AP Chemistry. Test on Aqueous Equilibrium. Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

NO CALCULATORS ON THIS PART OF THE EXAM!

Questions 1 to 3 are based on the following 3 acids and their Ka’s

HA , Ka = 1.0 x 10–6 HX Ka = 4.0 x 10–8 HZ Ka = 1.0 x 10–10

\_\_\_\_1. The pH of a 1.0 molar solution of HA is A) 0 B) 3 C) 6 D) 8 E) 11

\_\_\_\_2. What is the [H+] in a solution containing 1.0 mole of HX and 2.0 mol of NaX

 in 500 mL of solution? A) 2.0 x 10–8 B) 4.0 x 10–8 C) 8.0 x 10–8

D) 1.0 x 10–8 E. 1.6 x 10–7

\_\_\_\_3. Which 0.100 molar solution would have the highest pH ?

 A) NaA B) NaX C) KZ D) HZ E) HA

\_\_\_\_4. Which of the following anions has the **weakest** conjugate acid?

 A) O2– B) OH– C) Cl– D) HCO3– E) S2–

\_\_\_\_5. In an aqueous solution with a pH of 10.50 at 25o the molar concentration of

 OH– is approximately A) 3.2 x 10–11 M B) 3.2 x 10–4 M

 C) 0.25 M D) 2.5 M E) 3.2 x 1010 M

\_\_\_\_6. A saturated solution of a a metal hydroxide, M(OH)2 , has a pH of 9.0. What is the

 value of the Ksp of M(OH)2 ? A) 5.0 x 10–28 B) 1.0 x 10–27 C) 5.0 x 10–19

 D) 5.0 x 10–16 E) 1.0 x 10–15

Choices : A) A solution with a pH less than 7 that is not a buffer

 B) A solution with a pH less than 7 that **is** a buffer

 C) A solution with a pH of 7

 D) A solution with a pH greater than 7 that is not a buffer

 E) A solution with a pH greater than 7 that **is** a buffer.

Note: The Ka of acetic acid is 1.8 x 10–5, the Ka of HBrO is 2.5 x 10–9 , and the

 K**b** of NH3 is 1.8 x 10–5

\_\_\_\_7. 0.10 mole of NH3 is mixed with 0.10 mole of NH4Cl in 1.0 L of solution

\_\_\_\_8. 0.10 mole of NaBrO is dissolved in 250 mL of solution

\_\_\_\_9. 50.0 mL of 0.20 molar HBrO is mixed with 50.0 mL of 0.10 molar NaOH

\_\_\_\_10. 0.50 mole of NaC2H3O2 is dissolved in 250 mL of solution

\_\_\_\_11. 50.0 mL of 0.50 M HCl is added to 100.0 mL of 0.50 M NaC2H3O2

\_\_\_\_12. 50.0 mL of 0.50 M HCl is added to 100 mL of 0.25 M KOH.

\_\_\_\_\_13. The Ksp of PbF2 is 3.6 x 10–8. What is the lead ion concentration in

 a saturated solution of PbF2 in which the [F–] is 0.60 molar ?

 A) 6.0 x 10–8 B) 6.0 x 10–7 C) 1.0 x 10–7 D) 1.0 x 10–8 E) 1.0 x 10–9

\_\_\_\_\_14. What is the [H+] in an aqueous solution at 25o C that has an [OH–] of

 2.0 x 10–5 ? A) 2.0 x 10–5 B) 1.0 x 10–7 C) 2.0 x 10–9

D) 5.0 x 10–9 E) 5.0 x 10–10

\_\_\_\_\_15. Titration curves are constructed for two titrations with 0.50 molar NaOH. The first titration uses 0.50 molar HNO3, and the second uses 0.50 molar HC2H3O2. These two curves would be **identical** at pH values

A) from 1 to 3 B) from 2.8 to 7 C) from 9 to 12 D) of exactly 7 only

E) the curves would never be identical

\_\_\_\_\_16. In the Bronsted-Lowry reaction HNO3(aq) + H2O(ℓ) ➞ H3O+(aq) + NO3– (aq)

 the **strongest acid** and **strongest base** respectively are

 A) HNO3 and H2O B) H3O+ and NO3– C) HNO3 and NO3–

 D) H2O and NO3– E) HNO3 and H3O+

\_\_\_\_\_17. Based on the fact that HCO3– is a stronger base than H2PO4– , we can conclude that

 A) CO32– is a weaker base than HPO42– B) H2CO3 is a stronger acid than H3PO4

 C) H2CO3 is a weaker acid than H3PO4 D) CO32– is a stronger base than PO43–

E) HCO3– is a weaker base than H2O

\_\_\_\_\_18. In the reaction Cu2+(aq) + 4 NH3(aq) ➞ Cu(NH3)42+ , the copper (II) ion may be correctly described as A) a Lewis acid B) a Lewis base

 C) a Bronsted acid D) a Bronsted base E) none of these

\_\_\_\_\_19. Which statement about acid-base theories is correct?

