EXERCISE 19
pH and Several Applications

Objectives:

1. To study the neutralizing properties of a buffer mixture.
2. To become familiar with the use of a pH meter and various chemical indicators.
3. To determine the ionization constant of a weak acid.

Equipment

1. test tubes
2. dial-a-gram balances
3. pH meter
4. universal indicator
5. wide range pH paper
6. beakers and stirring rods

I. pH of Some Common Substances

In this procedure we will determine the pH of various aqueous solutions of common materials. Two methods will be used to demonstrate how pH can be measured. Also, the pH will be measured using indicators.

TABLE 19-1

Color vs. pH for Universal Indicator

Solution Color	pH
red	0-4
orange	4-5.5
yellow	5.5-6.0
yellow-green	6.0-6.5
green	7.0-7.5
blue-green	8.0-8.5
blue	8.5-9.0
purple	9.5
brown-red	10.0

Procedure - pH Using indicator and pH Meter

1. Arrange 6 test tubes to hold 1 ml of each of the following solutions:

   (1) distilled water
   (2) 5% solution of table salt, NaCl
   (3) 5% washing soda, Na_2CO_3
   (4) 5% baking soda, $NaHCO_3$
   (5) 5% Joy detergent
   (6) pure vinegar

   Add 2 drops of universal indicator to each solution and determine and record the pH (see Table 2-1). Your instructor will demonstrate the pH meter and determine the pH for these 6 solutions as well as the pH or pure orange juice, lemon juice, and Coke. Record the values.

2. Obtain a test tube and add 5-7 ml of distilled water. Blow under the surface of water for 2-3 minutes, using rubber tubing or polished glass tubing. Use universal indicator to determine pH of water. Record your observations and explanation.

II. Buffer Solutions

One of the most important properties of buffers is their tendency to resist a small change in pH upon the addition of an acid or a base to the buffered solution.

3. Pipet 10 ml distilled water in a test tube. Add 1 drop of methyl orange indicator. Now add 1.0 M HCl dropwise until he solution color changes to red. Record the number of drops of acid added.

4. Repeat this procedure but use 1.0 M NaOH using one drop of phenolphthalein indicator until the solution turns red. Record the number of drops of base added.

5. To study the tendency of a buffer to resist a change in pH, prepare a buffer solution by mixing 10 ml of 1.0 M acetic acid and 10 ml of 1.0 M sodium acetate using a pipet. dilute the mixture

to a total volume of 100 ml using a volumetric flask. Pipet 10 ml of this buffer into a clean test tube and add 1 drop of methyl orange. Add 1.0 M HCl dropwise until a red color is produced. Record the number of drops added.

6. Pipet another 10 ml of the same buffer into a test tube; add one drop of phenolphthalein and then add 1.0 M NaOH dropwise until the color of solution changes to red. Record the number of drops added.

7. Explain why a much larger amount of acid or base is required to change the pH of the buffer compared to pure water. Write equations for the reactions that occur upon addition of acid or of base to the buffer mixture.

III. Ionization Constant of Acetic Acid

8. Take the remainder of the buffer solution prepared in procedure (5) and determine the pH using the pH meter.

9. From the pH, calculate [H] using

$$pH = -\log [H] \qquad 19\text{-}1$$

From (5) above, and using the expression

$$(N_A)\ (ml_A) = (N_B)\ (ml_B) \qquad 19\text{-}2$$

Calculate the molar concentration of the acetate ion and the molar concentration or acetic acid. Then, using the expression

$$Ka = \frac{\left[H^+\right]\left[OAc^-\right]}{\left[HOAc\right]} \qquad 19\text{-}3$$

Calculate Ka for acetic acid.

10. Compare your calculated Ka for acetic acid to the accepted value, and calculate your percent error.

ANSWER SHEET - 1

EXERCISE 19

NAME _____ SECTION _____

DATE _____

I. pH

		pH from Indicator	pH from pH meter
1.	Distilled Water	_____	_____
	5% Table salt.....	_____	_____
	5% Washing soda.....	_____	_____
	5% Baking soda.....	_____	_____
	5% Joy.....	_____	_____
	Vinegar.....	_____	_____
	Orange Juice.....		_____
	Lemon Juice		_____
	Coke		_____

2. Observations:

Explanation:

ANSWER SHEET - 2

EXERCISE 19

II. Buffer Solutions

3. drops of 1 M HCl _____

4. drops of 1 M NaOH _____

5. drops of 1 M HCl _____

6. drops of 1 M NaOH _____

7. Explanation:

Equation for addition of acid to buffer_____

Equation for addition of base to buffer_____

III. Ionization Constant of Acetic Acid

8. pH _____

9. [H+] _____

[OAc-] _____

[HOAc] _____

Ka _____

10. Accepted Ka _____

Percent Error: