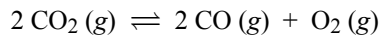


1. At a particular temperature,  $K_c = 2.0 \times 10^{-6}$  for the reaction



If 2.0 mol  $\text{CO}_2$  is initially placed into a 5.0 L vessel, calculate the equilibrium concentrations of all species.

	$2 \text{CO}_2(\text{g}) \rightleftharpoons 2 \text{CO}(\text{g}) + \text{O}_2(\text{g})$		
Initial (M)	0.40	0	0
Change (M)	$-2x$	$+2x$	$+x$
Equil (M)	$0.40 - 2x$	$2x$	$x$

$$K_c = \frac{[\text{CO}]^2[\text{O}_2]}{[\text{CO}_2]^2}$$

$$2.0 \times 10^{-6} = \frac{[2x]^2[x]}{[0.40 - 2x]^2}$$

Because the value of  $K_c$  is very small, very little reactant goes to product. We assume that  $0.40 - 2x \approx 0.40$ .

$$2.0 \times 10^{-6} = \frac{[2x]^2[x]}{[0.40]^2}$$

$$3.2 \times 10^{-7} = 4x^3$$

$$x^3 = 8.0 \times 10^{-8}$$

$$x = 4.3 \times 10^{-3} \text{ M}$$

$$[\text{O}_2] = x = 4.3 \times 10^{-3} \text{ M}$$

$$[\text{CO}] = 2x = 8.6 \times 10^{-3} \text{ M}$$

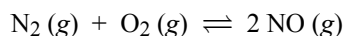
$$[\text{CO}_2] = 0.40 - 2x = 0.39 \text{ M}$$

Checking the assumption:

$$\frac{2x}{0.40} \times 100 = \frac{8.6 \times 10^{-3}}{0.40} \times 100 = 2.2\% < 5\%$$

The assumption was valid.

2. At 2200°C,  $K_p = 0.050$  for the reaction



What is the partial pressure of NO in equilibrium with  $\text{N}_2$  and  $\text{O}_2$  that was placed in a flask at initial pressures of 0.80 and 0.20 atm, respectively?

	$\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2 \text{NO}(\text{g})$		
Initial (pressure)	0.80	0.20	0
Change (pressure)	$-x$	$-x$	$+2x$
Equil (pressure)	$0.80 - x$	$0.20 - x$	$2x$

$$K_p = \frac{P_{\text{NO}}^2}{P_{\text{N}_2} P_{\text{O}_2}}$$

$$0.050 = \frac{(2x)^2}{(0.80 - x)(0.20 - x)}$$

$$0.050 = \frac{4x^2}{0.16 - x + x^2}$$

$$0.0080 - 0.050x + 0.050x^2 = 4x^2$$

$$3.95x^2 + 0.050x - 0.0080 = 0$$

A quadratic equation of the form  $ax^2 + bx + c = 0$ , has the solutions:  $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$$x = \frac{-0.050 \pm \sqrt{(0.050)^2 - 4(3.95)(-0.0080)}}{2(3.95)}$$

$$x = \frac{-0.050 \pm \sqrt{0.1289}}{7.90}$$

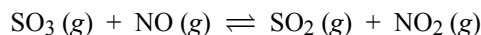
$$x = \frac{-0.050 \pm 0.359}{7.90}$$

$$x = 0.039 \text{ atm or } x = -0.052 \text{ atm}$$

The correct answer for  $x$  is 0.039 atm because you cannot have a negative pressure.

$$P_{\text{NO}} = 2x = \mathbf{0.078 \text{ atm}}$$

3. A 1.00 L flask was filled with 2.00 mol  $\text{SO}_2$  (g) and 2.00 mol  $\text{NO}_2$  (g) and heated. After equilibrium was reached, it was found that 1.30 mol  $\text{NO}$  (g) was present. Assume that the reaction



occurs under these conditions. Calculate the value of the equilibrium constant,  $K_c$ , for the above reaction.

	$\text{SO}_3 \text{ (g)}$	+	$\text{NO (g)}$	$\rightleftharpoons$	$\text{SO}_2 \text{ (g)}$	+	$\text{NO}_2 \text{ (g)}$
Initial (M)	2.00		2.00		0		0
Change (M)	-x		-x		+x		+x
Equil (M)	2.00 - x		2.00 - x		x		x

$$K_c = \frac{[\text{SO}_2][\text{NO}_2]}{[\text{SO}_3][\text{NO}]}$$

$$K_c = \frac{x^2}{(2.00 - x)^2}$$

Since the problem asks you to solve for  $K_c$ , it must indicate in the problem what the value of  $x$  is. The concentration of  $\text{NO}$  at equilibrium is given to be 1.30 M. In the table above, we have the concentration of  $\text{NO}$  set equal to  $2.00 - x$ .

$$2.00 - x = 1.30$$

$$x = 0.70$$

Substituting back into the equilibrium constant expression:

$$K_c = \frac{x^2}{(2.00 - x)^2}$$

$$K_c = \frac{(0.70)^2}{(2.00 - 0.70)^2}$$

$$\mathbf{K_c = 0.290}$$