Question 31. Predict which of the following will have appreciable concentration of reactants and products:

(a) $Cl_2(g) \rightleftharpoons 2Cl(g)$; $K_c = 5 \times 10^{-39}$

(b) $Cl_2(g) + 2NO\ (g) \rightleftharpoons 2NOCl\ (g)$; $K_c = 3.7 \times 10^{8}$

(c) $Cl_2(g) + 2NO_2(g) \rightleftharpoons 2NO_2Cl\ (g)$; $K_c = 1.8$.

Answer: Following conclusions can be drawn from the values of K_c.

(a) Since the value of K_c is very small, this means that the molar concentration of the products is very small as compared to that of the reactants.

(b) Since the value of K_c is quite large, this means that the molar concentration of the products is very large as compared to that of the reactants.

(c) Since the value of K_c is 1.8, this means that both the products and reactants have appreciable concentration.

Question 32. The value of K_c for the reaction $3O_2(g) \rightarrow 2O_3(g)$ is 2.0 x 10^{-50} at 25°C. If equilibrium concentration of O_2 in air at 25°C is 1.6 x 10^{-2}, what is the concentration of O_3?

Answer:

$$3O_2(g) \rightleftharpoons 2O_3(g)$$

$$K_c = \frac{[O_3]^2}{[O_2]^3} \quad \text{or} \quad (2.0 \times 10^{-50}) = \frac{[O_3]^2}{(1.6 \times 10^{-2})^3}$$

or $\quad [O_3]^2 = (2.0 \times 10^{-50}) \times (1.6 \times 10^{-2})^3$

$[O_3]^2 = 8.192 \times 10^{-56}$ or $[O_3] = (8.192 \times 10^{-56})^{1/2} = \mathbf{2.86 \times 10^{-28}\ M}$.

Question 33.

The reaction $CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$ is at equilibrium at 1300 K in a 1L flask. It also contain 0.30 mol of CO, 0.10 mol of H_2 and 0.02 mol of H_2O and an unknown amount of CH_4 in the flask. Determine the concentration of CH_4 in the mixture. The equilibrium constant, K_c for the reaction at the given temperature is 3.90.

Answer:

$$CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$$

According to available data

$$K_c = \frac{[CH_4] \times [H_2O]}{[CO] \times [H_2]^3} \quad \text{or} \quad 3.90 = \frac{[CH_4] \times [0.02]}{[0.30] \times [0.1]^3}$$

$$[CH_4] = \frac{(3.9) \times (0.30) \times (0.001)}{(0.02)} = \mathbf{5.85 \times 10^{-2}\ M}$$

Question 34. What is meant by conjugate acid-base pair? Find the conjugate acid/base for the following species: HNO_2, CH^-, $HClO_4$, OH^-, CO_3^{2-}, S^{2-}

Answer: An acid-base pair which differs by a proton only ($HA \rightarrow A^- + H^+$) is known as conjugate acid-base pair.

Conjugate acid: HCN, H_2O, HCO_3^-, HS^-.

Conjugate base: NO_2^-, ClO_4^-, O_2^-

Question 35. Which of the following are Lewis Acids?

H_2O,BF_3, H^+ and NH^{4+}

Answer: BF_3, H^+ ions are Lewis acids.

Question 36. What will be the conjugate bases for the Bronsted acids? HF, H_2SO_4 and H_2CO_3?

Answer: Conjugate bases: F^-, HSO^-_4 , HCO^-_3.

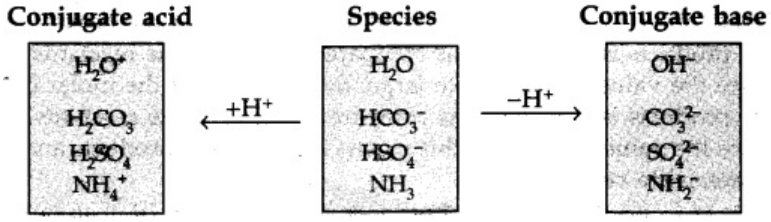
Question 37. Write the conjugate acids for the following Bronsted bases:

NH_2, NH_3 and $HCOO^-$

Answer: NH_3, NH_4^+ and HCOOH

Question 38.The species H_2O, HCO_3^-, HSO_4^- and NH_3 can act both as Bronsted acid and base. For each case, give the corresponding conjugate acid and base.

Answer:



Question 39. Classify the following species into Lewis acids and Lewis bases and show how these can act as Lewis acid/Lewis base?

(a) OH^- ions (b) F^- (c) H^+ (d) BCl_3

Answer:

(a) OH^- ions can demate an electron pair and act as Lewis base.

(b) F^- ions can donate an electron pair and act'as Lewis base.

(c) H^+ ions can accept an electron pair and act as Lewis acid.

(d) BCl_3 can accept an electron pair since Boron atom is electron deficient. It is a Lewis acid.

Question 40. The concentration of hydrogen ions in a sample of soft drink is 3.8×10^{-3} M. What is the pH value?

Answer: $pH = - \log [H^+] = - \log (3.8 \times 10^{-3}) = - \log 3.8 + 3 = 3 - 0.5798 = 2.4202 = 2.42$

********** END **********