Brooklyn College Chemistry Dept

Lecture Test I Spring 2009

Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Short answer and multiple choice questions.

\_\_\_\_\_\_1. Nitrogen dioxide decomposes to nitric oxide and oxygen via the reaction:

2 NO2 🠪 2 NO + O2

In a particular experiment at 300°C, [NO2] drops from 0.0100 to 0.00650 M in 100 s The rate of appearance of O2 for this period is \_\_\_\_\_\_\_\_\_\_ M/s.

A) 1.8 × 10−5 B) 3.5 × 10−5 C) 7.0 × 10−5

D) 3.5 × 10−3 E) 7.0 × 10−3

\_\_\_\_\_\_\_2. A reaction was found to be second order in carbon monoxide concentration. The rate of the reaction \_\_\_\_\_\_\_\_\_\_ if the [CO] is doubled, with everything else kept the same.

A) doubles B) remains unchanged C) triples

D) increases by a factor of 4 E) is reduced by a factor of 2.

\_\_\_\_\_\_\_\_3. A reaction was found to be third order in A. Increasing the concentration of A by a factor of 3 will cause the reaction rate to \_\_\_\_\_\_\_\_\_\_.

A )remain constant B) increase by a factor of 27 C) increase by a factor of 9

D) triple E) decrease by a factor of the cube root of 3

The data in the table below were obtained for the reaction A + B 🠪 P

|  |  |  |  |
| --- | --- | --- | --- |
| Run number | initial [A] M | initial [B] M | Initial rate, m/s |
| 1  2  3 | 0.273  0.273  0.819 | 0.763  1.526  0.763 | 2.83  2.83  25.47 |

\_\_\_\_\_\_\_4. The rate order of the reaction in A is A) first B) second C) third

D) fourth E) zero

\_\_\_\_\_\_\_5. The order of the reaction in B is is A) first B) second C) third

D) fourth E) zero

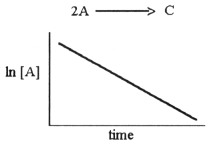
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_6. What is the numerical value of the rate constant?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_7. What is the **unit** of the rate constant?

\_\_\_\_\_\_\_\_8. The overall rate order of a reaction is best described as the sum of the

A) coefficients in the balanced equation B) concentrations of all reactants

C) exponents in the rate law D) forward and reverse reaction rates

Questions 9 and 10 are based on the graph below, for the chemical reaction

\_\_\_\_\_\_\_9. Based on this graph, we would assume that the overall reaction is

A) first order B) second order C) third order D) fourth order

E) zero order

\_\_\_\_\_\_\_10. The slope of this line is equal to ( where "k" is the rate constant)

A) k B) −k C) 1/k D) Ln k E) −1/k

Assume that the decomposition of peroxide, 2 H2O2 🠪 2 H2O + O2

is first order. In an aqueous solution of H2O2 , the rate of production of

oxygen gas is found to be 0.00400 mol/minute.

\_\_\_\_\_\_\_11. Assume that the volume of the peroxide solution is 1.00 liter. What is the

rate of disappearance of the peroxide, in M/ minute?

\_\_\_\_\_\_\_12. How much water must be added to the 1.00 liter solution in order to reduce

the rate of appearance of the oxygen to 0.00100 mol/min ?

\_\_\_\_\_\_\_13. Which best describes the effect of an increase in temperature on an exothermic reaction?

A) both the rate constant and the equilibrium constant increase

B) both the rate constant and the equilibrium constant decrease

C) the rate constant increases, while the equilibrium constant decreases

D) the rate constant decreases, while the equilibrium constant increases

Suppose that the peroxide decomposition can proceed by the following mechanism:

1. H2O2 + Br− 🠪 H2O + BrO−

2. BrO− 🠪 Br− + ½ O2

\_\_\_\_\_\_14. In the mechanism above,

A) Br− is an intermediate, while BrO− is a catalyst

B) ) Br− is a catalyst , while BrO− is an intermediate

C) O2 is an intermediate, while H2O2 is a catalyst

D) ) Br− is an intermediate, and BrO− is an intermediate

15. Write the net reaction produced through the mechanism above.

16. Write the rate law, if the first step shown above is the rate determining step.

17. Write the rate law if the **second** step is rate determining. Do not include an

intermediate in the rate law.

