CHM 1046 - JOENS WORKSHEET #6 Due date: M,W,F Wednesday, October 12
T,R Thursday, October 13

* While I prefer you turn in a hard copy of the worksheet, I will accept scanned copies sent to my email address, joensj@fiu.edu

Section: (circle one) M,W,F Tu,Tr

For problems involving calculations you must show your work for credit. Unless otherwise stated, you may assume T = 25.0 °C.

1) The data below are given at T = 25.0 °C, and may be of use in doing the following problem.

| substance | $\Delta H°_f$ (kJ/mol) | $\Delta G°_f$ (kJ/mol) | S° (J/mol•K) |
|---|---|---|---|
| CO(g) | – 110.5 | – 137.3 | 197.9 |
| $CO_2$(g) | – 393.5 | – 394.4 | 213.6 |
| $O_2$(g) | 0.0 | 0.0 | 205.0 |

Consider the reaction

$$2\ CO(g) + O_2(g) \leftrightarrows 2\ CO_2(g) \qquad (1.1)$$

a) Give the expression for K, the thermodynamic equilibrium constant, for the above reaction.

b) Using the thermochemical data above, find the numerical value for K at T = 25.0 °C.

c) Typical partial pressures of CO, $CO_2$, and $O_2$ in the lower atmosphere are $p_{CO} = 1.0 \times 10^{-7}$ atm, $p_{CO2} = 4.1 \times 10^{-4}$ atm, and $p_{O2} = 0.21$ atm. Based on your answer in b, are CO, $CO_2$ and $O_2$ in equilibrium in the lower atmosphere? Justify your answer.

2) For nominally insoluble ionic compounds a small amount of the compound will usually dissolve in water. As an example, consider the solubility reaction for silver chloride (AgCl).

$$AgCl(s) \leftrightarrows Ag^+(aq) + Cl^-(aq) \qquad K_C = 1.8 \times 10^{-10} \quad \Delta H°_{rxn} = +65.4 \text{ kJ/mol} \qquad (2.1)$$

Consider 1.000 of an aqueous solution of silver chloride in equilibrium with solid silver chloride. For each of the following changes, indicate whether the number of moles of $Ag^+(aq)$ will increase, stay the same, or decrease (circle your answer).

a) Add 0.100 moles of NaCl(s), a soluble ionic compound, to the solution.

moles $Ag^+(aq)$ increases moles $Ag^+(aq)$ stays the same moles $Ag^+(aq)$ decreases

b) Add 2.00 g of solid silver chloride to the solution.

moles $Ag^+(aq)$ increases moles $Ag^+(aq)$ stays the same moles $Ag^+(aq)$ decreases

c) Change the temperature of the solution from T = 25.0 °C to T = 50.0 °C.

moles $Ag^+(aq)$ increases moles $Ag^+(aq)$ stays the same moles $Ag^+(aq)$ decreases

3) The major industrial source of hydrogen gas is from the chemical reaction of methane with water.

$$CH_4(g) + H_2O(g) \leftrightarrows CO(g) + 3\,H_2(g) \qquad K_p = 1.0 \times 10^{-68} \text{ at T = 25.0 °C.} \qquad (3.1)$$

A system initially has the following partial pressures of gases: $p_{CH4}$ = 2.00 atm and $p_{H2O}$ = 0.0100 atm. There is initially no CO or $H_2$ in the system.

a) What is the partial pressure of $H_2(g)$ in the system when equilibrium is reached?

b) Based on your answer in a, is it likely that this reaction for producing $H_2(g)$ is carried out at T = 25.0 °C? Justify your answer.