Exam 1

Part I: Multiple Choice (2 points each)

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

Question 1. Which of the following statements is false?

1. The average rate of a reaction decreases during a reaction.
2. It is not possible to determine the rate of a reaction from its balanced equation.
3. The rate of zero order reactions is not dependent on concentration.
4. The half-life of a first order reaction is dependent on the initial concentration of reactant.
5. none of the above

Question 2. Identify a homogeneous catalyst.

1. SO2 over a vanadium(V) oxide
2. Pd in H2 gas
3. H2SO4 with concentrated HCl
4. N2 and H2 catalyzed by Fe.
5. Pt with methane

Question 3. Identify the rate determining step.

1. The slowest step.
2. The faster step
3. The fast step.
4. Always the last step.
5. Always the first step.

Question 4. In a reaction mixture containing only products, what is the value of Q?

1. -1
2. 1
3. ∞
4. 0
5. It cannot be determined without concentrations.

Question 5. The equilibrium constant is given for one of the reactions below. Determine the value of the missing equilibrium constant.

H2 (g) + Br2 (g) 2 HBr (g) Kc = 3.8 x 104

2 HBr (g)  H2 (g) + Br2 (g) Kc = ?

* 1. 6.9 x 10-4
  2. 1.9 x 104
  3. 2.6 x 10-5
  4. 1.6 x 103
  5. 5.3 x 10-5

Question 6. Which of the following statements is false?

1. When K ≈ 1, neither the forward or reverse reaction is strongly favored, and about the same amount of reactants and products exist at equilibrium.
2. When K >> 1, the forward reaction is favored and essentially goes to completion.
3. K >> 1 implies that the reaction is very fast at producing products.
4. When K << 2, the reverse reaction is favored and the forward reaction does not proceed to a great extent.
5. none of the above

Question 7. The stronger the acid,

1. the stronger the conjugate acid.
2. the stronger the conjugate base.
3. the weaker the conjugate base.
4. the weaker the conjugate acid.
5. none of the above

Question 8. How many weak acids: HCN, HClO2, HNO3, and H2PO4-?

1. 0
2. 1
3. 2
4. 3
5. 4

Question 9. In a triprotic acid, which Ka has the highest value?

1. Ka1
2. Ka2
3. Ka3
4. Kb1
5. Kb2

Question 10. In Spectrophometry a “blank” is

1. a cuvette filled with DI H2O
2. zero percent transmittance.
3. an absorbance of one.
4. a cuvette filled with your solution of interest.
5. your face during lecture.

Part II: 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.

Question 1. Derive an expression for a “1/3 life” for a first order reaction (6 points).

Question 2. Thiosulfuric acid, H2S2O3, can be prepared by the reaction of H2S and HSO3Cl (6 points):

HSO3Cl (l) + H2S (g) 🡪 HCl (g) + H2S2O3 (l)

1. Draw a Lewis structure for H2S2O3, given that it is isostructural with H2SO4.
2. Do you expect H2S2O3 to be a stronger or weaker acid than H2SO4? Explain your answer.

Question 3. Explain why pH values decrease as acidity increases (3 points).

Question 4. Hydrofluoric acid is a weak acid. Write the mass action expression for its acid-ionization reaction (3 points).

Question 5. Suppose the reaction A B in the forward direction is first order in A and the rate constant is 1.50 x 10-2 s-1. The reverse reaction is first order in B and the rate constant is 4.50 x 10-2 s-1 at the same temperature. What is the value of the equilibrium constant for the reaction A B at this temperature (5 points)?

Question 6. The reaction of nitrogen dioxide with ozone produces nitrogen trioxide in a second-order reaction overall (10 points):

NO2 (g) + O3 (g) 🡪 NO3 (g) + O2 (g)

* 1. Write the rate law for the reaction if the reaction is first order in each reactant.
  2. The rate constant for the reaction is at 298 K. What is the rate of reaction when [NO2] = and [O3] = ?
  3. What is the rate of the appearance of NO3 under these conditions?
  4. What happens to the rate of the reaction if the concentration of O3 (g) is doubled?

Question 7. A student inserts a glowing wood splint into a test tube filled with oxygen gas. The splint quickly catches on fire. Why does the splint burn so much faster in pure oxygen than in air (3 points)?

Question 8. Patients suffering from carbon monoxide poisoning are treated with pure oxygen to remove CO from the hemoglobin (Hb) in their blood. The two relevant equilibria are

Hb + 4 CO (g) Hb(CO)4

Hb + 4 O2 (g) Hb(O2)4

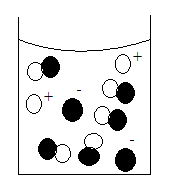
The value of the equilibrium constant for CO binding to Hb is greater than that for O2. How, then, does this treatment work (4 points)?

Question 9. Why is there more than one definition of acid-base behavior? Which definition is right (4 points)?

Question 10. Consider the following reaction (8 points):

SO2Cl2 (g) SO2 (g) + Cl2 (g) Kc = 2.99 x 10-7 M at 227 °C.

* 1. If a reaction mixture initially contains 0.195 M SO2Cl2, what is the equilibrium concentration of Cl2 at 227 °C?
  2. What is the value of Kp at 227 °C?

Question 11. What is the Ka of the monoprotic acid indicated by the diagram below (4 points)?

Question 12. Explain how checking the value of Q for a specified equilibrium system such as A B enables you to decide whether the reactant or product concentration increase as the system shifts to attain equilibrium (4 points).

Question 13. Calculate the pH of a 1.60 M potassium hypobromite solution. Ka for hypobromous acid, HBrO, is 2.0 x 10-9 M (12 points).

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Question 14. What is the percent ionization of a 0.490 M ammonia solution, Kb = 1.8 x 10-5 M (8 points)?