A) All Bronsted bases are also Arrhenius bases

 B) All Arrhenius acids are also Bronsted acids

 C) All Lewis acids are also Bronsted acids

 D) Bronsted-Lowry theory is useful only in aqueous solutions

 E) Arrhenius theory applies to gas phase reactions

 \_\_\_\_\_20. A chemist wishing to estimate the pH of a NH3/NH4+ buffer should use a pKa of

 approximately A) 3 B) 5 C) 7 D) 9 E) 15

 (the Kb of NH3 is 1.8 x 10−5 )

\_\_\_\_\_\_21. The Kp for the reaction N2(g) + 3 H2(g) ➞ 2 NH3(g) ( ΔH° = −92 kJ) may be

 increased by which of the following actions?

 I. Decrease the volume of the reaction vessel

 II. Decrease the temperature

 III. Remove NH3 from the reaction vessel.

A) I only B) I and II only C) II only D) II and III only E) I, II, and III

PROBLEMS I.

The base methyl amine, CH3NH2, has a Kb of 4.4 x 10–4

A. Write the formula of the conjugate acid of CH3NH2

B. Write the chemical equation for the ionization of the base in water

C. 0.10 mole of CH3NH2 is dissolved in an aqueous solution with a volume of 200. mL

 Find the pH of this solution.

D. To the solution in part C we add 50.0 mL of 1.0 molar HCl. Find the pH of the resulting

 mixture

E. To the solution in part D we add an *additional***50.0** mL of 1.0 molar HCl. The total volume is now 300. mL. Find the [H+] in this solution

II. The Ksp of Ag2CrO4 is 1.2 x 10–12

 A. What is the molar solubility of Ag2CrO4 in water?

 B. What silver concentration, in molarity, will saturate a Ag2CrO4 solution if the

 CrO42– concentration is known to be 2.0 x 10–3 M

 C. This precipitation is often used to test for the presence of silver ion. Suppose, in

 50.0 mL of solution, the [Ag+] is 0.010 molar. A single drop of solution is 0.050 mL.

 If a single drop of 0.050 molar Na2CrO4 is added to the 50.0 mL of 0.010 molar [Ag+]

 solution, will a precipitate form? Show the calculations that led to your answer.

III. Acetic acid, Ka 1.8 x 10–5 is titrated with potassium hydroxide.

 40.0 mL of 0.200 molar acetic acid is added to a flask. The KOH is 0.100 molar.

 A. What is the pH of the solution before any base is added?

 B. What is the pH after the addition of 60.0 mL of KOH ?

 C. What is the pH after the addition of 80.0 mL of KOH ?

 D. During the titration, a pH meter at one point reads a pH of 5.00 .

 How many mL of KOH had been added at this point?

IV.

H2(g) + CO2(g) ⇄ H2O(g) + CO(g)

When H2(g) is mixed with CO2(g) at 2,000 K, equilibrium is achieved according to the equation above. In one experiment, the following equilibrium concentrations were measured.

[H2] = 0.20 mol/L
[CO2] = 0.30 mol/L
[H2O] = [CO] = 0.55 mol/L

(a) What is the mole fraction of CO(g) in the equilibrium mixture?

(b) Using the equilibrium concentrations given above, calculate the value of Kc, the equilibrium constant for the reaction.

(c) Determine Kp, in terms of Kc for this system.

(d) When the system is cooled from 2,000 K to a lower temperature, 30.0 percent of the CO(g) is converted back to CO2(g). Calculate the value of Kc at this lower temperature.

(e) In a different experiment, 0.50 mole of H2(g) is mixed with 0.50 mole of CO2(g) in a 3.0-liter reaction vessel at 2,000 K. Calculate the equilibrium concentration, in moles per liter, of CO(g) at this temperature.