

Notre Dame University
Faculty of Natural and Applied Sciences
Department of Sciences
Quantitative Analysis / CHM 215
Final Exam – Duration: 120 minutes
Fall 2008

Student Name: _____ ID#: _____

Multiple-choice questions

1- Precipitation titration

- a) Is based on weighing the mass of the precipitate obtained during precipitation
- b) Is based on reactions that yield soluble complexes
- c) **Is based on reactions that yield ionic compounds of limited solubility**
- d) Includes EDTA titrations
- e) None of the above

Questions 2 through 4:

During an argentometric titration where a 0.1 M AgNO_3 solution is used to titrate 50 mL of an NaBr solution:

2- Select the incorrect statement:

- a) **pAg decreases as titration proceeds**
- b) pAg increases as titration proceeds
- c) At the equivalence point $\text{pAg} = \text{pK}_{\text{sp}}/2$
- d) The equivalence point is characterized by a major change in pAg

3- If the equivalence point is obtained upon the addition of 100 mL of AgNO_3 , this means that the initial concentration of NaBr is:

- a) 0.1 M, since Ag^+ react with sodium ion and with bromine ion with a 1:1 ration
- b) **0.2 M**
- c) 0.05 M
- d) It is impossible to answer this question, since the $[\text{NaBr}]$ is not given

4- Before the equivalence point, the Ag^+ concentration can be computed from:

- a) K_{sp}
- b) K_{sp} and initial NaBr
- c) **K_{sp} and excess NaBr**
- d) Excess Ag^+
- e) Excess NaBr

To be corrected

5- What does the ionization constant tell us about the strength of an acid?

- a) **The larger the ionization constant, the stronger the acid**
- b) The smaller the ionization constant, the weaker the acid
- c) The ionization constant does not reflect the strength of an acid
- d) The strength of an acid is inversely proportional to the ionization constant

6- Select the false statement about carbonic acid (H_2CO_3).

- a) It is a diprotic acid
- b) It is a weak acid
- c) **Its neutralization includes 2 stages with 1 buffering regions**
- d) Its half titration yield an amphiprotic species

7- Which solution will have the lowest pH value?

- a) 0.1 M HCN ($K_a = 4.9 \times 10^{-10}$)
- b) **0.1 M HNO_3**
- c) 0.1 M NaCl
- d) 0.1 M H_2CO_3
- e) 0.1 M NaOH

8- Which one of the following statements on buffers is false?

- a) The more the concentration of buffer components is large, the more the buffer capacity is important.
- b) A buffer system is always composed from a weak acid and its conjugate weak Base
- c) A buffer resists change in pH
- d) The buffer capacity is the best when the concentration of the weak acid is equal to the concentration of its conjugate base
- e) **All of the above are true**

9- An EDTA solution is added to a solution containing 0.1 mol/L of Ag^+ , Cu^{2+} , Ca^{2+} , and Zn^{2+} . Referring to the formation constants for EDTA complexes, which cation is complexed first?
 $K(\text{CaY}^{2-}) = 5 \times 10^{10}$, $K(\text{CuY}^{2-}) = 6 \times 10^{18}$, $K(\text{AgY}^{3-}) = 2 \times 10^7$, $K(\text{ZnY}^{2-}) = 6 \times 10^{13}$

- a) Ag^+
- b) **Cu^{2+}**
- c) Ca^{2+}
- d) Zn^{2+}

10- Calculate the pH of the solution that results when 20.0 ml of 0.20 M formic acid are diluted to 45.0 ml with distilled water. (K_a for formic acid = 1.8×10^{-4})

- a) 7
- b) 4.7
- c) 1.5
- d) 3.8
- e) **2.4**

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11- Calculate the percent ionization of 0.0010 M CH_3COOH . ($K_a = 1.75 \times 10^{-5}$)

- a) 6.71×10^{-2}
- b) 4.83×10^{-3}
- c) 2.56×10^{-5}
- d) **1.32×10^{-4}**
- e) 3.82×10^{-5}

12- In the Fajans method for signaling the end point in argentometric titration:

- a) The indicator used is an adsorption indicator
- b) The indicator used is fluorescein
- c) The end point is indicated by back titration
- d) **Two of the above**
- e) All of the above

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Problems (7 problems)

1- Calculate Ni^{2+} concentration in a solution that is buffered to a pH of 3 and prepared by mixing 50.0 ml of 0.025 M Ni^{2+} with:

