K_c and K_p

1. Write both K_p and K_c for the following reaction.

   $4\ NH_3\ (g) + 5\ O_2\ (g) \rightleftarrows\ 4\ NO\ (g) + 6\ H_2O\ (g)$

   $K_c = \frac{[NO]^4[H_2O]^6}{[NH_3]^4[O_2]^5}$ $\qquad$ $K_p = \frac{P_{NO}^4\ P_{H_2O}^6}{P_{NH_3}^4\ P_{O_2}^5}$

2. The following reaction has $K_c = 18.7$ at 28.0°C. Calculate K_p at the same temperature. Once equilibrium has been reached, are products or reactants favored?

   $SO_2\ (g) + Cl_2\ (g) \rightleftarrows\ SO_2Cl_2\ (g)$

   $K_p = K_c(RT)^{\Delta n}$ $\quad$ R = $0.0821\frac{L\cdot atm}{mol\cdot K}$ $\quad$ Δn = 1 mol – 2 mol = -1

   T = 28.0°C + 273.15 = 301.15 K

   $K_p = 18.7\ (0.0821\frac{L\cdot atm}{mol\cdot K} \times 301.15\ K)^{-1} = \mathbf{0.756}$

   Kc = 18.7, and products are favored. Kp is less than 1, therefore the reactants are favored due to Δn being equal to -1.

3. Use the data below to calculate K for the following reaction at 25.0 °C.

   $N_2\ (g) + O_2\ (g) + Br_2\ (g) \rightleftarrows\ 2\ NOBr\ (g)$ $\quad$ K = ?

   2 NO (g) + Br2 (g) ⇄ NOBr (g) $\qquad$ Kc = 2.0

   2 NO (g) ⇄ N_2 (g) + O_2 (g) $\qquad$ Kc = 2.1×10^{30}

   Leave the first equation alone and reverse the second equation.

   ~~2 NO~~ (g) + Br2 (g) ⇄ NOBr (g) $\qquad$ Kc = 2.0

   N_2 (g) + O_2 (g) ⇄ ~~2 NO~~ (g) $\qquad$ Kc = $\frac{1}{2.1 \times 10^{30}}$

   $N_2\ (g) + O_2\ (g) + Br_2\ (g) \rightleftarrows\ 2\ NOBr\ (g)$ $\quad$ K = $2.0 \times \frac{1}{2.1 \times 10^{30}} = \mathbf{9.5 \times 10^{-31}}$

4. The following reaction has $K_p = 49$ at 729 K. Calculate K_c.

   $H_2\ (g) + I_2\ (g) \rightleftarrows\ 2\ HI\ (g)$

   $K_c = \frac{K_p}{(RT)^{\Delta n}}$ $\qquad$ Δn = 0, therefore $(RT)^0 = 1$ and $\mathbf{K_p = K_c = 49}$