\_\_\_\_\_\_\_18. The value of Kc for the equilibrium H2 (g) + I2 (g)  2 HI (g) is 794 at 25 °C. What is the value of Kc for the equilibrium below?

1/2 H2 (g) + 1/2 I2 (g)  HI (g)

A) 397 B) 0.035 C) 28 D) 1588 E) 0.0013

\_\_\_\_\_\_19. Dinitrogentetraoxide partially decomposes according to the following equilibrium:

N2O4  (g)  2NO2 (g)

A 1.00-L flask is charged with 0.400 mol of N2O4. At equilibrium at 373 K, 0.0055 mol of N2O4 remains. Kc for this reaction is \_\_\_\_\_\_\_\_\_\_.

A) 2.2 × 10−4 B) 113 C) 0.22 D) 0.022 E) 0.87

\_\_\_\_\_\_\_20. A sample of solid NH4HS is placed in a closed vessel, and comes to

equilibrium.. NH4HS(s) ⇄ NH3(g) + H2S(g)

If the pressure of the ammonia gas at equilibrium is 0.26 atm., what is the

Kp of the reaction?

\_\_\_\_\_\_21 At 1000 K, the equilibrium constant for the reaction

2NO (g) + Br2 (g)  2NOBr (g) is Kp = 0.013.

Calculate Kp for the reverse reaction, 2NOBr (g)  2NO (g) + Br2 (g).

A) 0.013 B) 1.6 × 10-4 C) 77 D) 0.99 E) 1.1

\_\_\_\_\_\_\_\_\_\_\_22. If the system in question 21 is in equilibrium at 1000 K, and the

pressures of the NO and of the Br2 are BOTH found to be

2.00 atm., what is the pressure of the NOBr?

\_\_\_\_\_\_\_\_23 For the endothermic reaction

CaCO3 (s)  CaO (s) + CO2 (g)

Le Chätelier's principle predicts that \_\_\_\_\_\_\_\_\_\_ will result in an increase in the number of moles of CO2.

A) increasing the temperature B) decreasing the temperature

C) increasing the pressure D) removing some of the CaCO3 (s)

E) adding more CaCO3 (s)

\_\_\_\_\_\_\_24. For the reaction 2 SO2(g) + O2(g) 🠪 2 SO3 (g), ΔH° is < 0

The maximum quantity of SO3 would be produced at equilibrium by

A) decreasing the volume of the reaction vessel, and decreasing the temperature

B) decreasing the volume of the reaction vessel, and increasing the temperature

C) increasing the volume of the reaction vessel, and decreasing the temperature

D) increasing the volume of the reaction vessel, and increasing the temperature

\_\_\_\_\_\_\_25. For the reaction 2 C2H6(g) + 7 O2(g) ⇄ 4 CO2(g) + 6 H2O (g)

which of the following procedures would increase the equilibrium quantity of carbon dioxide, **without** changing the value of the equilibrium constant?

A) increasing the temperature B) decreasing the temperature

C) increasing the container volume D) decreasing the container volume

E) removing some oxygen from the equilibrium mixture

\_\_\_\_\_\_\_26.Consider the following reaction at equilibrium:

2NH3 (g)  N2 (g) + 3H2 (g) ΔH° = +92.4 kJ

Le Chätelier's principle predicts that adding N2 (g) to the system at equilibrium will result in \_\_\_\_\_\_\_\_\_\_. A) a decrease in the concentration of NH3 (g)

B) a decrease in the concentration of H2 (g)

C) an increase in the value of the equilibrium constant

D) a lower partial pressure of N2(g) E) removal of all of the H2 (g)

\_\_\_\_\_\_\_27. What is the conjugate acid of NH3  ?

A) NH3 B) NH2− C) NH3+ D) NH4+ E) NH4OH

\_\_\_\_\_\_\_28. The conjugate base of HSO4− is A) H2SO4 B) OH−  C) SO42−

D) HSO4+ E) H3O+

Find the pH of each of the following aqueous solutions.

