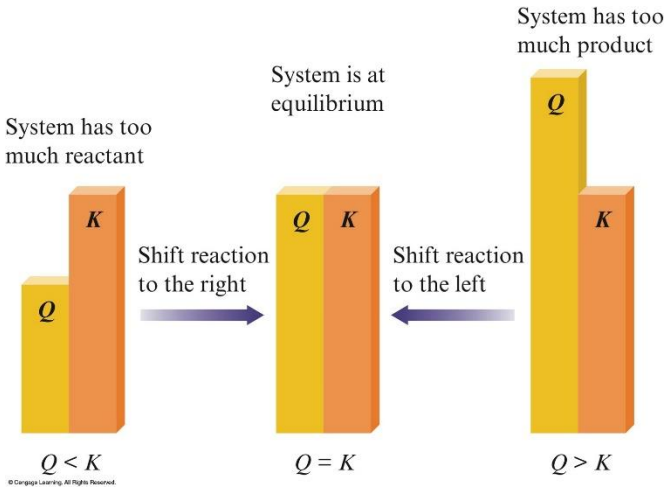
Using ICE Charts to Calculate Equilibrium Quantities and Constants

Solving Equilibrium Problems

1) Write the balanced equation for the reaction.
2) Write the equilibrium expression using the law of mass action.
3) List the initial concentrations.
4) Calculate *Q*, and determine the direction of the shift to equilibrium.
5) Define the change needed to reach equilibrium, and define the equilibrium concentrations by applying the change to the initial concentrations.
6) Substitute the equilibrium concentrations into the equilibrium expression, and solve for the unknown.
7) Check your calculated equilibrium concentrations by making sure they give the correct value of *K*.



Initial

Change

Equilibrium

Example 1. 0.500 mol SO_2 and 0.300 mol O_2 are placed into an evacuated 5.0 L vessel at 398 K. Once equilibrium is established, 0.100 mol of SO_3 are in the vessel.

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

a) What are the equilibrium concentrations of SO_2 and O_2?

b) What is the value of Kc at 398 K?

c) What is the value of Kp at 398 K?

Example 2. A reaction starts with 5.00 mol each of $SbCl_3$ and Cl_2 in a 2.00 L flask at 350 °C. When equilibrium is established at 350 °C, the moles of $SbCl_5$ present are 1.67 mol. What is the K_c for this rxn?

$$SbCl_{3\,(g)} + Cl_{2\,(g)} \leftrightarrow SbCl_{5\,(g)}$$

Example 3. $H_2(g)$, $I_2(g)$, and HI(g) are placed into a 5.25 L container at 698 K. The initial partial pressure of $H_2(g)$ is 3.27 atm, I_2 is 3.27 atm and HI is 32.7 atm. The Kc value of the reaction is 54.3 at 698 K.

$$H_2(g) + I_2(g) \leftrightarrow 2\,HI(g)$$

a) What is the value of Kp at 698K?

b) What is the equilibrium partial pressure of each gas in the reaction vessel?

Example 4. 0.100 moles of each reactant and product species are placed into a 5.00 L flask, equilibrium is established in the following reaction at 600 K:

$$CO_{(g)} + H_2O_{(g)} \leftrightarrow CO_{2(g)} + H_{2(g)} \qquad K_c = 23.2 \text{ at } 600K$$

a) What is the equilibrium concentration of H_2?

b) Once equilibrium has been established, 0.0150 moles of both $CO_2(g)$ and $H_2(g)$ are added to the reaction vessel.

   (i) How will the concentration of CO(g) change in response to this addition? Explain your reasoning.

   (ii) Calculate the concentration of CO(g) once equilibrium has been reestablished after this addition.