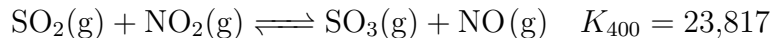


1.



10 mol of $\text{SO}_2(\text{g})$ and 10 mol of $\text{NO}_2(\text{g})$ are added to a 2.0 L rigid container. What is the partial pressure of $\text{SO}_2(\text{g})$ (in bar) when the system reaches equilibrium at 400 K?

$$P_i = \frac{nRT}{V}$$

$$= \frac{(10 \text{ mol})(0.08314 \frac{\text{L}\cdot\text{bar}}{\text{mol}\cdot\text{K}})(400 \text{ K})}{2.0 \text{ L}}$$

$$= 166.28 \text{ bar}$$

$$K = \frac{x^2}{(166.28 - x)^2} = 23817$$

$$154.3 = \frac{x}{166.28 - x}$$

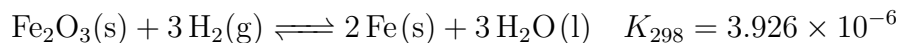
$$x = 154.3(166.28 - x)$$

$$x = 165.2 \text{ bar}$$

	SO_2	NO_2	SO_3	NO
I	166.28	166.28	0	0
C	$-x$	$-x$	$+x$	$+x$
E	$166.28 - x$	$166.28 - x$	x	x

$$P_{\text{SO}_2, \text{eq}} = 166.28 - x = \boxed{1.1 \text{ bar}}$$

2.



$\text{Fe}_2\text{O}_3(\text{s})$ (MW = $159.69 \frac{\text{g}}{\text{mol}}$) and hydrogen gas are added to an empty vessel of volume 5 L. The initial pressure of $\text{H}_2(\text{g})$ is 80 bar. What is the equilibrium pressure of $\text{H}_2(\text{g})$ and what mass of $\text{Fe}_2\text{O}_3(\text{s})$ is required to reach equilibrium at 298 K? Consider the volume of solids and liquids to be negligible.

$$P_i = 80 \text{ bar}$$

	3 H_2
I	80
C	$-3x$
E	$80 - 3x$

$$K = \frac{1}{(P_{\text{H}_2})^3} = 3.926 \times 10^{-6}$$

$$(80 - 3x)^3 = \frac{1}{3.926 \times 10^{-6}}$$

$$80 - 3x = \left(\frac{1}{3.926 \times 10^{-6}} \right)^{1/3}$$

$$3x = 16.4 \implies x = 5.47 \text{ bar}$$

$$P_{\text{H}_2, \text{eq}} = 80 - 3x$$

$$= \boxed{63.6 \text{ bar}}$$

$$n_{\text{H}_2, \text{consumed}} = \frac{PV}{RT}$$

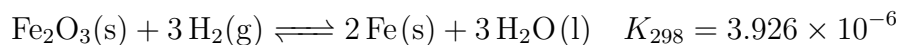
$$= \frac{3 \cdot 5.47 \text{ bar} \cdot 5 \text{ L}}{0.08314 \frac{\text{L}\cdot\text{bar}}{\text{mol}\cdot\text{K}} \cdot 298 \text{ K}}$$

$$= 3.35 \text{ mol H}_2$$

$$n_{\text{Fe}_2\text{O}_3} = 3.35 \text{ mol H}_2 \times \frac{1 \text{ mol Fe}_2\text{O}_3}{3 \text{ mol H}_2} \times \frac{159.69 \text{ g}}{1 \text{ mol}}$$

$$= \boxed{178 \text{ g Fe}_2\text{O}_3}$$

3.



(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 $\text{H}_2\text{O}(\text{l})$ ΔG_T ΔG_{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 $\text{H}_2\text{O}(\text{l})$ @ EQ1 = Activity of $\text{H}_2\text{O}(\text{l})$ @ EQ2

(g) Mols $\text{H}_2(\text{g})$ @ EQ1 < Mols $\text{H}_2(\text{g})$ @ EQ2

(h) P_{H_2} @ EQ1 = P_{H_2} @ EQ2

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

(a) What type of disturbance is introduced?

Add CO, Increase temperature

(b) K_c =, \downarrow

(c) Q_c =, \downarrow

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

(e) Moles of CO

\uparrow , \uparrow

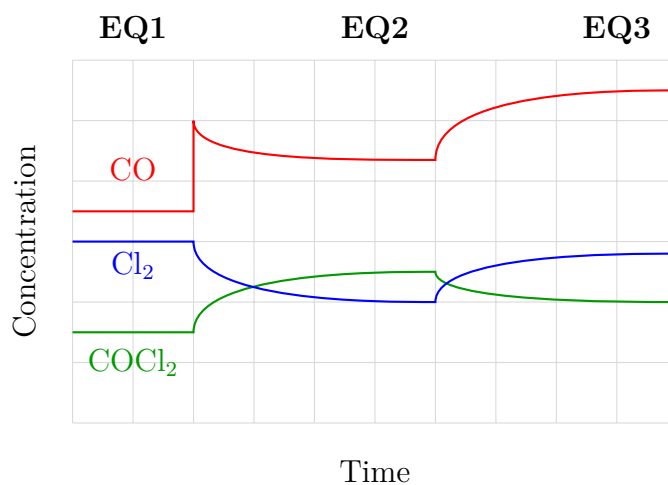
(f) P_{CO} \uparrow , \uparrow

(g) Moles of Cl_2

\downarrow , \uparrow

(h) Moles of COCl_2

\uparrow , \downarrow



Homework Problem 25

1. A sample of solid $\text{NH}_4\text{Cl}(\text{s})$ 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 $\text{NH}_4\text{Cl}(\text{s})$ has decreased. What are the equilibrium partial pressures of $\text{NH}_3(\text{g})$ and $\text{HCl}(\text{g})$?



	$\Delta H_f^\circ \left(\frac{\text{kJ}}{\text{mol}} \right)$	$\Delta S_m^\circ \left(\frac{\text{J}}{\text{mol}\cdot\text{K}} \right)$
$\text{NH}_4\text{Cl}(\text{s})$	-314.43	94.6
$\text{HCl}(\text{g})$	-167.16	56.5
$\text{NH}_3(\text{g})$	-46.11	192.45