium constant is $\swarrow \frac{1}{2}N_2(g) +$
	(1) 1 / (	(2K <sub>1</sub> K <sub>2</sub> )	(2) 1 / (4K <sub>1</sub> K <sub>2</sub> )		(3) [1 / K <sub>1</sub> K <sub>2</sub> ] <sup>½</sup>	(4) 1	/ (K <sub>1</sub> K <sub>2</sub> )	[AIPMT 2011]
18.	Given the difference of $A_2 = 0$ of $A_2 = 0$ of $AB = 0$	the reaction betw $A_2(g) + B_2(g) =$ ilibrium, the cond $3.0 \times 10^{-3} M$ $4.2 \times 10^{-3} M$ $2.8 \times 10^{-3} M$ .	veen 2 gases rep 2 AB(g). centration	presente	d by $A_2$ and $B_2$ to	give the com	pound AB	(g). [AIPMT 2012]
	If the re	eaction takes pla	ice in a sealed ve	essel at	527°C, then the v	alue of K <sub>c</sub> wil	ll be :	
	(1) 2.0		(2) 1.9		(3) 0.62	(4) 4.5		
19.	For the The eq (1) by i (2) by c (3) by c (4) by i	e reversible react juilibrium shifts in increasing the co decreasing the p decreasing the co increasing press	tion : N <sub>2</sub> (g) + 3H In forward direction oncentration of N pressure concentrations of ure and decreasi	H₂(g)	$\Rightarrow$ 2NH <sub>3</sub> (g) + hea nd H <sub>2</sub> (g) perature	at		[AIPMT 2014]
20.	For a g respec readily	given exothermi tively. Assuming observation tha	c reaction, K <sub>p</sub> ar that heat of read t:	nd K <sub>p</sub> ' ar ction is c	e the equilibriun	n constants a eratures range	t tempera e between	tures $T_1$ and $T_2$ $T_1$ and $T_2$ , it is [AIPMT 2014]
	(1) K <sub>p</sub> :	> K <sub>p</sub> '	(2) $K_p < K_p$		(3) $K_p = K_p'$	(4) K	$K_{p} = \frac{1}{K_{p}}$	
21.	If the system (1) mos (3) sim	value of an equ will contain? stly reactions. ilar amounts of u	illibrium constant	t for a p	particular reactio (2) mostly prode (4) all reactants	n is 1.6×10 <sup>12</sup> ucts	, then at	equilibrium the [AIPMT 2015]
22	Which	of the following	statements is cor	rect for	a reversible proc	ess in a state	of equilibr	ium ?

22.Which of the following statements is correct for a reversible process in a state of equilibrium ?(1)  $\Delta G = 2.30 \text{ RT} \log K$ (2)  $\Delta G^\circ = -2.30 \text{ RT} \log K$ [AIPMT 2015]

(4) 2 litre

[NEET-2017]

(3)  $\Delta G^{\circ} = 2.30 \text{ RT} \log K$ (4)  $\Delta G = -2.30 \text{ RT} \log K$ 

23. A 20 litre container at 400 K contains CO<sub>2</sub>(q) at pressure 0.4 atm and an excess of SrO neglect the volume of solid SrO). The volume of the container is now decreased by moving the movable piston fitted in the container. The maximum volume of the container, when pressure of CO<sub>2</sub> attains its maximum value, will be : [NEET-2017]

(Given that :  $SrCO_3(s) \rightleftharpoons SrO(s) + CO_2(g)$ , Kp = 1.6 atm) (1) 5 litre (2) 10 litre (3) 4 litre

