Name____

Pre-Laboratory Assignment

1. Using the structural formula of citric acid shown in Figure 1, determine the molecular formula of citric acid and calculate its molar mass (g/mole).

2. A 10.0-mL sample of pineapple juice was titrated with 0.100 *M* sodium hydroxide solution. The average volume of NaOH required to reach the endpoint was 12.8 mL.

   a. Calculate the number of moles of sodium hydroxide required to reach the endpoint.

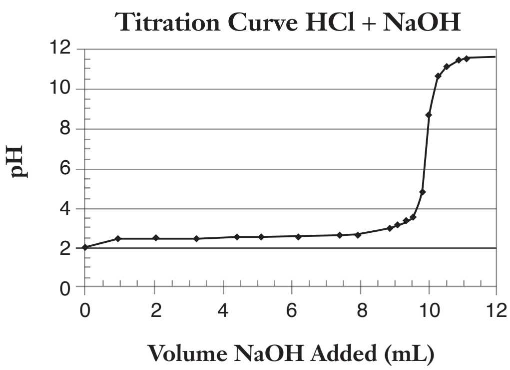
   b. Using the mole ratio for the neutralization reaction shown in Equation 1, determine the number of moles of citric acid in 10.0 mL of pineapple juice.

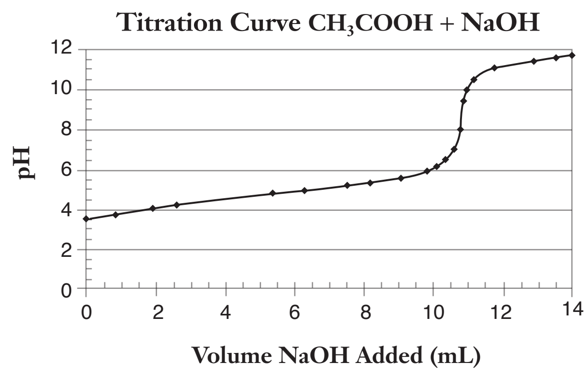
   c. Multiply the number of moles of citric acid by its molar mass to calculate the mass of citric acid in 10.0 mL of the juice.

   d. The concentration of acid in juices is usually expressed in grams of acid per 100 mL of juice. What is the concentration of citric acid in pineapple juice?

3. Write a balanced chemical equation for the neutralization reaction of (a) hydrochloric acid and (b) acetic acid with sodium hydroxide.

4. The titration curves for hydrochloric acid and acetic acid with sodium hydroxide are shown below. Distinguish between the strong and weak acid in terms of the initial pH, the pH at the equivalence point, and the overall shape of the titration curve.





Post-Laboratory Review Questions

1. Why is phenolphthalein an appropriate indicator for titration of a strong acid with a strong base? Explain based on the pH at the equivalence point and the transition range for phenolphthalein.

2. A 10.00-mL sample of HCl solution was transferred to an Erlenmeyer flask and diluted by adding about 40 mL of distilled water. Phenolphthalein indicator was added, and the solution was titrated with 0.215 *M* NaOH until the indicator just turned pink. The exact volume of NaOH required was 22.75 mL. Calculate the concentration of HCl in the original 10.00-mL sample.

3. One student accidentally "overshot" the endpoint and added 23.90 mL of 0.215 *M* NaOH. Is the calculated concentration of HCl likely to be too high or too low as a result of this error?

4. Acid–base indicators are large organic molecules that behave as weak acids. The distinguishing characteristic of indicators is that the acid (HIn) and conjugate base (In^-) forms are different colors.

$$\underset{\text{(Color A)}}{HIn(aq)} + H_2O(l) \rightarrow \underset{\text{(Color B)}}{In^-(aq)} + H_3O^+(aq)$$

The color of an indicator solution depends on pH and the relative amount of HIn and In^- at a given pH. Consider the following indicators and their acidic and basic colors, as well as the pH transition range for each.

Indicator	HIn	In^-	pH Transition
Alizarin*	Yellow	Red	5.5–6.8
	Red	Purple	11.0–12.4
Bromthymol blue	Yellow	Blue	6.0–7.6
Phenolphthalein	Colorless	Pink	8.2–10.0

**Alizarin has two ionizable hydrogen atoms and three color forms, H_2In, HIn^-, and In^{2-}.*

a. The intermediate or transition color of bromthymol blue is green. What are the relative proportions of HIn and In^- when bromthymol blue is green? Explain.

b. A colorless solution was tested with phenolphthalein, bromthymol blue and alizarin. The solution was colorless with phenolphthalein, yellow with bromthymol blue and orange with alizarin. What is the pH of the solution? Explain.