II. Short Answer Type Questions

Question 1. The following concentration were obtained for the formation of NH_3 from N_2 and H_2 at equilibrium at 500 K.$[N_2(g)]$ = 1.5 x 10^{-2} M $[H_2(g)]$ = 3.0 x 10^{-2} M $[NH_3]$ = 1.2 x 10^{-2} M. Calculate equilibrium constant.
Answer:

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

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

$$= \frac{[1.2 \times 10^{-2} M]^2}{[1.5 \times 10^{-2} M][3.0 \times 10^{-2} M]^3}$$

$$= \mathbf{3.55 \times 10^{-2}\ M}$$

Question 2. Write the equilibrium constant (K_c) expression for the following reactions.

(i) $Cu^{2+}(aq) + 2\,Ag\,(s) \rightleftharpoons Cu(s) + 2Ag^{+}\,(aq)$

(ii) $4HCl\,(g) + O_2(g) \rightleftharpoons 2Cl_2\,(g) + 2H_2O(g)$

Answer:

(i) $$K_c = \frac{[Ag^{+}(aq)]^2}{[Cu^{2+}(aq)]}$$

(ii) $$K_c = \frac{[Cl_2(g)]^2[H_2O(g)]^2}{[HCl(g)]^4[O_2(g)]}$$

Question 3. Given the equilibrium N_2O_4 (g) → $2NO_2$ (g) K=0.15 atm at 298 K
(a) What is K_p using pressure in torr?
(b) What is K_c using units of moles per litre.

Answer:

(a) $$K_p = \frac{(760\ \text{torr}) \times (0.15\ \text{atm})}{(1\ \text{atm})}$$

$$= \mathbf{1.14 \times 10^2\ torr}$$

(b)

$$K_p = K_c (RT)^{\Delta n}$$

$$K_c = \frac{K_p}{(RT)^{\Delta n}}$$

$$= \frac{(0.15 \text{ atm})}{\left(0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1} \times 298 \text{ K}\right)^{2-1}}$$

$$= \mathbf{6.13 \times 10^{-3} \text{ mol L}^{-1}}$$

Question 4. In the reaction A + B → C + D, what will happen to the equilibrium if concentration of A is increased?
(b) The equilibrium constant for a reaction is 2×10^{23} at 25°C and 2×10^{-2} at 50°C. Is the reaction endothermic or exothermic?
(c) Mention at least three ways by which the concentration of SO_3 can be increased in the following reaction in a state of equilibrium.
Answer:
(a) The reaction will shift in the forward direction.
(b) Endothermic
(c) (i) lowering the temperature
(ii) increasing pressure.
(iii) increasing concentration of oxygen.

Question 5. (i) Define Le Chatelier's principle.
(ii) Following reactions occur in a Blast furnace.
$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$
use Le chatelier's principle to predict the direction of reaction when equilibrium mixture is disturbed by
(a) adding Fe_2O_3
(b) removing CO_2 .
(c) removing CO.
Answer:
(i) When a system under equilibrium is subjected to a change in temperature, pressure or concentration, then the equilibrium shifts in such a direction so as to undo the effect of the change.
(ii) (a) On adding $Fe_2O_3(s)$, the equilibrium will remain unaffected.
(b) By removing CO_2 (g), the equilibrium will be shifted in the forward direction.
(c) By removing CO(g), the equilibrium will be shifted in the backward direction.

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