- 24. The equilibrium constants of the following are :  $N_2 + 3H_2 \rightleftharpoons 2 NH_3$ K₁  $N_2 + O_2 \rightleftharpoons 2 NO$ K2  $H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$  K<sub>3</sub> The equilibrium constant (K) of the reaction :  $2NH_3 + \frac{5}{2}O_2 \xrightarrow{K} 2NO + 3 H_2O$ , will be : (2) K<sub>2</sub> K<sub>3</sub><sup>3</sup>/K<sub>1</sub> (1)  $K_1 K_3^3/K_2$ (3) K<sub>2</sub> K<sub>3</sub> /K<sub>1</sub>
- 25. Which of the following conditions will favour maximum formation of the product in the reaction  $A_2(g) + B_2(g) \rightleftharpoons X_2(g) \Delta_r H = -XkJ?$ [NEET-2018]
  - (1) Low temperature and high pressure
- (2) High temperature and low pressure
- (3) High temperature and high pressure
- 26. For the chemical reaction  $N_2(g) + 3H_2(g) \implies 2NH_3(g)$ the correct option is :

(1) 
$$3\frac{d[H_2]}{dt} = 2\frac{d[NH_3]}{dt}$$
$$(3) - \frac{d[N_2]}{dt} = 2\frac{d[NH_3]}{dt}$$

- (4) Low temperature and low pressure
  - [NEET-1-2019]

(4)  $K_2^3 K_3/K_1$ 

$$(2) - \frac{1}{3} \frac{d[H_2]}{dt} = -\frac{1}{2} \frac{d[NH_3]}{dt}$$
$$(4) - \frac{d[N_2]}{dt} = \frac{1}{2} \frac{d[NH_3]}{dt}$$

## PART - II : AIIMS QUESTION (PREVIOUS YEARS)



- In which of the following reactions, the concentration of the product is higher than the concentration of reactant at equilibrium ? (K = equilibrium constant)
   [AIIMS 2008]
  - (1)  $A \Longrightarrow B$ ; K = 0.001(2)  $M \Longrightarrow N$ ; K = 10(3)  $X \Longrightarrow Y$ ; K = 0.005(4)  $R \rightleftharpoons P$ ; K = 0.01
- 4. Assertion : For the reaction,  $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ Unit of  $K_c = L^2 \text{ mol}^{-2}$ . Reason : For the reaction,  $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

Equilibrium constant,  $K_c = \frac{[NH_3]^2}{[N_2] [H_2]^3}$ .

[AIIMS 2008]

- (1) If both assertion and reason are true and reason is the correct explanation of assertion.
- (2) If both assertion and reason are true but reason is not the correct explanation of assertion.
- (3) If Assertion is true but reason is false.
- (4) If both assertion and reason are false.

5. Two moles of each reactant A and B are taken in a reaction flask. They react in the following manner, A (g) + B (g)  $\rightleftharpoons$  C (g) + D (g)

At equilibrium, it was found that the concentration of C is triple to that B. The equilibrium constant for the reaction is : [AIIMS 2009]

(1) 4.5 (2) 6 (3) 9 (4) 
$$\frac{1}{6}$$

Assertion : For the reaction, 2NO(g) + O₂(g) ⇒ 2NO₂ (g) increase in pressure favours the formation of NO₂.
 Reason : The reaction is exothermic.

(1) If both assertion and reason are true and reason is the correct explanation of assertion.

- (2) If both assertion and reason are true but reason is not the correct explanation of assertion.
- (3) If Assertion is true but reason is false.
- (4) If both assertion and reason are false.
- 7. The following equilibria are given (I)  $N_2 + 3H_2 \rightleftharpoons 2NH_3$ ;  $K_1$  (II)  $N_2 + O_2 \rightleftharpoons 2NO$ ;  $K_2$  (III)  $H_2 + O_2 \rightleftharpoons H_2O$ ;  $K_3$

The equilibrium constant for the reaction,

$$2NH_3 + \frac{5}{2}O_2 \Longrightarrow 2NO + 3H_2O$$

in terms of  $\rm K_{1},\,\rm K_{2}$  and  $\rm K_{3}$  will be :

(1) 
$$K_1 K_2 K_3$$
 (2)  $\frac{K_1 K_2}{K_3}$  (3)  $\frac{K_1 K_3^2}{K_2}$  (4)  $\frac{K_2 K_3^3}{K_1}$ 

