# EQUILIBRIUM

This worksheet should help you identify how we can use equilibrium to understand chemical reactions. It is intended for you to work through it in order. *(Don't skip ahead.)* The double headed arrow (⇌) indicates equilibrium.

**Consider three different chemical reactions that involve $CO_2$:**

**A. $4\ COF_{2\ (g)} \rightleftharpoons 2\ CO_{2\ (g)} + 2\ CF_{4\ (g)}$** **$K_c = 4.4 \times 10^{-6}$**

**B. $CO_{2\ (g)} + C_{(s)} \rightleftharpoons 2\ CO_{(g)}$** **$K_c = 1.9$**

**C. $CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2\ (g)} + H_{2\ (g)}$** **$K_c = ???$**

Write out the equilibrium expression for the three reactions, so that each produces 1 mole of $CO_2$.

*USE THESE EQUILIBRIUM EXPERSSIONS FOR THE REST OF THE WORKSHEET*

What is the equilibrium constant of **Reaction C** if the equilibrium concentrations are:

$[CO] = 0.011\ M$ $[H_2O] = 0.011\ M$ $[CO_2] = 0.109\ M$ $[H_2] = 0.109\ M$

What is the value of $K_p$ for each reaction (25 °C)?

What is the value of $\Delta G°_{rxn}$ for each reaction (25 °C)?

Which reaction is the most spontaneous at 25 °C? Why?

Consider **Reaction B**: The initial concentrations are [$CO_2$] = 0.00 M, [CO] = 0.215 M, and 10.4 g C. The equilibrium concentration of [CO] = 0.180 M. What is the equilibrium concentration of $CO_2$?

Consider **Reaction A**: When 1.12 mole of $COF_2$ is placed in a 2.00 L container, what is the concentration of $CO_2$ at equilibrium?

Assuming all three reactions have been optimized to have the same theoretical yield of $CO_2$, which reaction will produce the most $CO_2$ before it reaches equilibrium? Why? Is this consistent with your $\Delta G°_{rxn}$ values?

At some point in each reaction, Q is found to be 0.741. What direction would each reaction proceed to reach equilibrium?

When each reaction is at equilibrium, CO(g) is added to the mixture. How will each reaction respond?