Equilibrium Questions - K_{eq}

1) One mole of very cold, colorless $N_2O_{4\,(g)}$ is placed into a 1.0L glass container of room temperature. The reaction:

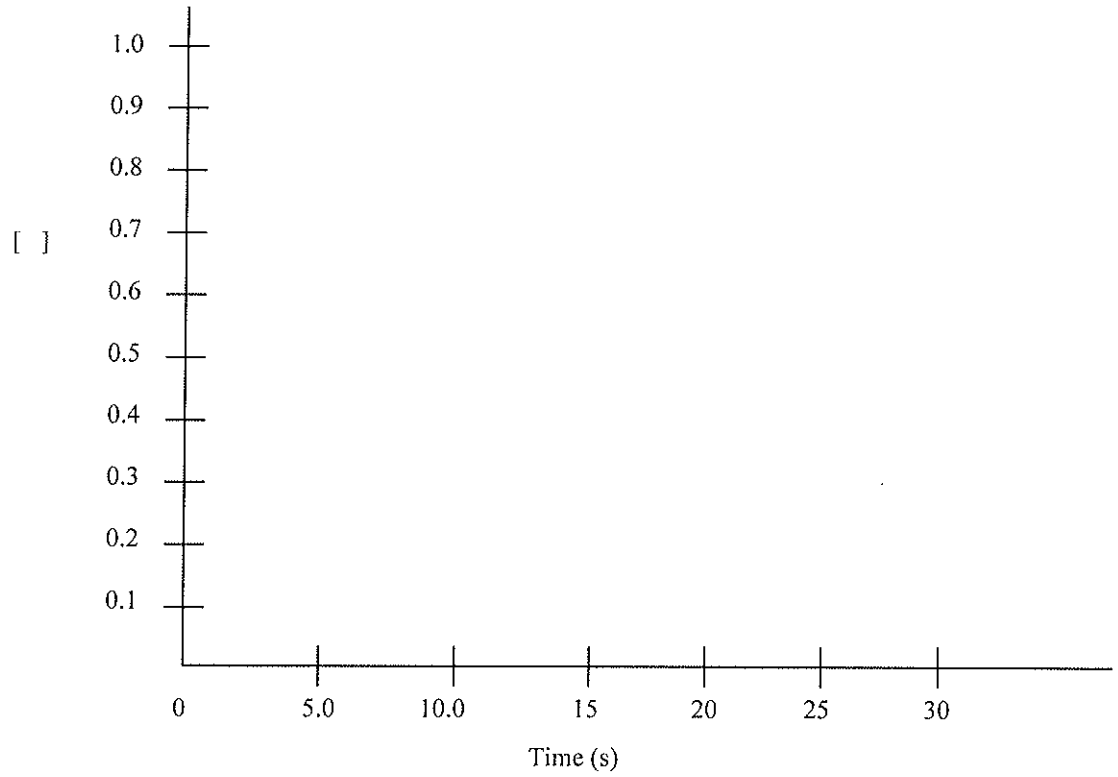
$$N_2O_{4\,(g)} \Leftrightarrow 2\ NO_{2\,(g)} \qquad \Delta H = +58KJ$$

(colorless) (brown)

proceeds to equilibrium. The concentration of each gas is measured as a function of time.

Time (s)	0	5	10	15	20	25
$[N_2O_4]$ (M)	1.0	0.83	0.81	0.80	0.80	0.80
$[NO_2]$ (M)	0.0	0.34	0.38	0.40	0.40	0.40

a) Plot concentration of N_2O_4 and NO_2 against time on the same graph below.



b) After what time interval has equilibrium been established? _____

c) Describe the change in the appearance of the container over 25 seconds (describe the colour change and when it becomes constant).

d) Calculate the rate of NO_2 production in (M/s) over the first 5s period and then the second 5s period.