8. Steam reacts with iron at high temperature to give hydrogen gas and  $Fe_{3}O_{4}(s)$ . The correct expression for the equilibrium constant is [AIIMS 2013]

(1) 
$$\frac{p_{H_2}^2}{p_{H_2O}^2}$$
 (2)  $\frac{(P_{H_2})^4}{(P_{H_2O})^4}$  (3)  $\frac{(P_{H_2})^4[Fe_3O_4]}{(P_{H_2O})^4[Fe]}$  (4)  $\frac{[Fe_3O_4]}{[Fe]}$ 

9. Which of the following equilibria will shift to right side on increasing the temperature? [AIIMS 2014] (1)  $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$  (2)  $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ (3)  $H_2O(g) \rightleftharpoons \frac{1}{2}O_2(g) + H_2(g)$  (4)  $4HCI(g) + O_2(g) \rightleftharpoons 2CI_2(g) + 2H_2O(g)$ 

10.'a' moles of  $PCl_5$  are heated in a closed container to equilibriate :[AIIMS 2015] $PCl_5(g)$  $PCl_3(g) + Cl_2(g)$  at a pressure of p atm. If x moles of  $PCl_5$  dissociate at equilibrium, then :

[AIIMS 2010,2012]

.

(1) 
$$\frac{x}{a} = \left(\frac{K_p}{p}\right)^{\frac{1}{2}}$$
 (2)  $\frac{x}{a} = \frac{K_p}{K_p + p}$  (3)  $\frac{x}{a} = \left(\frac{K_p}{K_p + p}\right)^{\frac{1}{2}}$  (4)  $\frac{x}{a} = \left(\frac{K_p + p}{K_p}\right)^{\frac{1}{2}}$ 

**11.** Consider the reaction equilibrium :

The favourable conditions for forward reaction are :

- (1) low temperature, high pressure and excess of ice
- (2) low temperature, low pressure and excess of ice
- (3) high temperature, low pressure and excess of ice
- (4) high temperature, high pressure and excess of ice
- 12. One mole of a compound react with one mole of a compound CD according to the equation  $AB(g) + CD(g) \Longrightarrow AD(g) + CB(g)$ : [AIIMS 2016]

when equilibrium had been established it was found that 3/4 mole each of reactants AB and CD had been converted to AD and CB. There is no change in volume. The equilibrium constant for the reaction is :

**13.** Density of equilibrium mixture of  $N_2O_4$  and  $NO_2$  at 1 atm and 384 K is 1.84 g/dm<sup>3</sup>. Equilibrium constant of the following reaction is : [AIIMS 2016]  $N_2O_4 \implies 2NO_2$ 

**14.** Assertion : Additing inert gas to disociation equilibrium of  $N_2O_4$  at constant temperature and pressurei ncreases the dissociation. [AIIMS 2016]

**Reason :** Due to the addition of inert gas molar concentration of reactants and products decreases.

- (1) If both assertion and reason are true and reason is the correct explanation of assertion.
- (2) If both assertion and reason are true but reason is not the correct explanation of assertion.
- (3) If Assertion is true but reason is false.
- (4) If both assertion and reason are false.

#### **15.** For the reaction

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 $H_2(g) + CO_2(g) \rightleftharpoons CO(g) + H_2O(g)$ , If the initial concentration of  $[H_2] = [CO_2]$  and x mol/L of hydrogen is consumed at equilibrium, the correct expression of  $k_p$  is [AIIMS 2017]

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

16.For the reaction,  
$$A_2(g) + 4B_2(g) \rightleftharpoons 2AB4(g), \Delta H < 0$$
, the formation of AB4 will be favoured at  
(1) Low temperature, high pressure  
(3) Low temperature, low pressure  
(3) Low temperature, low pressure  
(4) High temperature, high pressure[AIIMS 2017]17. $2ICI \longrightarrow I_2 + CI_2$   
Initial concentration of ICI is 0.6 M  
then equilibrium concentration of  $I_2$  is :  
(1) 0.37M[AIIMS 2018]18. $A + 2B \rightleftharpoons 2C$   
2 mole each A and B present in 10 It so that C form is 1 mole, Calculate Kc  
(1) 1.5[AIIMS 2018]

