K_c CALCULATIONS 1

Simplest questions – equilibrium quantities given

1) Calculate K_c for the following equilibrium given the results of an analysis of the equilibrium mixture which show that the concentration of SO_2 = 0.230, O_2 = 1.370, and SO_3 = 0.920 mol dm^{-3}.

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

2) Calculate K_c for the equilibrium below if [A] = 0.0200 mol dm^{-3}, [B_2] = 0.100 mol dm^{-3} and [AB] = 0.400 mol dm^{-3}.

$$2\ A + B_2 \rightleftharpoons 2\ AB$$

3) Some PCl_5 was heated in a sealed container resulting in the following equilibrium. Analysis of the equilibrium mixture showed that it contained 0.00420 moles of PCl_5, 0.0400 moles of PCl_3 and 0.0400 moles of Cl_2. The total volume was 2.00 dm^3. Calculate the concentration of each species at equilibrium and then K_c.

$$PCl_5(g) \rightleftharpoons Cl_2(g) + PCl_3(g)$$

Next step up – you need to find equilibrium quantities first

4) 2.00 moles of PCl_5 vapour are heated to temperature *T* in a vessel of volume 2.0 x 10^1 dm^3. The equilibrium mixture contains 1.20 moles of chlorine. Calculate K_c for the equilibrium at temperature *T*.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

5) When 5.0 moles of A is mixed with 5.0 moles of B in a container of volume 12 dm^3, an equilibrium is established which contains 3.0 moles of C. Find K_c at this temperature.

$$A + 2B \rightleftharpoons 2C$$

6) 200.0 g of ethyl ethanoate and 7.00 g of water were refluxed together. At equilibrium, the mixture contained 0.250 mol of ethanoic acid. Calculate K_c for the hydrolysis of ethyl ethanoate.

$$CH_3COOCH_2CH_3(l) + H_2O(l) \rightleftharpoons CH_3COOH(l) + CH_3CH_2OH(l)$$

Working back from K_c to find equilibrium quantities

7) In the following equilibrium, K_c = 54.1 at a particular temperature. The equilibrium mixture was found to contain H_2 at a concentration of 4.80 x 10^{-4} mol dm^{-3}, and HI at a concentration of 3.53 x 10^{-3} mol dm^{-3}.

$$H_2(g) + I_2(g) \rightleftharpoons 2\ HI(g) \qquad \Delta H > 0$$

a) What is the equilibrium concentration of I_2?

b) What effect would doubling the concentration of hydrogen have on the equilibrium position and K_c?

c) What effect would increasing the temperature have on the equilibrium position and K_c?

8) K_c for the equilibrium below is 0.00360 at temperature *T*. If 1.00 mole of N_2 and 1.00 mole of O_2 are allowed to reach equilibrium, what mass of NO will be present in the mixture (you do **not** need to solve a quadratic equation to answer this)?

$$N_2(g) + O_2(g) \rightleftharpoons 2\ NO(g)$$

Something harder

9) The following equilibrium is established at temperature *T* when 1.00 mol of HI is contained. It is found that 22% of the HI has broken down. Calculate K_c.

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

10) When 1.00 moles of steam and 1.00 moles of carbon monoxide were allowed to reach equilibrium, 33.3% of the equilibrium volume is hydrogen. Calculate K_c at this temperature (you will need to think **very** carefully about equilibrium quantities).

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

11) K_c for the equilibrium below is 10.0 at temperature *T*. If 1.0 mole of the ester is mixed with 5.0 moles of water and the mixture allowed to reach equilibrium, how many moles of each species will be present at equilibrium (you will need to solve a quadratic equation to answer this)?

$$HCOOCH_3(g) + H_2O(g) \rightleftharpoons HCOOH(g) + CH_3OH(g)$$