1.

$$SO_2(g) + NO_2(g) \rightleftharpoons SO_3(g) + NO(g) \quad K_{400} = 23{,}817$$

10 mol of $SO_2(g)$ and 10 mol of $NO_2(g)$ are added to a 2.0 L rigid container. What is the partial pressure of $SO_2(g)$ (in bar) when the system reaches equilibrium at 400 K?

2.

$$Fe_2O_3(s) + 3\,H_2(g) \rightleftharpoons 2\,Fe(s) + 3\,H_2O(l) \quad K_{298} = 3.926 \times 10^{-6}$$

$Fe_2O_3(s)$ (MW = 159.69 $\frac{g}{mol}$) and hydrogen gas are added to an empty vessel of volume 5 L. The initial pressure of $H_2(g)$ is 80 bar. What is the equilibrium pressure of $H_2(g)$ and what mass of $Fe_2O_3(s)$ is required to reach equilibrium at 298 K? Consider the volume of solids and liquids to be negligible.

3.

$$Fe_2O_3(s) + 3\,H_2(g) \rightleftharpoons 2\,Fe(s) + 3\,H_2O(l) \quad K_{298} = 3.926 \times 10^{-6}$$

(a) Solid Fe(s) is added to a system at equilibrium and equilibrium is re-established at the same temperature. Which quantities are unchanged?

☐ $P_{H_2}$ ☐ mass of Fe(s) ☐ volume of $H_2O(l)$ ☐ $\Delta G_T$ ☐ $\Delta G_{\text{toeq}}$

The system is at equilibrium (EQ1), and the vessel expands at constant temperature. Immediately after expansion:

(b) ☐ $\Delta G_{\text{toeq}} < 0$ ☐ $\Delta G_{\text{toeq}} = 0$ ☐ $\Delta G_{\text{toeq}} > 0$

(c) ☐ $Q < K$ ☐ $Q = K$ ☐ $Q > K$

(d) ☐ $K$ decreases ☐ $K$ does not change ☐ $K$ increases

A new equilibrium (EQ2) is established at the new volume. Write $<, >, =$, or $X$.

(e) Mass Fe(s) @ EQ1 _____ Mass Fe(s) @ EQ2

(f) Activity of $H_2O(l)$ @ EQ1 _____ Activity of $H_2O(l)$ @ EQ2

(g) Mols $H_2(g)$ @ EQ1 _____ Mols $H_2(g)$ @ EQ2

(h) $P_{H_2}$ @ EQ1 _____ $P_{H_2}$ @ EQ2

4. For both EQ1 → EQ2 and EQ2 → EQ3, answer the following questions

$$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g) \quad \Delta H^\circ_{\text{rxn}} < 0$$

(a) What type of disturbance is introduced?

(b) $K_c$

(c) $Q_c$

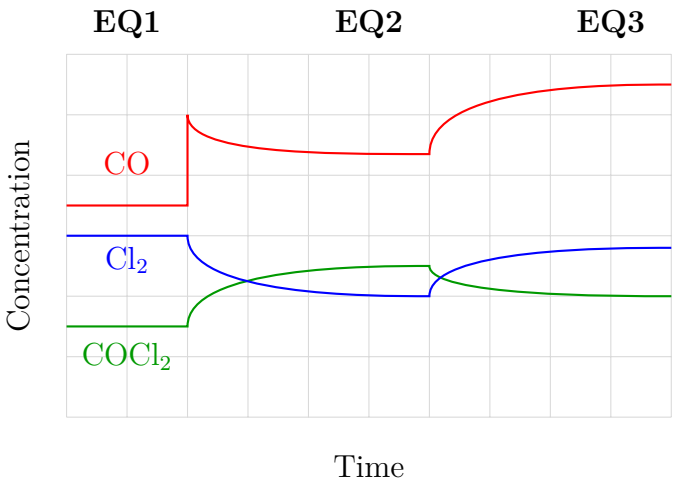
(d) $\Delta G_{\text{to eq}}$

(e) Moles of CO

(f) $P_{CO}$

(g) Moles of $Cl_2$

(h) Moles of $COCl_2$



**Homework Problem 25**

1. A sample of solid $NH_4Cl(s)$ is placed in an empty flask at 298 K. The flask is heated to 750 K, and equilibrium is established. You observe that the mass of $NH_4Cl(s)$ has decreased. What are the equilibrium partial pressures of $NH_3(g)$ and $HCl(g)$?

$$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$$

| | $\Delta H_f^\circ$ $(\frac{\text{kJ}}{\text{mol}})$ | $\Delta S_m^\circ$ $(\frac{\text{J}}{\text{mol}\cdot\text{K}})$ |
|---|---|---|
| $NH_4Cl(s)$ | -314.43 | 94.6 |
| $HCl(g)$ | -167.16 | 56.5 |
| $NH_3(g)$ | -46.11 | 192.45 |