Chem 112
Quiz No. 2
Jan 19, 2007

Name: KEY

This quiz (front and back) is to be taken during one of the permitted time slots. It is expected that the student spend 20-30 minutes on the quiz, but it MUST be handed in by the end of the selected time slot. SHOW ALL WORK. NO "MAGIC" PERMITTED. WATCH SIG FIGS. USE PROPER SET-UPS

1. In each case below you will be given the description of a solution described in terms of a bulk substance placed into water. Note there are NO major reactions occurring here. In each case below:
   a) Identify the Ultimate Units.
   b) Explain HOW the pH will be determined in each case. YOU NEED NOT DO ANY CALCULATIONS HERE. If appropriate, write the minor reaction and the appropriate K expression which applies in each case, from the information given. If the final pH can be determined "directly", explain how you come to such a conclusion.

I. 10.0 mL of Sodium Hydroxide, NaOH(MW = 40.00) is brought to a final volume of 100.0 mL by the addition of water.

a) Na⁺ and OH⁻

b) Find [OH⁻] by "direct" calculation, from this you can get pOH and then pH = 14 - pOH

II. 12.6 g of ammonium chloride, NH₄Cl (MW = 53.50) is brought to a final volume of 500 mL by the addition of water. The Kₐ for NH₄⁺ is 5.5x10⁻¹⁰

a) NH₄⁺, Cl⁻ NH₄⁺ has A/B properties, Cl⁻ is spectator

b) NH₄⁺ + H₂O ⇌ H₃O⁺ + NH₃; calc. using \( \frac{x^2}{C} = K_a \)

\[ 5.5 \times 10^{-10} = \frac{x^2}{[NH_4^+]}; x = [H_3O^+] \text{ and } pH = -\log [H_3O^+] \]

III. A beaker containing 50.00 mL of pure distilled water has placed into it 5.85 g of Sodium Chloride, NaCl (MW = 58.50).

a) Na⁺, Cl⁻; NEITHER have A/B properties

b) Calculate using Kw expression: \([H_3O^+][OH^-] = 1.0 \times 10^{-14}\)

Since \([H_3O^+]= [OH^-], [H_3O^+] = 1.0 \times 10^{-7}\) and \(pH = 7.00\)

IV. 23.6 g of Potassium Acetate, KOAc (MW = 98.00) is diluted with distilled water to a final volume of one liter in a volumetric flask. The Kₐ for HOAc is 1.8x10⁻⁵

a) K⁺, OAc⁻ K⁺ is spectator; OAc⁻ present in the form of HOAc/OAc⁻ = A/B pair

b) OAc⁻ + H₂O ⇌ HOAc + OH⁻

use \( k_b = \frac{x^2}{C} \): calculation: \( k_b = \frac{K_w}{K_a} [OAc^-] = \frac{x^2}{K_a [OAc^-]} \); find pOH, then pH
2. Given a pH value of 7.40 (the pH value of normal blood, by the way) what other 3 pieces of immediately-related information are available to you?

\[
\text{pOH} \quad \text{[OH}^-\text{]} \quad \text{and} \quad \text{[H}_3\text{O}^+\text{]}
\]

What are their values?

\[
6.60 \quad 10^{-6.60} = 2.5 \times 10^{-7} \quad \text{and} \quad 10^{-7.4} = 4.0 \times 10^{-8}
\]

\[
\text{or } \frac{K_w}{K_b} = \frac{1.0 \times 10^{-14}}{2.5 \times 10^{-7}} = 4.0 \times 10^{-8}
\]

3. Caproic Acid, \( \text{C}_5\text{H}_11\text{COOH} \), is the protonated form of a Weak Acid/Base conjugate pair.

a) Indicate the position of the acidic proton

in the \( \text{H} \) on the \( \text{COOH} \)

b) Write the formula of the conjugate of Caproic Acid

\[
\text{Conjugate} = \text{C}_5\text{H}_11\text{COO}^-
\]

c) The pKa for Caproic Acid is 4.88. What other 3 pieces of immediately-related information are available to you?

\[
pK_b \quad \text{for } \text{C}_5\text{H}_11\text{COO}^- \quad K_b \quad \text{and} \quad K_a
\]

What are their values?

\[
9.12 \quad 10^{-9.12} = 7.6 \times 10^{-10} \quad \text{and} \quad \frac{K_w}{K_b} = 1.3 \times 10^{-5}
\]

d) The \( K_a \) for Acetic Acid, \( \text{HOAc} \), has a value of \( 1.8 \times 10^{-5} \). Which is the stronger acid, Caproic Acid or Acetic Acid? How do you know?

\[
\text{The } pK_a \text{ for } \text{HOAc} \text{ is } -\log (1.8 \times 10^{-5}) = 4.74
\]

The smaller the \( pK_a \), the stronger the acid.

\[
\text{The } pK_a \text{ for caproic acid is } 4.88 \text{ (from part C above)}
\]

so \( \text{HOAc} \) is the stronger acid.

* Pledge: I have neither given nor received any unacknowledged aid on this quiz: