CHM 1046 - JOENS WORKSHEET #5 Due date: Monday, October 1st

WORKSHEETS ARE DUE AT THE BEGINNING OF CLASS ON THE DATE GIVEN ON THE WORKSHEET. LATE WORKSHEETS WILL NOT BE ACCEPTED.

NAME ______________________________ Panther ID ____________________________

For problems involving calculations you must show your work for credit.

1) For each of the following reactions give the expression for K_C (the equilibrium constant in terms of concentrations). For cases where it is possible to do so, also given the expression for K_p (the equilibrium constant in terms of partial pressures). If it is not possible to give an expression for K_p, write n/a (not applicable).

a) $PCl_3(g) + Cl_2(g) \leftrightarrows PCl_5(g)$

$K_C = \dfrac{[PCl_5]}{[PCl_3]\,[Cl_2]}$ $K_p = \dfrac{(p_{PCl5})}{(p_{PCl3})\,(p_{Cl2})}$

b) $HNO_2(aq) + H_2O(\ell) \leftrightarrows H_3O^+(aq) + NO_2^-(aq)$

$K_C = \dfrac{[H_3O^+]\,[NO_2^-]}{[HNO_2]}$ K_p n/a

c) $3\ Fe(s) + 4\ H_2O(g) \leftrightarrows Fe_3O_4(s) + 4\ H_2(g)$

$K_C = \dfrac{[H_2]^4}{[H_2O]^4}$ $K_p = \dfrac{(p_{H2})^4}{(p_{H2O})^4}$

2) At high temperatures and in the presence of a catalyst ammonia (NH_3) exists in equilibrium with nitrogen and hydrogen gas. The reaction can be written as

$N_2(g) + 3\ H_2(g) \leftrightarrows 2\ NH_3(g)$

For a system at equilibrium at some temperature T the following partial pressures are observed

$pN_2 = 0.85$ atm $pH_2 = 0.0031$ atm $pNH_3 = 0.031$ atm

Find the numerical value for K_p for the above reaction at temperature T.

$$K_p = \frac{(p_{NH3})^2}{(p_{N2})\,(p_{H2})^3} = \frac{(0.031)^2}{(0.85)\,(0.0031)^3} = 3.8 \times 10^4$$

3) The equilibrium constant for the reaction

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

is $K_C = 1.84$ at T = 425. °C.

a) A system at equilibrium at T = 425. °C has $[H_2] = 3.2 \times 10^{-3}$ mol/L and $[I_2] = 4.1 \times 10^{-4}$ mol/L. What is the concentration of HI in the system?

$$K_C = \frac{[H_2]\,[I_2]}{[HI]^2} \qquad \text{So } [HI]^2 = \frac{[H_2]\,[I_2]}{K_C} = \frac{(3.2 \times 10^{-3})\,(4.1 \times 10^{-4})}{1.84} = 7.13 \times 10^{-7}$$

Therefore, $[HI] = (7.13 \times 10^{-7})^{1/2} = 8.4 \times 10^{-4}$ mol/L

b) What is the numerical value for K_p for the above reaction at T = 425. °C?

$K_p = K_C\,(RT)^{\Delta ng}$ Since $\Delta n_g = 0$, $K_p = K_C = 1.84$

c) What is the numerical value for K_C for the reaction

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

at T = 425. °C?

$$K_C = \frac{[HI]^2}{[H_2]\,[I_2]} = \frac{1}{(\,[H_2]\,[I_2] / [HI]^2\,)} = \frac{1}{1.84} = 0.543$$