

## 4 • Classifying Chemicals: Acids & Bases

### VINEGAR TITRATION

#### Introduction:

The label on a bottle of commercial white vinegar will state, by law, the % by mass of acetic acid ( $\text{HC}_2\text{H}_3\text{O}_2$ ).

Usually it is 5% (5 grams  $\text{HC}_2\text{H}_3\text{O}_2$  per 100 grams vinegar solution). Some brands may be as low as 3%.

The vinegar we are testing is labeled as : \_\_\_\_\_

#### Equipment:

50 mL Erlenmeyer flask

Dropper bottle with vinegar & phenolphthalein indicator

Distilled water bottle

Dropper bottle with \_\_\_\_\_ M NaOH solution

We will roughly test to see whether the label is correct. Perform four trials of a titration (as demonstrated in class). Use the designated amount of Vinegar. Fill in the Data Table below:

DATA	Trial #	Drops of Vinegar	Drops of NaOH(aq)	CALCULATIONS	Calculated [Vinegar]
	1	10			
	2	10			
	3	30			
	4	30			

#### Questions:

- Calculate the concentration of the vinegar solution in each of the four trials. Fill in the Calculation Table above. Use the equation:  $V_a \underline{M}_a = V_b \underline{M}_b$ .
- What is the average of your four trials? [Vinegar] = \_\_\_\_\_
- We are using 5% vinegar. This means there should be \_\_\_\_\_ g  $\text{HC}_2\text{H}_3\text{O}_2$  in 100 g of vinegar solution. How many grams of  $\text{HC}_2\text{H}_3\text{O}_2$  would be in 1000 g of vinegar solution? \_\_\_\_\_
- How many *moles* of  $\text{HC}_2\text{H}_3\text{O}_2$  would be in 1000 g of vinegar solution? \_\_\_\_\_  
Show your line equation (with units):
- The density of vinegar is 1.08 g/mL. Using density as a conversion factor, calculate the volume of 1000 g of vinegar solution (in Liters). Show work:  
  
1000 g vinegar x \_\_\_\_\_ x \_\_\_\_\_ =
- Using answers from 4 & 5, calculate the concentration (M) of a vinegar solution labeled "5% acidity". Show work.
- According to your data, is this vinegar *at least* 5% acidity? \_\_\_\_\_  
Suggest two ways this experiment could be carried out more carefully:
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### Practice Problems:

In an experiment very much like the “Vinegar Titration,” a student tests the concentration of another bottle of vinegar. This bottle says that it has been diluted with water to a strength of 4% (by mass).

- 1) What is the molarity (M) of acetic acid in this new vinegar?  
(Show your work.)

- 2) Using a standardized NaOH solution of 0.650 M, the student does the following dropwise titrations.

Trial #	Drops of Acid	Drops of Base	[Vinegar]
1	50	53	
2	50	55	
3	100	109	
4	100	111	

Determine from this data:

- a) the concentration of acid for each trial (show work for Trial 1)

- b) the average concentration of the vinegar. \_\_\_\_\_

Would your evidence suggest that this vinegar is “legal” according to the label? \_\_\_\_\_

- 3) Now let’s use some 1.00 M HCl and test the concentration of household ammonia (actually  $\text{NH}_4\text{OH}$ ). In each of the following trials, we measure out about 10 mL of HCl and add our “ammonia” until we reach the endpoint.

DATA	Trial #	Volume of HCl (mL)	Volume of $\text{NH}_4\text{OH}$ (mL)	[ $\text{NH}_4\text{OH}$ ]
	1	10.00	25.72	
	2	10.34	28.59	
	3	10.58	27.76	

Calculate the concentration of ammonium hydroxide in each of the three trials. (Show your work for trial 1.)