[AIIMS 2015]

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## CHEMICAL EQUILIBRIUM

19.  $CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$  at const Temp, the pressure will increase if : [AIIMS 2018] (1) Vol. of container increase (2) Temperature increases (3) Concentration of CaO increases. (4) Concentration of CaCO<sub>3</sub> increases. PART - III : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS) Change in volume of the system does not alter the number of moles in which of the following 1. [AIEEE 2002, 3/225] equilibriums : (2)  $PCI_{s}(g) \Longrightarrow PCI_{s}(g) + CI_{2}(g)$ (1)  $N_2(g) + O_2(g) \implies 2NO(g)$ (3)  $N_2(g) + 3H_2(g) \implies 2NH_3(g)$ (4)  $SO_2Cl_2(g) \longrightarrow SO_2(g) + Cl_2(g)$ In which of the following reactions, increase in the volume at constant temperature don't effect the 2. number of moles of at equilibrium : [AIEEE 2002, 3/225] (2) C (g) + (1/2) O<sub>2</sub> (g)  $\rightleftharpoons$  CO (g) (1)  $2NH_3 \implies N_2 + 3H_2$ (3)  $H_{2}(g) + O_{2}(g) = H_{2}O_{2}(g)$ (4) none of these. Consider the reaction equilibrium 3.  $2SO_{2}(g) + O_{2}(g) \implies 2SO_{3}(g); \Delta H^{\circ} = -198 \text{ kJ}.$ On the basis of Le Chatelier's principle, the condition favourable for the forward reaction is : (1) lowering of temperature as well as pressure [AIEEE 2003, 3/225] (2) increasing temperature as well as pressure (3) lowering the temperature and increasing the pressure (4) any value of temperature and pressure. For the reaction equilibrium,  $N_2O_4$  (g)  $\implies$   $2NO_2$  (g) the concentrations of  $N_2O_4$  and  $NO_2$  at equilibrium 4. are  $4.8 \times 10^{-2}$  and  $1.2 \times 10^{-2}$  mol L<sup>-1</sup> respectively. The value of K<sub>c</sub> for the reaction is : [AIEEE 2003, 3/225] (3) 3 × 10<sup>-3</sup> mol L<sup>-1</sup> (2) 3 × 10<sup>-1</sup> mol L<sup>-1</sup> (1)  $3.3 \times 10^2 \text{ mol } \text{L}^{-1}$ (4) 3 × 10<sup>3</sup> mol L<sup>-1</sup> 5. What is the equilibrium constant expression for the reaction  $P_4(s) + 5O_2(g) \rightleftharpoons P_4O_{10}(s)$ ? [AIEEE 2004, 3/225] (2)  $K_c = 1/[O_2]^5$ (4)  $K_c = [P_4O_{10}]/5[P_4][O_2]$ (1)  $K_c = [P_4O_{10}]/[P_4] [O_2]^5$ (3)  $K_{c} = [O_{2}]^{5}$ For the reaction,  $CO(g) + Cl_2(g) \implies COCl_2(g)$  then  $K_p/K_c$  is equal to : [AIEEE 2004] 6. (3) √RT (1) 1/RT (2) 1.0 (4) RT The equilibrium constant for the reaction,  $N_2(g) + O_2(g) \implies 2NO(g)$  at temperature T is 4 × 10<sup>-4</sup>. The 7. value of K<sub>2</sub> for the reaction, NO(g)  $\implies$  N<sub>2</sub>(g) + O<sub>2</sub>(g) at the same temperature is :[AIEEE 2004, 2012] (3)  $4 \times 10^{-4}$ (1)  $2.5 \times 10^2$ (2) 0.02 (4) 50 For the reaction,  $2NO_2(g) \implies 2NO(g) + O_2(g)$ , [AIEEE 2005] 8.  $(K_{c} = 1.8 \times 10^{-6} \text{ at } 184^{\circ}\text{C})$ (R = 0.0831 kJ/(mol.K))When K<sub>o</sub> and K<sub>c</sub> are compared at 184°C it is found that (1) Whether  $K_{p}$  is greater than, less than or equal to  $K_{p}$  depends upon the total gas pressure (2)  $K_{0} = K_{0}$ (3)  $K_{o}$  is less than  $K_{o}$ (4)  $K_{o}$  is greater than  $K_{c}$ 9. The exothermic formation of CIF<sub>3</sub> is represented by the equation : [AIEEE 2005]  $Cl_2(g) + 3F_2(g) \Longrightarrow 2ClF_3(g)$ ;  $\Delta_r H = -329 J$ which of the following will increase the quantity of CIF<sub>3</sub> in an equilibrium mixture of Cl<sub>2</sub>, F<sub>2</sub> and CIF<sub>3</sub>.