\_\_\_\_\_\_\_\_\_\_\_29. The [OH−] is 3.26 x 10−4 M

\_\_\_\_\_\_\_\_\_\_\_30. The hydronium ion concentration is 0.0400 M

\_\_\_\_\_\_\_\_\_\_\_31. A 0.500 molar solution of HF, given that the Ka of HF is 6.8 x 10-4

\_\_\_\_\_\_\_\_\_\_32. A 3.00 molar solution of NH3 , given a Kb of 1.8 x 10−5

\_\_\_\_\_\_\_\_\_\_33. 0.500 molar solution of KCl

\_\_\_\_\_\_\_\_\_\_34. A solution containing 2.00 mole of NaC2H3O2 and 1.00 mol of HC2H3O2 in a volume of 2.00 liters (Ka of HC2H3O2 is 1.8 x 10−5 )

\_\_\_\_\_\_\_\_\_\_35. A solution containing ONLY the 2.00 mole of NaC2H3O2 in the volume of 2.00 liters.

Identify each of the following salts as acidic (A) basic (B) or neutral (N)

\_\_\_\_\_36. Fe(NO3)3

\_\_\_\_\_37. BaBr2

\_\_\_\_\_38. NH4Cl

\_\_\_\_\_\_\_\_39. Which of the following ions would be most strongly basic in water?

A) HCO3− B) CO32− C) Al3+ D) Cl− E) H3O+

\_\_\_\_\_\_\_\_\_\_\_\_\_40. What is the concentration of sodium hydroxide that will produce

a solution with a pH of 12.830 ?

Problems:

I. Write the balanced equation for the ionization of acetic acid in water to form hydronium and acetate ions.

A. Label each of the reactants and products as either acid (A) or base (B)

B. Which is the stronger of your two bases? How do you know?

(6)

II. According to one acid base theory, the Co3+ ion is acting as an acid in the reaction

Co3+ + 6 NH3 🠪 Co(NH3)3+

Identify that acid-base theory, and explain why the cobalt (III) ion is an acid in the given reaction.

(3)

III. Assume that the decomposition of H2O2  H2O2(*l*) 🠪 H2O (*l*) + ½ O2(g)

is first order.

At a certain temperature, it is found that it takes 60.0 minutes for a 2.00 M

solution of H2O2 to decompose to a conc. of 1.50 M.

A. What is the rate constant for the decomposition at that temperature? ( you need not change the time unit to seconds. Minutes are fine)

B. Starting with a concentration of 1.50 molar, how long would it take until the

concentration became 0.50 molar?

C. What is the half life of the reaction, in minutes?

(6)

IV. Assume that the reaction 2 SO3(g) 🠪 2SO2(g) + O2(g) is **second**  order.

The initial pressure of the SO3 gas is 2.00 atm. After 90.0 seconds,

the pressure of the SO3 gas is 1.80 atm. What would the pressure of the

SO3 gas be after 300. seconds?

(3)

V. Formic acid, HCOOH, has a Ka of 1.8 x 10−4 .

A buffer is prepared by adding 0.200 mol of HCOONa, sodium formate

to 500 mL of a 0.200 molar solution of formic acid.

A. Find the [H+] and the pH of the buffer.

B. Find the pH of the buffer after 50.0 mL of 1.00 molar HCl is added to it.

(6)

C. EXTRA CREDIT. What would the pH have been if 50.0 mL of 4.00 molar HCl had been added to the original buffer?

(4)

VI. A 0.200 molar solution of an unknown, monoprotic acid, HA, is found to have a pH of 3.400.

A. What is the Ka of the unknown acid?

B. What is the Kb of the ion A−

C. What would the concentration of HA have to be to produce a pH of

2.900 ?

(8)

There is another page!!

VII. 50.00 mL of 0.2000 molar HCl is titrated with 0.250 molar NaOH.

Find the pH

A. Of the initial 0.2000 molar HCl solution

B. Of the mixture after 20.00 mL of NaOH is added to the 50.00 mL of HCl

C. After a total of 40.00 mL of NaOH has been added

D. After a total of 42.00 mL of NaOH has been added.

(10)