- a) 25 mL of a 0.05 M EDTA solution (6 points)
 $K(\text{NiY}^{2-}) = 4.2 \times 10^{18}$; $\alpha_4 = 2.51 \times 10^{-11}$

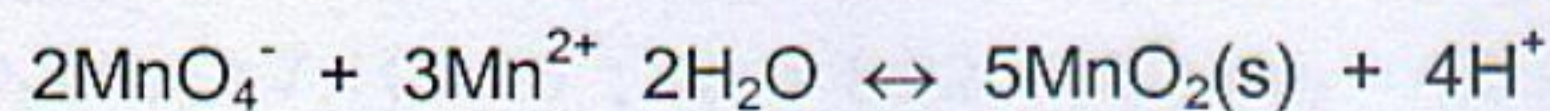
Answer: $1.26 \times 10^{-5}\text{M}$

- b) 50 ml of a 1.86% (m/v) EDTA (372.24 g/mol) solution. (6 points)

Answer: 9.52×10^{-9}

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2- Calculate the equilibrium constant for the reaction (10 points)



$$E^\circ \text{MnO}_4^-/\text{MnO}_2 = +1.695 \text{ V and } E^\circ \text{MnO}_2/\text{Mn}^{2+} = +1.23 \text{ V}$$

Hint: multiply equations by appropriate integers so that the numbers of electrons are equal.

Answer: 1.44×10^{47}

$$4.848 \times 10^{-3} \text{ g/L}$$

3- A solution containing 4.48 ppm KMnO_4 (158.04 g/mol) has a transmittance of 0.309 in a 1.0 cm cell at 520 nm. An unknown KMnO_4 solution has a transmittance of 0.502 in the same cell at 520 nm. What is the concentration in ppm of the unknown KMnO_4 solution?

8 pts

$$A = -\log T \Rightarrow A = -\log 0.309 = 0.51$$

$$A = abc \Rightarrow a = \frac{A}{bc} = \frac{0.51}{1 \times 4.48 \times 10^{-3}} = 113.85$$

$$A' = -\log 0.502 = 0.3$$

$$c = \frac{A'}{bc} = \frac{0.3}{1 \times 113.85} = 2.62 \times 10^{-3} \text{ g/L}$$

$$= 2.62 \text{ g/L}$$

$$= 2.62 \text{ ppm}$$

4- Calculate the hydronium ion concentration in a solution that is 0.040 M in

(Given Data on H_3PO_4 : $K_{a1} = 7.11 \times 10^{-3}$; $K_{a2} = 6.32 \times 10^{-8}$; $K_{a3} = 4.5 \times 10^{-13}$)

a) Na_3PO_4 (6 points)

Answer: 1.18×10^{-11}

b) Na_2HPO_4 (6 points)

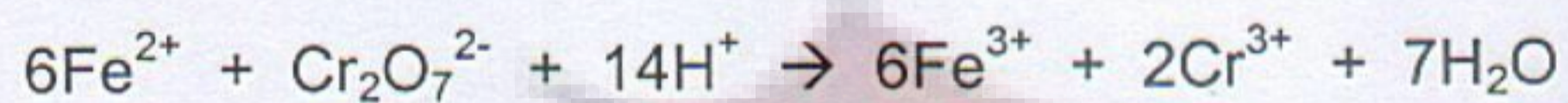
Answer: 2.4×10^{-10}

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5- Calculate the pH of a solution made by mixing 50.0 ml 0.2 M NH_4Cl (aq) and 75 mL of 0.1 M NaOH (aq). $K_b(\text{NH}_3) = 1.8 \times 10^{-5}$ at 25°C . (10 points)

Answer: 9.72

6- A 100 mL sample of spring water was treated to convert any iron present to Fe^{2+} . Addition of 25.00 mL of 0.002107 M $\text{K}_2\text{Cr}_2\text{O}_7$ to the previously treated sample resulted in the following reaction:



The excess $\text{K}_2\text{Cr}_2\text{O}_7$ was back titrated with 7.47 mL of a 0.00979 M standard Fe^{2+} solution. Calculate the parts per million (mg/L) of iron in the sample. (10 points)

Answer: 135.4 ppm

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7- BONUS: Calculate the potential of a platinum electrode immersed in a solution that is 0.0183 M in $\text{K}_3\text{Fe}(\text{CN})_6$ and 0.00566 M in $\text{K}_4\text{Fe}(\text{CN})_6$. (6 points)

$$E^\circ \text{Fe}(\text{CN})_6^{3-}/\text{Fe}(\text{CN})_6^{4-} = 0.36 \text{ V}$$

0.329 V

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