0-5 sec. rate = _____M/s

5-10 sec. rate = _____M/s

e) How does the rate of formation of NO_2 compare to the rate of consumption of N_2O_4? Remember, if you measure the reactants or products, it is still the overall rate.

f) What are the equilibrium concentrations of N_2O_4 and NO_2?

$[N_2O_4]$= _____M Are they equal? _____!

$[NO_2]$ = _____M

g) Is the reaction over, when equilibrium has been achieved? If not, explain.

h) What are the necessary conditions to establish equilibrium?

i) What are the characteristics of an equilibrium?

2) $SO_{3\,(g)} + H_2O_{\,(g)} \Leftrightarrow H_2SO_{4\,(l)}$
At equilibrium $[SO_3] = 0.400M$ $[H_2O] = 0.480M$ $[H_2SO_4] = 0.600M$
Calculate the value of the equilibrium constant.

3) At equilibrium at 100°C, a 2.0L flask contains:
0.075 mol of PCl_5 0.050 mol of H_2O 0.750 mol 0f HCl 0.500 mol of $POCl_3$
Calculate the K_{eq} for the reaction:

$$PCl_5\,(s) + H_2O\,(g) \Leftrightarrow 2\,HCl\,(g) + POCl_3\,(g)$$

4) $K_{eq} = 798$ at 25°C for the reaction: $2\,SO_{2\,(g)} + O_{2\,(g)} \Leftrightarrow 2\,SO_{3\,(g)}$
In a particular mixture at equilibrium, $[SO_2] = 4.20$ M and $[SO_3] = 11.0$ M. Calculate the equilibrium $[O_2]$ in this mixture at 25°C.

5) Consider the following equilibrium:

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

0.600 moles of SO_2 and 0.600 moles of O_2 are present in a 4.00 L flask at equilibrium at 100°C. If the $K_{eq} = 680$, calculate the SO_3 concentration at 100°C.

6) $2\ SO_{3\,(g)} \Leftrightarrow 2\ SO_{2\,(g)} + O_{2\,(g)}$
4.00 moles of SO_2 and 5.00 moles O_2 are present in a 2.00 L container at 100°C and are at equilibrium. Calculate the equilibrium concentration of SO_3 and the number of moles SO_3 present if the $K_{eq} = 1.47 \times 10^{-3}$.

7) Consider the following equilibrium: $2\ SO_{2\,(g)} + O_{2\,(g)} \Leftrightarrow 2\ SO_{3\,(g)}$
When a 0.600 moles of SO_2 and 0.600 moles of O_2 are placed into a 2.00 litre container and allowed to reach equilibrium, the equilibrium $[SO_3]$ is to be 0.250 M. Calculate the K_{eq} value.

8) $H_{2\,(g)} + S_{(s)} \Leftrightarrow H_2S_{(g)}$ $\quad K_{eq} = 14$
0.60 moles of H_2 and 1.4 moles of S are placed into a 2.0L flask and allowed to reach equilibrium. Calculate the $[H_2]$ at equilibrium.

9) K_{eq} = 0.0183 for the reaction:

$$2\ HI_{(g)} \Leftrightarrow H_{2\,(g)} + I_{2\,(g)}$$

If 3.0 moles of HI are placed in a 5.00L vessel and allowed to reach equilibrium, what is the equilibrium concentration of H_2?

10) Consider the equilibrium: $2\ ICl_{(g)} \Leftrightarrow I_{2\,(g)} + Cl_{2\,(g)}$ K_{eq} = 10.0

If x moles of ICl were placed in a 5.0 L container at 10°C and if an equilibrium concentration of I_2 was found to be 0.60 M, calculate the number of moles ICl initially present.

11) A student places 2.00 moles SO_3 in a 1.00 L flask. At equilibrium $[O_2]$ = 0.10 M at 130°C. Calculate the K_{eq}.

$$2\ SO_{2\,(g)} + O_{2\,(g)} \Leftrightarrow 2\ SO_{3\,(g)}$$