- (1) Adding  $F_2$
- (3) Removing Cl

- (2) Increasing the volume of container
- (4) Increasing the temperature
- **10.**An amount of solid  $NH_4HS$  is placed in a flask already containing ammonia gas at a certain temperature<br/>at 0.50 atm pressure. Ammonium hydrogen sulphide decomposes to yield  $NH_3$  and  $H_2S$  gases in the<br/>flask. When the decomposition reaction reaches equilibrium, the total pressure in the flask rises to 0.84<br/>atm? The equilibrium constant for  $NH_4HS$  decomposition at this temperature is :[AIEEE 2005](1) 0.11(2) 0.17(3) 0.18(4) 0.30
- **11.** Phosphorus pentachloride dissociates as follows in a closed reaction vessel.  $PCI_{5}(g) \rightleftharpoons PCI_{3}(g) + CI_{2}(g)$

If total pressure at equilibrium of the reaction mixture is P and degree of dissociation of  $PCI_5$  is x, the partial pressure of  $PCI_3$  will be : [AIEEE 2006, 3/165]

(1)  $\left(\frac{x}{x+1}\right) P$  (2)  $\left(\frac{2x}{1-x}\right) P$  (3)  $\left(\frac{x}{x+1}\right) P$  (4)  $\left(\frac{x}{1-x}\right) P$ 

**12.** The equilibrium constant for the reaction,  $SO_3(g) \rightleftharpoons SO_2(g) + \frac{1}{2} O_2(g)$  

 is  $K_c = 4.9 \times 10^{-2}$ . The value of  $K_c$  for the reaction  $2SO_2(g) + O_2(g)$   $2SO_3(g)$  will be :[AIEEE 2006, 3/165]

 (1) 416
 (2)  $2.40 \times 10^{-3}$  (3)  $9.8 \times 10^{-2}$  (4)  $4.9 \times 10^{-2}$ 

**13.** For the following three reactions a, b and c, equilibrium constants are given:

 $\begin{array}{ll} (A) \operatorname{CO}(g) + \operatorname{H}_2\operatorname{O}(g) & \Longrightarrow \operatorname{CO}_2(g) + \operatorname{H}_2(g); & \operatorname{K}_1 \\ (B) \operatorname{CH}_4(g) + \operatorname{H}_2\operatorname{O}(g) & \rightleftharpoons \operatorname{CO}_2(g) + 3\operatorname{H}_2(g); & \operatorname{K}_2 \\ (C) \operatorname{CH}_4(g) + 2\operatorname{H}_2\operatorname{O}(g) & \rightleftharpoons \operatorname{CO}_2(g) + 4\operatorname{H}_2(g); & \operatorname{K}_3 \\ \end{array} \\ \text{Which of the following relations is correct ?} \\ (1) \operatorname{K}_2 \operatorname{K}_3 = \operatorname{K}_1 & (2) \operatorname{K}_3 = \operatorname{K}_1 \operatorname{K}_2 \\ \end{array} \\ \begin{array}{l} (3) \operatorname{K}_3 \operatorname{K}_2^3 = \operatorname{K}_1^2 & (4) \operatorname{K}_1 \sqrt{\operatorname{K}_2} = \operatorname{K}_3 \end{array}$ 

