CHEM 188 – Spring, 2013

Hour Exam 3 (Green)

April 4, 2013

Instructions:

Your scantron answer sheet must show your **NAME**, **7-DIGIT KU ID NUMBER**, and **LAB SECTION**. (Begin these entries at the LEFT end of the space provided.) In answering the questions, be careful to fill in the corresponding circles on the answer sheet according to the number of the question on the exam. **USE A SOFT (No. 2) PENCIL**.

Note that a **periodic table** of the elements is attached at the end of the exam.

Useful information:

Henderson-Hasselbalch eqn. $\mathbf{pH = pK_a + \log \frac{[conj.\ base]}{[acid]}}$

Quadratic formula: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Gas constant $\mathbf{R = 8.314\ J\,K^{-1}\,mol^{-1} = 0.0821\ L\,atm\,K^{-1}\,mol^{-1}}$

Boltzmann constant $\mathbf{k = 1.38 \times 10^{-23}\ J\,K^{-1}}$

Conversion factor: **1 L atm = 101.3 J**

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1. Assuming equal concentrations of conjugate base and acid, which one of the following mixtures is suitable for making a **buffer solution** with an initial pH of 3.1–3.2?

   A. NaF / HF ($K_a = 7.1 \times 10^{-4}$)
   B. C_6H_5COONa/C_6H_5COOH ($K_a = 6.5 \times 10^{-5}$)
   C. CH_3COONa / CH_3COOH ($K_a = 1.8 \times 10^{-5}$)
   D. NaOCl / HOCl ($K_a = 3.2 \times 10^{-8}$)
   E. NaCN/HCN ($K_a = 4.9 \times 10^{-10}$)

2. A solution is prepared by mixing 500. mL of 0.10 M NaOCl and 250. mL of 0.25 M HOCl. What is the **pH** of this solution? K_a(HOCl) = 3.2 x 10^{-8}.

   A. 7.10 B. 7.40 C. 7.70 D. 8.00 E. 8.30

3. You are asked to prepare an carbonic acid - sodium hydrogen carbonate buffer solution with a pH of 6.71. What **molar ratio of $NaHCO_3$ to H_2CO_3** should be used? [K_a = 4.2 x 10^{-7} for H_2CO_3.]

   A. 0.22 B. 0.47 C. 1.0 D. 2.1 E. 4.6

4. You have 500.0 mL of a buffer solution containing 0.20 M acetic acid (CH_3COOH) and 0.30 M sodium acetate (CH_3COONa). What will the **pH** of this solution be after the addition of 5.0 mL of 1.00 M NaOH solution? [$K_a(CH_3COOH) = 1.8 \times 10^{-5}$]

A. 4.41 B. 4.74 C. 4.56 D. 4.95 E. 5.07

5. For which **type of titration** will the pH be <u>less than 7.0</u> at the equivalence point?

A. strong acid vs. strong base
B. strong acid vs. weak base
C. weak acid vs. strong base
D. all of the above
E. none of the above

6. Given that $K_a(HNO_2) = 4.5 \times 10^{-4}$, calculate the **equilibrium constant** for the reaction

$$HNO_2(aq) + OH^-(aq) \rightleftharpoons NO_2^-(aq) + H_2O(l)$$

A. 4.5×10^{-18} B. 2.2×10^{-11} C. 4.5×10^{10} D. 2.2×10^{17} E. none of the above

7. What is the **pH at the equivalence point** in the titration of 100 mL of 0.10 M acetic acid ($K_a = 1.8 \times 10^{-5}$) with 1.00 M NaOH?

A. 8.72 B. 8.92 C. 9.07 D. 9.22 E. 9.35

8. Calculate the **pH of the solution** resulting from the addition of 30.0 mL of 0.10 M NaOH to 50.0 mL of 0.10 M benzoic acid ($K_a = 6.5 \times 10^{-5}$).

A. 3.59 B. 4.01 C. 4.19 D. 4.36 E. 4.79

9. The solubility of lead(II) chromate ($PbCrO_4$) is 1.7×10^{-5} g/100 mL at 20°C. What is the **solubility product, K_{sp},** for lead(II) chromate?

A. 1.1×10^{-8} B. 3.9×10^{-6} C. 1.1×10^{-11} D. 2.8×10^{-13} E. 1.4×10^{-3}

10. The pH of a saturated solution of $Fe(OH)_2$ is 9.50. What is the value of $\mathbf{K_{sp}}$ for this compound?

A. 1.7×10^{-18} B. 4.0×10^{-15} C. 1.6×10^{-14}
D. 2.5×10^{-10} E. 1.6×10^{-5}

11. The solubility product for chromium(III) fluoride, CrF_3, is $K_{sp} = 6.6 \times 10^{-11}$. What is the **molar solubility**, **s**, of chromium(III) fluoride?

A. 1.6×10^{-3} M B. 1.2×10^{-3} M C. 6.6×10^{-11} M
D. 2.2×10^{-3} M E. 1.6×10^{-6} M

12. What is the **pH** of a saturated copper(II) hydroxide solution? [K_{sp} = 2.2 □ $10^{□20}$ for $Cu(OH)_2$]

A. 7.55 B. 9.50 C. 10.46 D. 11.23 E. 12.40

13. The solubility product for MgF_2 is K_{sp} = 8.0 x $10^{□8}$. Calculate the **molar solubility, s**, of MgF_2 in a solution that is 0.050 M in NaF.

A. 8.0 x $10^{□8}$ M B. 3.2 x $10^{□7}$ M C. 2.0 x $10^{□6}$ M

D. 8.0 x $10^{□6}$ M E. 3.2 x $10^{□5}$ M

14. Given that K_{sp} = 1.3 □ $10^{□33}$ for aluminum (III) hydroxide, $Al(OH)_3$, calculate the **molar solubility** of this compound in a solution buffered at a pH of 7.00.

A. 1.3 □ $10^{□9}$ M B. 4.1 □ $10^{□11}$ M C. 1.3 □ $10^{□12}$ M

D. 4.1 □ $10^{□14}$ M E. 1.3 □ $10^{□15}$ M

15. Given the following data,

$K_{sp}[CdS] = 8.0 \times 10^{□28}$

$K_f[Cd(CN)_4^{2□}] = 7.1 \times 10^{16}$

Calculate the **solubility in g/L** of cadmium sulfide, CdS, in 2.0 M NaCN.

A. 4.1 x $10^{□12}$ g/L B. 6.8 x $10^{□5}$ g/L C. 2.7 x $10^{□4}$ g/L

D. 1.1 x $10^{□3}$ g/L E. 4.4 x $10^{□3}$ g/L

16. Calculate **w**, the work done on the system, when 10.0 g of carbon reacts with an excess amount of carbon dioxide to form carbon monoxide at 5.00 atm and 300°C. (Assume that the volume of C(*s*) is negligible, and that the gases show ideal gas behavior.)

$C(s) + CO_2(g)$ □ $2CO(g)$

A. –1.98 kJ B. –3.97 kJ C. –5.95 kJ D. –7.93 kJ E. –9.92 kJ

17. The combustion of coal (*i.e.*, carbon) produces heat according to the equation

$C(s) + O_2(g)$ □ $CO_2(g)$ $□H°_{rxn} = □393.5$ kJ/mol

How much **heat** is generated by the combustion of 1.00 kg of coal?

A. 8,190 kJ B. 16,400 kJ C. 24,600 kJ D. 32,800 kJ E. 41,000 kJ