Exam 1

# Part 1: Multiple Choice (2 points each)

## Directions: Please circle the *best* answer for each of the following questions.

1. For which of the following reactions will the equilibrium mixture contain an appreciable concentration of both reactants and products?
2. Cl2 (g) 2 Cl (g); Kc = 6.4 x 10-39
3. Cl2 (g) + 2 NO (g)  2 NOCl (g); Kc = 3.7 x 108
4. Cl2 (g) + 2 NO2 (g) 2 NO2Cl (g); Kc = 1.8
5. all of the above
6. none of the above
7. Identify the methods used to monitor a reaction as it occurs in the reaction flask.
8. Polarimeter
9. Spectrometer
10. Pressure measurement
11. none of the above
12. all of the above
13. Give the characteristic of a zero order reaction have only one reactant.
    1. The rate of the reaction is not proportional to the concentration of the reactant.
    2. The rate of the reaction is proportional to the square of the concentration of the reactant.
    3. The rate of the reaction is proportional to the square root of the concentration of the reactant.
    4. The rate of the reaction is proportional to the natural logarithm of the concentration of the reaction.
    5. The rate of the reaction is directly proportional to the concentration of the reactant.
14. What is ∆n for the reaction N2O4 (g) ⇌ 2 NO2 (g) in relating Kc to Kp?
    1. -2
    2. -1
    3. 3
    4. 2
    5. 1
15. The reaction 2 SO2 (g) + O2 (g) ⇌ 2 SO3 (g) is exothermic. Which change will shift the equilibrium to the left?
    1. Raising the temperature
    2. Decreasing the pressure
    3. Increase volume
    4. all of the above
    5. none of the above
16. Which of the following is not a conjugate acid-base pair?
    1. NH4+/NH3
    2. H3O+/OH-
    3. H2SO3/HSO3-
    4. C2H3O2-/HC2H3O2
    5. all of the above
17. The stronger the acid, then which of the following is true?
    1. The stronger the conjugate acid.
    2. The stronger the conjugate base.
    3. The weaker the conjugate acid.
    4. The weaker the conjugate base.
    5. none of the above
18. Place the following in order of increasing acid strength: HBrO2 HBrO3 HBrO HBrO4
    1. HBrO2 < HBrO4 < HBrO < HBrO3
    2. HBrO < HBrO2 < HBrO3 < HBrO4
    3. HBrO2 < HBrO3 < HBrO4 < HBrO
    4. HBrO4 < HBrO2 < HBrO3 < HBrO
    5. HBrO < HBrO4 < HBrO3 < HBrO2
19. If an equal number of moles of the weak acid HCN and the strong base KOH are added to water, is the resulting solution acidic, basic, or neutral?
    1. There is insufficient information provided to answer this question.
    2. Acidic
    3. Basic
    4. Neutral
    5. Pink
20. When using the SpectroVis
    1. be sure to calibrate the SpectroVis using alcohol.
    2. it is okay if there are air bubbles in the cuvette.
    3. it measures the concentration of the solution.
    4. be sure to wipe off finger prints and water off the cuvette before putting it into the SpectroVis.
    5. all of the above

# Part 2: Short Answer

## Directions: Answer each of the following questions. Be sure to use complete sentences where appropriate. For full credit be sure to show all of your work.

1. The following data were collected in a study of the effect of temperature on the decomposition of ClO into Cl2 and O2 in the reaction (5 points):
2. ClO (g) 🡪 Cl2 (g) + O2 (g)

Determine the activation energy, Ea, for the reaction.

1. Explain what the exponential factor in the Arrhenius equation represents (3 points).
2. Hydrogenation reactants, processes wherein H2 is added to a molecule, are usually catalyzed. An excellent catalyst is a very finely divided metal suspended in the reaction solvent. Tell why finely divided rhodium, for example, is a much more efficient catalyst than a small block of the metal (3 points).
3. Ammonia reacts with nitrous acid to from an intermediate, ammonium nitrate (NH4NO3), which decomposes to nitrogen gas and water (6 points):

NH3 (g) + HNO2 (aq) 🡪 NH4NO2 (aq) 🡪 N2 (g) + 2 H2O (l)

* 1. The reaction is first order in ammonia and second order in nitrous acid. What is the rate law for the reaction?
  2. What are the units on the rate constant if concentrations are expressed in molarity and time in seconds?
  3. The rate law for the reaction has also been written as

rate = k[NH4+][NO2-][HNO2]

Is this expression equivalent to the one you wrote in part a?

1. Classify each of the following ions according to whether they react with water to give a neutral, acidic, or basic solution (6 points):
   1. F- \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. Br- \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   3. NH4+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   4. K(H2O)6+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   5. SO32- \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   6. Cr(H2O)63+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Sucrose, C12H22O11, decomposes to fructose and glucose in acid solution with the rate law:

rate = (0.216 hr-1) [C12H22O11] at 25 °C (6 points).

* 1. What is the half-life of sucrose at this temperature?
  2. What amount of time is required for 87.5% of the initial concentration of sucrose to decompose?

1. The equilibrium constant is given for two of the reactions below. Determine the value of the missing equilibrium constant (5 points).

A(g) + 2B(g) ⇌ AB2(g) Kc = 59

AB2(g) + B(g) ⇌ AB3(g) Kc = ?

A(g) + 3B(g) ⇌ AB3(g) Kc = 478

1. Define Le Chatelier's Principle (3 points).
2. How can water be both a Brønsted-Lowry base and a Lewis base? Can water be a Brønsted-Lowry acid? A Lewis acid (5 points)?
3. Suppose that 1.50 mol of phosphorus pentachloride gas is placed in a reaction vessel of volume 250 mL and allowed to reach equilibrium with its decomposition products phosphorus trichloride and chlorine gases at 250 °C, when Kc is 1.80 M. what is the compositions of the equilibrium mixture (6 points)?
4. Do both protons ionize instantaneously from a diprotic acid such as H2CO3? Explain your answer (4 points).
5. Consider the reaction xenon and fluorine gases to produced xenon tetrafluoride gas. A reaction mixture initially contains 2.24 atm xenon and 4.27 atm fluorine gases (12 points).
   1. If the equilibrium pressure of xenon is 0.34 atm, find the equilibrium constant, Kp, for the reaction.
   2. What is the value of the equilibrium constant, Kc, if the reaction takes place at 215 °C?
6. A solution of 0.25 M sodium acetate has a [H3O+] = 9.3 x 10-9 M at 25 °C (16 points).
   1. Identify the conjugate acid and conjugate base.
   2. Calculate the [OH-].
   3. Calculate Kb.
   4. Calculate the pKb.
   5. Calculate the pKa.
   6. Calculate the pH.
   7. Calculate the pOH.
   8. Calculate the percent dissociation.