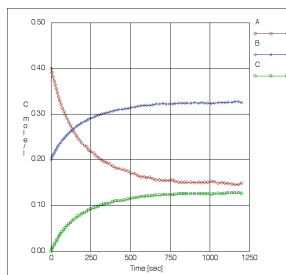
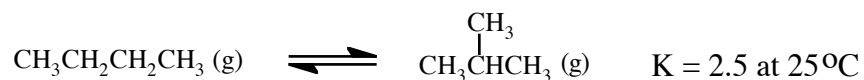


Chemistry 106
Fundamental Chemistry II



Equilibrium Calculation
Practice Problems

- 1) A petroleum "cracking" reaction is the conversion of pentane gas into propane gas and ethene gas. Starting with just pentane, when the reaction reaches equilibrium at 500 °C, the partial pressures of each gas in a sealed container are 2.00 atm for pentane and 5.29 atm for each product. Calculate the value of K_{eq} . Calculate the value of Q if a mixture of gases has $P_{pentane} = 0.50$ atm , $P_{propane} = 4.50$ atm and $P_{ethene} = 2.00$ atm. Which direction will the reaction go from those conditions? Calculate all equilibrium pressures.
- 2) The equilibrium constant for the solubility reaction of calcium carbonate is 8.7×10^{-9} at 25°C. Calculate the equilibrium concentrations of the calcium and carbonate ions at 25°C.
- 3) The equilibrium constant for the solubility reaction of iron (III) hydroxide is 2.0×10^{-39} at 25°C. Calculate the equilibrium concentration of the iron(III) ion in water where $[OH^-] = 1.0 \times 10^{-7}$ M at 25°C.
- 4) The equilibrium constant for the solubility reaction of lead fluoride is 3.7×10^{-8} at 25 °C. Calculate the equilibrium concentrations of the Pb^{+2} and F^- ions at 25°C.
- 5) The two isomers butane and 2-methylpropane can equilibrate according to the following equation:



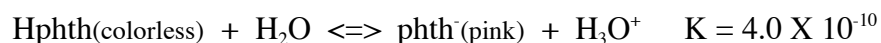
If butane is put in a container at a partial pressure of 1860 mm Hg at 25 °C with a catalyst and allowed to equilibrate by this reaction, what will be the equilibrium partial pressures of the two gases?

- 6) A solution is prepared by dissolving 5.6×10^{-4} moles of bromocresol green indicator in 1 L of water. The indicator reacts with water according to the following chemical equation:



Set up an equilibrium table and calculate $[\text{Hbg}]$, $[\text{OH}^-]$ and $[\text{bg}^-]$ when the solution reaches equilibrium.

- 7) A solution is prepared by dissolving 1.6×10^{-3} moles of phenolphthalein indicator in 1 L of water plus ethanol. The indicator reacts with the water according to the following chemical equation:



Set up an equilibrium table and calculate $[\text{Hphth}]$, $[\text{H}_3\text{O}^+]$ and $[\text{phth}^-]$ when the solution reaches equilibrium.

- 8) A reaction with $\Delta H^\circ = -64.0 \text{ kJ/mole}$ has $K = 1.00 \times 10^{-8}$ at 25.0°C . What would be the value of K at 0.00°C ?
- 9) A reaction with $\Delta H^\circ = 618.0 \text{ kJ/mole}$ has $K = 1.00 \times 10^{-60}$ at 25.0°C . What would be the value of K at 500.0°C ?

ANSWERS

- 1) $K_{\text{eq}} = 14.0$; $Q = 18.0$; reaction will go to form more pentane (shift towards reactants) at equilibrium here: $P_{\text{pentane}} = 0.60 \text{ atm}$, $P_{\text{propane}} = 4.40 \text{ atm}$ and $P_{\text{ethene}} = 1.90 \text{ atm}$
- 2) $[\text{Ca}^{+2}] = [\text{CO}_3^{-2}] = 9.3 \times 10^{-5} \text{ M}$ 3) $[\text{Fe}^{+3}] = 2.0 \times 10^{-18} \text{ M}$
- 4) $[\text{Pb}^{+2}] = 2.1 \times 10^{-3} \text{ M}$ $[\text{F}^-] = 4.2 \times 10^{-3} \text{ M}$
- 5) $P_{\text{but}} = 0.70 \text{ atm}$ (530 mm Hg), $P_{2\text{mp}} = 1.75 \text{ atm}$ (1330 mm Hg)
- 6) $[\text{Hbg}] = [\text{OH}^-] = 5.3 \times 10^{-7} \text{ M}$, $[\text{bg}^-] = 5.595 \times 10^{-4} \text{ M}$ (extra sig figs shown)
- 7) $[\text{phth}^-] = [\text{H}_3\text{O}^+] = 8.0 \times 10^{-7} \text{ M}$, $[\text{Hphth}] = 1.5992 \times 10^{-3} \text{ M}$ (extra sig figs)
- 8) $K = 1.06 \times 10^{-7}$ 9) 3.20×10^6