53. At a particular temperature, $K = 2.0 \times 10^{-6}$ for the reaction

$$2CO_2(g) \rightleftharpoons 2CO(g) + O_2(g)$$

If 2.0 mol CO_2 is initially placed into a 5.0-L vessel, calculate the equilibrium concentrations of all species.

55. At 25°C, $K_p = 2.9 \times 10^{-3}$ for the reaction

$$NH_4OCONH_2(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$$

In an experiment carried out at 25°C, a certain amount of NH_4OCONH_2 is placed in an evacuated rigid container and allowed to come to equilibrium. Calculate the total pressure in the container at equilibrium.

75. Suppose $K = 4.5 \times 10^{-3}$ at a certain temperature for the reaction

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

If it is found that the concentration of PCl_5 is twice the concentration of PCl_3, what must be the concentration of Cl_2 under these conditions?

76. For the reaction below, $K_p = 1.16$ at 800.°C.

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

If a 20.0-g sample of $CaCO_3$ is put into a 10.0-L container and heated to 800.°C, what percentage by mass of the $CaCO_3$ will react to reach equilibrium?

77. A 2.4156-g sample of PCl_5 was placed in an empty 2.000-L flask and allowed to decompose to PCl_3 and Cl_2 at 250.0°C:

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

At equilibrium the total pressure inside the flask was observed to be 358.7 torr. Calculate the partial pressure of each gas at equilibrium and the value of K_p at 250.0°C.

86. A sample of iron(II) sulfate was heated in an evacuated container to 920 K, where the following reactions occurred:

$$2FeSO_4(s) \rightleftharpoons Fe_2O_3(s) + SO_3(g) + SO_2(g)$$
$$SO_3(g) \rightleftharpoons SO_2(g) + \tfrac{1}{2}O_2(g)$$

After equilibrium was reached, the total pressure was 0.836 atm and the partial pressure of oxygen was 0.0275 atm. Calculate K_p for each of these reactions.

55. $NH_4OCONH_{2\,(s)} \rightleftharpoons 2NH_{3\,(g)} + CO_{2\,(g)}$

		$2NH_3$	CO_2
I		0	0
C		+2x	+x
E		2x	x

$K_p = (P_{NH_3})^2(P_{CO_2})$

$2.9 \times 10^{-3} = (2x)^2(x)$

$2.9 \times 10^{-3} = 4x^3$

$x = .090$ atm

$P_T = 2(.090) + (.090)$

$= \boxed{.27 \text{ atm}}$

53. $2CO_{2\,(g)} \rightleftharpoons 2CO_{(g)} + O_{2\,(g)}$

		$2CO$	O_2
I	.40	0	0
C	−2x	+2x	+x
E	.40 − 2x	2x	x

$2.0 \times 10^{-6} = \dfrac{(2x)^2(x)}{(.40-2x)^2}$ used 5% Rule

$x = .0043$

$[CO_2] = .39M \quad [CO] = .0086M \quad [O_2] = .0043M$

75. $PCl_{5\,(g)} \rightleftharpoons PCl_3 + Cl_2$

E	2x	x	x

$4.5 \times 10^{-3} = \dfrac{x^2}{2x}$

$2(4.5 \times 10^{-3}) = \dfrac{x^2}{x} = x$

$\boxed{9.0 \times 10^{-3} = [Cl_2]}$

(76) $CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$

$K_p = P_{CO_2} = 1.16 \text{ atm}$

$PV = nRT$

$n = \frac{PV}{RT} = \frac{(1.16)(10.0)}{(.08206)(1073)} = .132 \text{ mol } CO_2$

$\frac{.132 \text{ mol } CO_2}{1} \times \frac{1 \text{ mol } CaCO_3}{1 \text{ mol } CO_2} \times \frac{100.09 \text{ g}}{1 \text{ mol } CaCO_3} = 13.2 \text{ g } CaCO_3$

$\frac{13.2}{20.0} \times 100 = \boxed{66.0\%}$

(77) $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$

I	.2489	0	0
C	$-x$	$+x$	$+x$
E	$.2489 - x$	x	x

$\frac{2.4156 \text{ g } PCl_5}{1} \times \frac{1 \text{ mol } PCl_5}{208.22 \text{ g } PCl_5} = .011691 \text{ mol } PCl_5$

$P = \frac{nRT}{V} = \frac{(.011691)(.08206)(523)}{2.000} = .2489 \text{ atm}$

$P_T = 358.7 \text{ torr} = .4720 \text{ atm}$

$.4720 = .2489 - x + x + x$

$.4720 = .2489 + x$

$x = .2231 \text{ atm}$

$P_{PCl_3} = .2231 \text{ atm}$

$P_{Cl_2} = .2231 \text{ atm}$

$P_{PCl_5} = .0258 \text{ atm}$

(86)

$2\,FeSO_{4(s)} \rightleftharpoons Fe_2O_{3(s)} + SO_{3(g)} + SO_{2(g)}$

1 mol : 1 mol

$K_p = (P_{SO_3})(P_{SO_2})$ $\quad P_{SO_3} = P_{SO_2}$

$SO_{3(g)} \rightleftharpoons SO_{2(g)} + \frac{1}{2}O_{2(g)}$

$K_p = \dfrac{(P_{SO_2})(P_{O_2})^{1/2}}{(P_{SO_3})}$

$P_T = .836\ atm = P_0 - x + P_0 + x + \frac{x}{2} = 2P_0 + \frac{x}{2}$

$.836 = 2P_0 + \frac{x}{2}$

$.836 - .0275 = 2P_0$

$P_0 = .404\ atm$

	SO_3	$\rightleftharpoons$ SO_2	$+ \frac{1}{2}O_2$
I →	P_0	P_0	0
C	$P - x$	$P + x$	$+\frac{x}{2}$
E	$P_0 - x$	$P_0 + x$	$\frac{x}{2}$

$.0275 = \frac{x}{2}$

$x = .0550\ atm$

Rxn 1: $K_p = (.404)(.404)$

$K_p = .163$

Rxn 2: $K_p = \dfrac{(.459)(.0275)^{1/2}}{.349}$

$K_p = .218$