Salts in Water and Buffer Solutions Experimental Confirmations

Chemistry for the Sciences II Summer 2008

You will now experimentally confirm many of the answers you have already submitted in the form of a pre-lab. You will notice that experimental confirmation numbers correlate with the pre-lab numbers.

Calibrate a pH electrode (pH 4 & pH 10), and set up a laptop computer, complete with Logger Pro.

10. Prepare 100 mL of a 0.10 M solution of NH_4HCO_3. (Note that you have already done the necessary calculations in your pre-lab.)

    a. What is the pH of your solution? _____

    b. Is the solution acidic, basic, or neutral? _____

    c. Do your experimental results match your prediction for this salt (from pre-lab)? _____

    d. If not, did you make your prediction incorrectly, was there a problem with your experiment, or is there another reason why your predicted result didn't match your experimental finding? If necessary, make the appropriate corrections and try again.

11. Mass approximately 0.4 grams (to at least 3 decimals) of aluminum nitrate nonahydrate and dissolve in a 100-mL volumetric flask.

    a. What is the molarity of Al^{3+}? (see your pre-lab!) _____

    b. Measure the pH of this solution? _____

    c. Do your experimental results match your prediction for this salt (from pre-lab)?

    d. Write out an equilibrium for $Al(H_2O)_6^{3+}$ in water that agrees with the pH found in b.

    e. Set-up an ICE table and calculate the K_a or using your *experimentally measured pH* (an equilibrium calculation!). Compare with the literature value to that in your text/CRC. How well do they agree?

The Preparation of a Buffer

13. **Make 250 mL of a HCO_3^- / CO_3^{2-} buffer.** Use your pre-lab calculations to prepare a buffer involving HCO_3^- to CO_3^{2-} ions that would have a pH = 9.8. In a 250-mL volumetric flask, dissolve the appropriate mass of each reagent in distilled water and fill to the mark.

    a. What is the pH of your solution? _____

    b. Show your instructor your work to this point. Have him/her initial your paper.

    c. Add 1 drop of concentrated HCl to this solution. What is the new pH? _____

    d. How much did the pH change? _____

    e. Measure the pH of a 250-mL sample of distilled water. _____

    f. Add 1 drop of conc. HCl to the water. What is the new pH? _____

    g. How much did the pH change? _____

    h. Did the buffer solution seem to resist changes in pH when compared to the water? Explain!

14. Prepare a CH_3COOH/CH_3COO^- buffer of pH = 5.1. K_a of $CH_3COOH = 1.8 \times 10^{-5}$

RULES (remember you outlined this procedure in your pre-lab):

a. You must prepare <u>exactly</u> 250 mL of the buffer solution.

b. You may use no more than 5 grams of any solid reagent or 5 mL of any liquid reagent. Therefore, you will find that the amounts of reagents used should be on the order of 10^{-2} moles.

c. Use whatever equipment you know will be available to you- analytical balances, various sizes of volumetric pipets (ask your instructor if you don't know where to find the volumetric pipets). There are also graduated 1-mL pipets for dispensing volumes of less than 1-mL.

d. Use distilled water for the preparation of your solution.

e. Acetic acid is a liquid; the acetate will be in the form of a salt. Assume that you have sodium acetate.

Use the same method you just used for the preparation of HCO_3^- / CO_3^{2-} buffer. As you prepare your solutions, be sure to take careful notes of everything you do. With ample documentation in your lab notebook, your instructor will be better able to diagnose any error in calculation or experimentation.

To prepare this buffer solution, you will use sodium acetate and glacial (concentrated) acetic acid. My advice: make a dilute solution of acetic acid from glacial acetic acid, then use that dilute solution as your source of acetic acid (i.e., DO NOT use the glacial acetic acid directly in the preparation of your buffer solution- dilute it first).

*** SAFETY COMMENT: When using glacial acetic acid, work under a fume hood and wear gloves!! Do NOT open the bottle outside of a fume hood. Clean up ANY SPILL IMMEDIATELY and THOROUGHLY with lots of water, no matter how small the spill may be- even if it is a drop of liquid that rolled down the outside of the bottle- CLEAN IT UP!!! ***

a. What is the pH of your solution? _____

b. Add 1 drop of concentrated HCl to this solution. What is the new pH? _____

c. How much did the pH change? _____

d. Measure the pH of a 250-mL sample of distilled water. _____

e. Add 1 drop of conc. HCl to the water. What is the new pH? _____

f. How much did the pH change? _____

g. Did the buffer solution seem to resist changes in pH when compared to the water? Explain!

Post-lab Questions

1. What is meant by *buffer capacity*?

2. At what pH values are acid buffers effective, assuming equal molarities of the acid and its conjugate base? Name an acid buffer system and the pH where it is most effective.

3. Consult the table of pK_a values suggest acid/conjugate base system that would yield a pH of 6.0. Explain your selection.

4. Novocaine, which is used by dentists as a local anesthetic, is a weak base with a $pK_b = 5.05$. Blood has a pH of 7.4. What is the ratio of concentrations of novocaine to its conjugate acid in the bloodstream?

5. A buffer solution is prepared by mixing 50.0 mL of 0.022 M $C_6H_5COOH_{(aq)}$ (benzoic acid) and 20.0 mL of 0.032 M $NaC_6H_5CO_2(aq)$.

    a. What is the pH of the buffer solution?

    b. What are the pH and the change in pH after the addition of 10.0 mL of 0.054 M HCl to the buffer solution?

    c. What are the pH and the change in pH after the addition of 10.0 mL of 0.054 M HCl to the original benzoic acid solution (NOT the buffer)?