14.The equilibrium constants  $K_{p_1}$  and  $K_{p_2}$  for the reactions X  $\rightleftharpoons$  2Y and Z  $\rightleftharpoons$  P + Q, respectively are<br/>in the ratio of 1 : 9. If the degree of dissociation of X and Z be equal then the ratio of total pressures at<br/>these equilibria is<br/>(1) 1 : 1[AIEEE 2008, 3/105]<br/>(3) 1 : 9(1) 1 : 1(2) 1 : 3(3) 1 : 9(4) 1 : 36

- **15.** If  $10^{-4}$  dm<sup>3</sup> of water is introduced into a 1.0 dm<sup>3</sup> flask at 300 K, how many moles of water are in the vapour phase when equilibrium is established ? [AIEEE 2010, 4/144] (Given : Vapour pressure of H<sub>2</sub>O at 300 K is 3170 Pa ; R= 8.314 J K<sup>-1</sup> mol<sup>-1</sup>) (1) 5.56 x 10<sup>-3</sup> mol (2) 1.53 x 10<sup>-2</sup> mol (3) 4.46 x 10<sup>-2</sup> mol (4) 1.27 x 10<sup>-3</sup> mol
- **16.** A vessel at 1000 K contains  $CO_2$  with a pressure of 0.5 atm. Some of the  $CO_2$  is converted into CO on the addition of graphite. If the total pressure at equilibrium is 0.8 atm, the value of K is:

- **17.** For the reaction  $SO_{2(g)} + \frac{1}{2}O_{2(g)} \iff SO_{3(g)}$ , 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

[AIEEE 2011, 4/120]

**18.** The standard Gibbs energy change at 300 K for the reaction  $_{2A} \implies _{B+C}$  is 2494.2 J. At a given time, the composition of the reaction mixture is  $[A] = \frac{1}{2}$ , [B] = 2 and  $[C] = \frac{1}{2}$ . The reaction proceeds in the : [R = 8.314 J/K/mol, e = 2.718] [JEE(Main) 2015, 4/120] (1) forward direction because  $Q > K_c$  (2) reverse direction because  $Q > K_c$ (3) forward direction because  $Q < K_c$  (4) reverse direction because  $Q < K_c$ 

19. The equilibrium constant at 298 K for a reaction A + B \_\_\_\_\_ C + D is 100. If the initial concentration of all the four species were 1 M each, then equilibrium concentration of D (in mol L<sup>-1</sup>) will be :

[JEE(Main) 2016, 4/120]

- (1) 0.818 (2) 1.818 (3) 1.182 (4) 0.182
- 20. Which of the following lines correctly show the temperature dependence of equilibrium constant, K, for an exothermic reaction ? [JEE(Main) 2018, 4/120]



(4) B and C [JEE(Main) 2019, 4/120]

(1) C and D(2) A and D(3) A and B21.Consider the following reversible chemical reactions :

$$A_{2}(g) + B_{2}(g) \xrightarrow{} 2AB(g) \qquad \dots \dots 1)$$

$$6AB(g) \xrightarrow{K_{2}} 3A_{2}(g) + 3B_{2}(g) \qquad \dots \dots (2)$$

<u>K<sub>1</sub></u>

The relation between  $K_1$  and  $K_2$  is :

(1)  $K_1K_2 = \frac{1}{3}$  (2)  $K_2 = K_1^{-3}$  (3)  $K_1K_2 = 3$  (4)  $K_2 = K_1^{-3}$ 

