HW03 - Chemical Equilibria 1

Question 1 3 pts

When the chemical reaction

$A + B \rightleftharpoons C + D$

is at equilibrium, which of the following is true?

- ○ both the forward and reverse reactions have stopped
- ○ neither the forward nor the reverse reactions have stopped
- ○ all four concentrations are equal
- ○ the sum of the concentrations of A and B equals the sum of the concentrations of C and D

Question 2 3 pts

Explain why equilibrium constants are dimensionless.

- ○ They are dimensionless because the pressures or concentrations we put in are all for the substances in their standard states.
- ○ They are not really dimensionless, but we must treat them as such in order to be able to take ln(K) in the expression:
  $\Delta G^\circ = -RT \ln K$
- ○ Activities (which are dimensionless) are actually what should be used in the mass action expression and therefore equilibrium constants. Concentration and pressure *values* are used in place of activities of species. Therefore true equilibrium constants have no units.
- ○ This is a trick question. Equilibrium constants have units that involve some multiple of atmospheres or moles per liter.

Question 3 3 pts

The expression for K_c for the reaction

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

at equilibrium is:

- ○ $\frac{[NO]^4[H_2O]^6}{[NH_3]^4[O_2]^5}$
- ○ $\frac{[NO][H_2O]}{[NH_3][O_2]}$
- ○ $\frac{[NH_3]^4[O_2]^5}{[NO]^4[H_2O]^6}$
- ○ $[NH_3]^4[O_2]^5$

Question 4 3 pts

Consider the following reactions at 25°C:

$2NO(g) \rightleftharpoons N_2(g) + O_2(g)$ $K_c = 1x10^{30}$

$2H_2O(g) \rightleftharpoons 2H_2(g) + O_2(g)$ $K_c = 5x10^{-82}$

$2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g)$ $K_c = 3x10^{91}$

Which compound is most likely to dissociate and give $O_2(g)$ at 25°C?

- ○ CO
- ○ NO
- ○ H_2O
- ○ CO_2

Question 5 3 pts

At 600°C, the equilibrium constant for the reaction

$2HgO(s) \longrightarrow 2Hg(l) + O_2(g)$

is 2.8. Calculate the equilibrium constant for the reaction

$0.5O_2(g) + Hg(l) \longrightarrow HgO(s)$

- ○ 1.7
- ○ 0.60
- ○ 1.1
- ○ 0.36

Question 6 3 pts

Consider the reaction

$2HgO(s) \rightleftharpoons 2Hg(l) + O_2(g)$

What is the form of the equilibrium constant K_c for this reaction?

- ○ $[Hg]^2\,[O_2]$
- ○ $\frac{[O_2]}{[HgO]^2}$
- ○ $\frac{[Hg]^2[O_2]}{[HgO]^2}$
- ○ $[O_2]$

Question 7 — 4 pts

$K_c = 2.6 \times 10^8$ at 825 K for the reaction

$2H_2(g) + S_2(g) \rightleftharpoons 2H_2S(g)$

The equilibrium concentration of H_2 is 0.0020 M and S_2 is 0.0010 M. What is the equilibrium concentration of H_2S?

- ○ 10 M
- ○ 1.0 M
- ○ 0.10 M
- ○ 0.0010 M

Question 8 — 4 pts

Consider the reaction below

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

At 1000 K the equilibrium pressures of the three gases in one mixture were found to be 0.562 atm SO_2, 0.101 atm O_2, and 0.332 atm SO_3. Calculate the value of K_p for the reaction.

- ○ 3.46
- ○ 0.171
- ○ 0.289
- ○ 2.64

Question 9 — 4 pts

Consider the following reaction:

$2NO(g) + Br_2(g) \rightleftharpoons 2NOBr(g)$ $K_p = 2.40$ @ 373 K

Calculate K_c for this reaction at 100°C.

- ○ 73.5
- ○ 7440
- ○ 0.0784
- ○ 19.7