SOLVED EXAMPLES

1. What is K_c for the following equilibrium when the equilibrium concentration of each substance is; [SO_2 = 0.6M, O_2 = 0.82M, SO_3 = 1.9M?[NCERT: 7.2]

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

ANSWER:
K_c expression for the given equilibrium

$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$$
$$= \frac{(1.9)^2}{(0.6)2 \times 0.82} = 12.23$$

2. At 450K, $K_p = 2.0 \times 10^{10}$ bar^{-1} for the given reaction at equilibrium.

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

What is K_c at this temperature?[NCERT: 7.10]
ANSWER:
For the given equilibrium, $\Delta n_g = 2 - (2 + 1) = -1$
Relation between K_c and K_p is

$$K_p = K_c \times (RT)^{\Delta_{n_g}}$$
$$2.0 \times 10^{10} = K_c \times (0.083 \times 450)^{-1}$$
$$K_c = 2 \times 10^{10} \times 0.083 \times 450 = 7.47 \times 10^{11}$$

3. One mole of H_2O and one mole of CO are taken in 10L vessel and heated to 725K. At equilibrium 40% of water (by mass) reacts with CO according to the equation:[NCERT: 7.14]

$$H_2O\,(g) + CO\,(g) \rightleftharpoons H_2(g) + CO_2(g)$$

Calculate the equilibrium constant for the reaction.
ANSWER:

$$H_2O\,(g) + CO\,(g) \rightleftharpoons H_2(g) + CO_2(g)$$

$$\text{Initially} \Rightarrow n_{H_2O} = 1; \quad n_{CO} = 1$$

As per the reaction 40% of H_2O(0.1 mole) reacts with 40 % of CO(0.1 mole) and forms 40% each of H_2 and CO_2. Therefore, at equilibrium $1 - 0.4 = 0.60$ mole each of H_2O and CO and 0.4 mole each of $H_2$and CO_2 are present

$$\text{Molarity} = \frac{\text{Number of moles}}{\text{Volume in liters}}$$

At Equilibrium $\Rightarrow [H2O] = \frac{0.6}{10}M$; $[CO] = \frac{0.6}{10}M$; $[H2] = \frac{0.4}{10}$ and $[CO2] = \frac{0.4}{10}M$

$$K_c = \frac{[H_2][CO_2]}{[H_2O][CO]}$$

$$K_c = \frac{\frac{0.4}{10} \times \frac{0.4}{10}}{\frac{0.6}{10} \times \frac{0.6}{10}} = \frac{4}{9} = 0.44$$