- 22.The values of  $K_P/K_C$  for the following reactions at 300 K are, respectively : (At 300 K, RT = 24.62 dm<sup>3</sup> atm mol<sup>-1</sup>)[JEE(Main) 2019, 4/120]
  - $$\begin{split} N_2(g) + O_2(g) &= 2NO(g) \\ N_2O_4(g) &= 2NO_2(g) \\ N_2(g) + 3H_2(g) &= 2NH_3(g) \\ (1) \ 1,4.1 \times 10^{-2} \ dm^{-3} \ atm^{-1} \ mol, \ 606 \ dm^6 \ atm^2mol^{-2} \\ (2) \ 1,24.62 \ dm^3 \ atm^{-1} \ mol^{-1}, \ 1.65 \times 10^{-3} \ dm^{-6} \ atm^{-2} \ mol^{-2} \\ (3) \ 24.62 \ dm^3 \ atm \ mol^{-1} \ 606.0 \ dm^6 \ atm^2 \ mol^{-2}, \ 1.65 \times 10^{-3} \ dm^{-6} \ atm^{-2} \ mol^{-2} \end{split}$$
  - (4) 1,24.62 dm<sup>3</sup> atm mol<sup>-1</sup>, 606.0 dm<sup>6</sup> atm<sup>2</sup>mol<sup>-2</sup>
- 23.5.1 g NH<sub>4</sub>SH is introduced in 3.0 L evacuated flask at 327°C. 30% of the solid NH<sub>4</sub>SH decomposed to<br/>NH<sub>3</sub> and H<sub>2</sub>S as gases. The K<sub>p</sub> of the reaction at 327°C is (R= 0.082 L atm mol<sup>-1</sup>K<sup>-1</sup>, molar mass of S =<br/>32 g mol<sup>-1</sup>, molar mass of N= 14 g mol<sup>-1</sup>)[JEE(Main) 2019, 4/120]<br/>(1)  $4.9 \times 10^{-3}$  atm<sup>2</sup>(2)  $0.242 \times 10^{-4}$  atm<sup>2</sup>(3)  $1 \times 10^{-4}$  atm<sup>2</sup>(4) 0.242 atm<sup>2</sup>
- 24Consider the reaction,  $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ . The equilibrium constant of the above reaction is<br/>KP. If pure ammonia is left to dissociate, the partial pressure of ammonia at equilibrium is given by<br/>(Assume that  $p_{NH_3} \ll p_{total}$  at equilibrium)[JEE(Main) 2019, 4/120]

(1) 
$$\frac{3^{3/2} K_p^{1/2} P^2}{16}$$
 (2)  $\frac{3^{3/2} K_p^{1/2} P^2}{4}$  (3)  $\frac{K_p^{1/2} P^2}{4}$  (4)  $\frac{K_p^{1/2} P^2}{16}$ 

25. In a chemical reaction, A + 2B → 2C+D, the initial concentration of B was 1.5 times of the concentration of A, but the equilibrium concentrations of A and B were found to be equal. The equilibrium constant (K) for the aforesaid chemical reaction is : [JEE(Main) 2019, 4/120]

(1) 16 (2) 1 (3) 
$$\frac{1}{4}$$
 (4) 4

**26.** Two solids dissociate as follows

[JEE(Main) 2019, 4/120

 $A(s) \longrightarrow B(g) + C(g)$ ;  $K_{P_1} = x atm^2$ 

$$D(s) = C(g) + E(g)$$
;  $K_{P_2} = yatm^2$ 

The total pressure when both the solids dissociate simultaneously is :

