CBSE TEST PAPER 02

CLASS XI CHEMISTRY (Equilibrium)

1. State the law of chemical equilibrium. [1]

2. Write the equilibrium constant for the following equation :

aA +bB $\rightleftharpoons$ cC + dD [1]

3. Write the expression for the equilibrium constant for the reaction :

$4NH_3$ (g) + 50_2 (g) $\rightleftharpoons$ 4NO (g) + $6H_2O$ (g) [2]

4. Write the chemical equation for the following chemical constant.

$Kc = \frac{[HI]^2}{[H_2][I_2]}$ [1]

5. When the total number of moles of product and reactants are equal, K has no unit. Give reason. [2]

6. What is the unit of equilibrium for the reaction N_2(g) + $3H_2$(g) $\rightleftharpoons$ $2NH_3$ (g). [2]

7. Give the relation Kp = Kc $(RT)^{\Delta n}$. [2]

8. Write the relationship between Kp and Kc for the following reactions:

(a) PCl_5 $\rightleftharpoons$ PCl_3 (q)+ Cl_2(q)

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

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

(d) $2H_2O$(g) $\rightleftharpoons$ $2H_2O$ (g) +O_2(g) [2]

9. Write the expression for equilibrium constant Kp for the reaction

3Fe (s) + $4H_2O$ (g) $\rightleftharpoons$ Fe_3O_4 (s) + $4H_2$(g) [1]

10. The equilibrium constant for the reaction H_2O + CO $\rightleftharpoons$ H_2 + CO_2

Is 0.44 at 1260k. What will be the value of the equilibrium constant for the reaction : $2H_2$ (g) + 2CO (g) $\rightleftharpoons$ 2CO(g) + $2H_2O$ (g) at 1260 K [1]

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[ANSWERS]

Ans 1. At a given temperature, the product of concentrations of the reaction products raised to the respective stoichiometric coefficient in the balanced chemical equation divided by the product of concentrations of the reactants raised to their individual stoichiometric coefficients has a constant value. This is known as the equilibrium law or law of chemical equilibrium.

Ans 2. The equilibrium constant for a general reaction

aA + bB $\rightleftharpoons$ cC +dD is expressed as $Kc = \frac{[C]^c[D]^d}{[A]^a[B]^b}$

Where [A], [B], [C] and [D] are the equilibrium concentrations of the reactants and products.

Ans 3. The equilibrium constant is given by $Kc = \frac{[NO]^4[H_2O]^6}{[NH_3]^4[O_2]^5}$

Ans 4. The chemical equation is given by H_2 (g) +I_2(g) $\rightleftharpoons$ 2HI(g)

Ans 5. When the total number of moles of products is equal to the total number of moles of reactants the equilibrium constant k has no unit for eg.

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

$$K = \frac{[HI(g)]^2}{[H_2(g)][I_2(g)]}$$

Units of $K = \frac{mol/L \text{ x mol/L}}{mol/L \text{ x mol/L}} = No$ units .

Ans 6. $K = \frac{[NH_3(g)]^2}{[N_2(g)][H_2(g)]^3}$

$$units \text{ of K} = \frac{(mol/L)^2}{(mol/L)(mol/L)^3} = \frac{1}{(mol/L)^2}$$

= $(mol/L)^{-2}$ $= \underline{\underline{L^2 mol^{-2}}}$

Ans 7. Let us consider a reaction

aA +bB $\rightleftharpoons$ cC + dD

$$Kc = \frac{[C]^c[D]^d}{[A]^a[B]^b} \quad ......(i) < Kp = \frac{p_C^{\ c}\ p_D^{\ d}}{p_A^{\ a}\ p_B^{\ b}}$$

Assuming the gaseous components to behave ideally,

Pi Vi = ni RT ...

Or, $pi = \frac{ni}{vi}RT = CiRT = [c]RT....(iv).$

Where [i] is the molar concentration of the species i

Then,

$$Kp = \frac{p_C^{\ c}\, p_D^{\ d}}{p_A^{\ a}\, p_B^{\ b}} = \frac{([c]RT)^c x([D]RT)^d}{([A]RT)^a x([B]RT)^b}$$

$$= \frac{[C]^c[D]^d}{[A]^a[B]^b} x(RT)\left(\overline{c+d} \quad - \quad \overline{a+b}\right)....(v)$$

$$\Delta n = \left(\overline{c+d} \quad - \quad \overline{a+b}\right)$$

$$\therefore \text{ Kp} = \text{Kc } (RT)^{\Delta n}$$

Ans 8. (a) $\Delta n = 1+1-1=1$

$\therefore$ Kp = Kc (RT)' = KcRT

(b) $\Delta n = 2-(3+1) = -2$

$\therefore$ Kp = Kc $(RT)^{-2}$

(c) $\Delta n = 2-(1+1) = 0$

$\therefore$ Kp =Kc$(RT)^0 = Kc$

(d) $\Delta n = (2+1)-2 = 3-2 = 1$

$\therefore$ Kp=Kc$(RT)' = KcRT.$

Ans 9. $Kp = \frac{(PH_2)^4}{(PH_2O)^4} = \frac{PH_2}{PH_2O}.$

Ans 10. The reaction is reversed and also doubled,

$$\therefore \text{ Kc} = \left(\frac{1}{0.44}\right)^2 = \underline{\underline{5.16}}.$$