Chemistry 112 Sample Questions (Exam 3)

Part A: Multiple Choice.

1. NO₂ has a brownish color. At elevated temperatures, NO₂ reacts with CO according to

\[ \text{NO}_2(g) + \text{CO}(g) \rightleftharpoons \text{NO}(g) + \text{CO}_2(g) \]

The other three gases in this reaction are colorless so that the brownish color slowly fades as the reaction proceeds to form products. If the mixture at equilibrium is colorless, we expect
a) K < 1  b) K > 1  c) K = 1

2. We expect the intermolecular attractive forces between H₂ and He to be
   a) Nonpolar   b) dispersion forces only   c) dipole-induced dipole forces   d) ion-dipole forces

3. We expect the intermolecular attractive forces between HBr and He to be
   a) dipole-induced dipole forces   b) dispersion forces only   c) nonpolar   d) ion-dipole forces

4. At the point in an acid-base titration when moles initial weak acid = moles conjugate base,
   a) pH = 0  b) pH = pKa  c) pH = 7  d) pH + pOH = 14

5. Write the balanced equation represented by this equilibrium expression:

\[ \frac{(\text{P}_\text{N}_2\text{O})^2}{(\text{P}_\text{N}_2)^2(\text{P}_\text{O}_2)} \]

Include the physical state of each reactant and product.

6. 5.00 mL of 0.0800 M NaOH is added to 50.0 mL water. You expect the pH of the resulting solution to be
   a) 7.00  b) pH > 7  c) pH < 7

7. The Ka of some weak acid HX is \(3.0 \times 10^{-4}\). The Ka of some other weak acid HA is \(5.0 \times 10^{-5}\). You expect to find that in a 50.0 mL solution of each acid
   a) HA and HX have the same small number of hydronium ions in solution
   b) HX has more hydronium ions in solution than HA
   c) HA has more hydromium ions in solution than HX
   d) HA and HX have the same large number of hydronium ions in solution

8. You add 2.00 mL of 0.0900 M NaOH to 50.0 mL of 0.100 M HF (Ka = \(6.6 \times 10^{-4}\)). You expect that
   a) the moles of H₃O⁺ initially in solution will increase
   b) the moles of F⁻ initially in solution will increase
   c) the moles of F⁻ initially in solution will decrease
   d) the moles of HF initially in solution will increase

9. You dissolve 0.25 moles Na₂SO₃ in water. You expect the resulting solution to be
   a) basic  b) neutral  c) acidic

10. A weak acid HA has pKa = 6.25 while a second weak acid HB has pKa = 9.24. You conclude that
    a) B⁻ is a weaker base than A⁻  b) HA is a weaker acid than HB  c) A⁻ is a weaker base than B⁻
    d) HB is a stronger acid than HA

11. A solution is made by mixing 25.0 mL of 0.200 M NaOH with 25.0 mL of 0.200 M HF (Ka = \(6.6 \times 10^{-4}\)). You expect the resulting solution to be
    a) neutral  b) basic  c) acidic
12. In the synthesis of ammonia, the reaction is \( 3 \text{H}_2(g) + \text{N}_2(g) \leftrightarrow 2 \text{NH}_3(g) \). If we want to increase the amount of \( \text{NH}_3 \) produced, we should
   a) decrease the amount of \( \text{N}_2 \)
   b) increase the volume of the container holding the \( \text{NH}_3 \)
   c) increase the amount of \( \text{H}_2 \)

13. Solution A has pH = 5.00 and solution B has pOH = 8.00. Comparing the two solutions, you expect that
   a) solution A has more OH\(^-\) in solution
   b) solution B has more H\(_3\)O\(^+\) in solution

14. A solution is made by mixing 25.0 mL of 0.200 M NaOH with 25.0 mL of 0.200 M HCl. You expect the resulting solution to be
   a) neutral
   b) basic
   c) acidic

15. In the synthesis of methanol, the reaction is \( 2 \text{H}_2(g) + \text{CO}(g) \leftrightarrow \text{CH}_3\text{OH}(g) + \text{heat} \). If we want to increase the amount of \( \text{CH}_3\text{OH} \) produced, we should
   a) decrease the amount of \( \text{H}_2 \)
   b) cool the reactant vessel
   c) increase the volume
   d) heat the reactant vessel

Part B. Calculations and Concepts

1. Calculate the pH of the following solutions.
   a) a 20.0 mL solution of 0.400 M KOH.
   b) A 30.0 mL solution of 0.0900 M HCl
   c) A 25.0 mL solution of 0.0800 M H\(_2\)S.

   \[
   \text{H}_2\text{S} (aq) + \text{H}_2\text{O}(l) \rightleftharpoons \text{H}_3\text{O}^+(aq) + \text{HS}^- (aq) \quad \text{Ka} = 9.1 \times 10^{-8}
   \]

2. An experiment is run at 425°C to check the equilibrium constant for the reaction
   \( \text{H}_2(g) + \text{I}_2(g) \leftrightarrow 2 \text{HI}(g) \)

   Some \( \text{H}_2 \) at an initial partial pressure of 2.75 atm is mixed with some \( \text{I}_2 \) at initial partial pressure of 1.50 atm and the reaction mixture is allowed to reach equilibrium. The partial pressure of \( \text{HI} \) at equilibrium is measured to be 2.70 atm. Calculate the equilibrium constant for this reaction.

3. Calculate the pH of the solution resulting when 25.0 mL of 0.0400 M H\(_2\)S is mixed with 25.0 mL of 0.0400 M NaOH. Check any assumptions made.

   \[
   \text{H}_2\text{S} (aq) + \text{H}_2\text{O}(l) \rightleftharpoons \text{H}_3\text{O}^+(aq) + \text{HS}^- (aq) \quad \text{Ka} = 9.1 \times 10^{-8}
   \]

4. Calculate the pH of the solution resulting when 25.0 mL of 0.0400 M H\(_2\)S is mixed with 5.00 mL of 0.0200 M NaHS.

5. When Cl\(_2\), Br\(_2\), and BrCl are mixed at 298 K such that their initial partial pressures are 2.00 atm, 4.00 atm, and 3.00 atm, respectively, they take part in the reaction

   \[
   \text{Cl}_2(g) + \text{Br}_2(g) \leftrightarrow 2 \text{BrCl}(g) \quad \text{K} = 58.0
   \]

   Calculate Q for this reaction mixture and determine the direction the reaction must go to reach equilibrium.
Chemistry 112 Sample Questions (Exam 3)
Sample exam answers: Exam 3, Spring 2005

Part A
1) b
2) b
3) a
4) b
5) \(2 \text{N}_2(g) + \text{O}_2(g) \leftrightarrow 2 \text{N}_2\text{O}(g)\)
6) b
7) b
8) b
9) a
10) c
11) b
12) c
13) c (mislabeled as a “second” b in the problem)
14) a
15) b

Part B
1 a) 13.602 b) 1.046 c) 4.069
2) 34.7 \approx 35 = K
3) pH = 9.671
4) 6.041
5) Q = 1.125; Q < K so reaction proceeds from left to right