(1)  $\sqrt{x+y}$  atm (2) (x+y) atm (3)  $x^2 + y^2$  atm

(4)  $2(\sqrt{x+y})$  atm

**Answers** 

E

EXERCISE - 1													
SECT	SECTION (A)												
1.	(2)	2.	(1)	3.	(2)	4.	(4)	5.	(1)	6.	(1)	7.	(2)
8.	(2)	9.	(3)	10.	(3)	11.	(1)	12.	(3)	13.	(1)	14.	(4)
15.	(2)	16.	(3)	17.	(3)	18.	(3)	19.	(3)	20.	(4)	21.	(1)
22.	(2)	23.	(3)	24.	(2)	25.	(2)						
SECT	ION (B)												
1.	(1)	2.	(1)	3.	(3)	4.	(3)	5.	(3)	6.	(2)	7.	(1)
8.	(4)	9.	(4)	10.	(2)	11.	(2)	12.	(1)	13.	(3)	14.	(3)
15.	(2)	16.	(1)	17.	(4)	18.	(1)	19.	(3)	20.	(1)	21.	(2)
22.	(3)												
SECT	ION (C)												
1.	(4)	2.	(3)	3.	(2)	4.	(1)	5.	(4)				
SECT	ION (D)												
1.	(4)	2.	(2)	3.	(1)	4.	(1)	5.	(2)	6.	(2)	7.	(2)
8.	(4)	9.	(3)	10.	(1)	11.	(2)	12.	(3)	13.	(1)	14.	(1)
SECT	ION (E)												
1.	(2)	2.	(3)	3.	(2)	4.	(3)	5.	(2)	6.	(1)		
SECT	ION (F)												
1.	(1)	2.	(2)	3.	(1)	4.	(1)	5.	(1)	6.	(1)	7.	(3)
8.	(2)												
SECT	ION (G)												
1.	(4)	2.	(2)	3.	(2)	4.	(3)	5.	(1)	6.	(4)	7.	(1)
8.	(1)	9.	(4)	10.	(1)	11.	(2)	12.	(2)	13.	(4)	14.	(4)
15.	(1)												
SECT	ION (H)												
1.	(3)	2.	(3)	3.	(4)	4.	(2)	5.	(1)				
						EXER	CISE	- 2					

СН	EMIS	TRY F	OR N										
1.	(4)	2.	(3)	3.	(3)	4.	(3)	5.	(2)	6.	(2)	7.	(3)
8.	(1)	9.	(4)	10.	(4)	11.	(2)	12.	(2)	13.	(4)	14.	(1)
15.	(1)	16.	(2)	17.	(1)	18.	(3)	19.	(1)	20.	(1)	21.	(1)
22.	(2)	23.	(2)	24.	(3)	25.	(1)	26.	(2)	27.	(1)	28.	(2)
29.	(1)	30.	(1)	31.	(4)	32.	(2)	33.	(2)	34.	(2)	35.	(2)
36.	(1)	37.	(1)	38.	(2)	39.	(2)	40.	(4)	41.	(3)	42.	(2)
43.	(3)												
						EXER	CISE	- 3					
						P/	ART-I						
1.	(3)	2.	(2)	3.	(3)	4.	(2)	5.	(3)	6.	(4)	7.	(3)
8.	(2)	9.	(2)	10.	(3)	11.	(3)	12.	(2)	13.	(4)	14.	(2)
15.	(3)	16.	(4)	17.	(3)	18.	(3)	19.	(4)	20.	(1)	21.	(2)
22.	(2)	23.	(1)	24.	(2)	25.	(1)	26.	(4)				
						PA	ART-II						
1.	(3)	2.	(1)	3.	(2)	4.	(1)	5.	(3)	6.	(2)	7.	(4)
8.	(2)	9.	(3)	10.	(3)	11.	(4)	12.	(4)	13.	(2)	14.	(1)
15.	(1)	16.	(1)	17.	(2)	18.	(2)	19.	(2)				
						PA	RT-III						
1.	(1)	2.	(4)	3.	(3)	4.	(3)	5.	(2)	6.	(1)	7.	(4)
8.	(4)	9.	(1)	10.	(1)	11.	(1)	12.	(1)	13.	(2)	14.	(4)
15.	(4)	16.	(1)	17.	(2)	18.	(2)	19.	(2)	20.	(3)	21.	(2)
22.	(2)	23.	(4)	24	(1)	25.	(4)	26.	(4)				