Chemistry 1210 Spring 2024 Test 2

Friday, March 1, 2024 Time: 1 hour 50 minutes

Name: _____ Student #: _____

*This test consists of **six** pages of questions, the formula sheet, and a periodic table. Please ensure that you have a complete test and, if you do not, obtain one from me **immediately**. There are **37.5** marks available. Good luck!*

1) **[2 marks]** A certain reaction has $\Delta H° = 65.0$ kJ/mol and K = 50.0 at 25°C. What will be its value of K at 50°C?

a) 50.1
b) 380.1
c) 3.09×10^{8}
d) 1.25×10^{88}
e) None of these

2) **[2 marks]** The normal boiling point of hexane is 68.75°C, and its enthalpy of vaporization is 31 kJ/mol. It's vapour pressure at 22°C will be:

a) 7.33×10^{-73} torr
b) 6.78×10^{-48} torr
c) 7.51×10^{-3} torr
d) 135.1 torr
e) 758.7 torr

3) **[5 marks total]** A 10-litre flask was charged with 5 moles of H_2, 5 moles of Cl_2, and 10 moles of HCl, and the equilibrium

$H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$ $\quad K_p = 0.25$ @ 27.53°C

established.

a) **[1 mark]** In which direction did the reaction shift to attain equilibrium? How do you know? (No marks for guessing. ☺)

b) **[4 marks]** What were the equilibrium pressures of all species?

4) **[4 marks]** A flask was charged with 4.0×10^{-4} bar of CO_2 and the equilibrium

$CO_2(g) \rightleftharpoons CO(g) + \frac{1}{2}O_2(g)$ $\quad\quad$ $K_p = 4.0 \times 10^{-26}$

established. Calculate the equilibrium pressures of all species.

5) **[6 marks]** The K_{sp} of Ag_2SO_4 is 1.2×10^{-5}. How many grams of Ag_2SO_4 (311.8 g/mol) will dissolve in **half a litre** of:

a) water

b) a solution with $[AgNO_3] = 0.100$ M

6) **[3 marks]** You have a solution with $[CO_3^{2-}] = 3.28 \times 10^{-3}$ M and $[Cl^-] = 1.7 \times 10^{-5}$ M. You choose to separate these two anions by adding solid $AgNO_3$. The K_{sp} of Ag_2CO_3 is 8.2×10^{-12}, and the K_{sp} of AgCl is 1.7×10^{-10}. At the point of maximum separation, what percent of the first of the two anions to precipitate will remain in solution?

7) **[4 marks]** Give the oxidation number of oxygen in the following molecules or ions:

a) O_2 _____ b) HOF _____ c) OF_2 _____ d) H_2O_2 _____

8) **[5.5 marks]** Given the following redox reaction, occurring in **basic** solution:

$Al + ClO_4^{-1} \longrightarrow Al(OH)_4^{-1} + Cl^{-1}$

a) **[4 marks]** Balance the reaction.

b) **[0.5 marks]** Which species is oxidized?

c) **[0.5 marks]** Which species is the reducing agent?

d) **[0.5 marks]** How many electrons are transferred in the overall reaction?

9) **[3 marks]** Given the half-reactions:

$NO_2 + H^+ + e^{-1} \rightleftharpoons HNO_2$ $\varepsilon° = 1.07$ V
$2HNO_2 + 4H^+ + 4e^{-1} \rightleftharpoons N_2O + 3H_2O$ $\varepsilon° = 1.297$ V

calculate ε° for:

$2NO_2 + 6H^+ + 6e^{-1} \rightleftharpoons N_2O + 3H_2O$

10) **[3 marks]** Given the half-reactions:

$MnO_2 + 4H^+ + 2e^{-1} \rightleftharpoons Mn^{2+} + 2H_2O$ $\varepsilon° = 1.23$ V
$MnO_4^{-1} + 4H^+ + 3e^{-1} \rightleftharpoons MnO_2 + 2H_2O$ $\varepsilon° = 1.70$ V

Will MnO_2 disproportionate? Calculate ε° for the disproportionation to prove your answer.