sterling

Lab Title: Acid-Base Titration

Research Question:

What can we determine from a titration?

Introduction:

In this experiment, we will use a standardize solution of NaOH (sodium hydroxide) with a concentration of 0.50 (M) to find the concentration of $HC_2H_3O_2$ (acetic acid) in vinegar. This is an organic acid. The reaction with sodium hydroxide and vinegar is an acid-base reaction; the balanced chemical equation for this reaction is:

$NaOH\ (aq) + HC_2H_3O_2\ (aq) \longrightarrow NaC_2H_3O_2\ (aq) + H_2O\ (l)$

H_2O can also be thought of as H-O-H to better understand that the first H is donated to the base, thereby forming water because this base has the OH^{-1} ion. The product is water and a salt, which is the combination of sodium (Na) and the acetate ion ($C_2H_3O_2$).

We will be using the following formulas in our calculations:

$NaOH_{final} - NaOH_{initial} = NaOH_{used}$

$M_A \times V_A = M_B \times V_B$

Sum/# items = Average

[(Experimental Value – Accepted Value)/Accepted Value] x 100 = % Error

Procedure:

Place the NaOH in the biuret using a funnel and the vinegar into the Erlenmeyer flask with distilled water so that there is 20 mL in the flask. Then, add a few drops of phenolphthalein for the indicator. Use the stop cock to adjust the flow of NaOH from the biuret into the flask of vinegar. Swirl and rinse inside of flask with distilled water as the NaOH is being dripped into it. When the pink coloration appears and does not fade, turn the stop cock on the biuret to stop the flow of NaOH. Use a white piece of paper to read the biuret. Record the final amount onto the table for the NaOH. Repeat this procedure twice, recording the results for each of these trials as well in the table. After all three trials are completed, perform the calculations necessary to obtain the volume of NaOH used, the molarity (M) of acetic acid in the vinegar, and the % error for our experiment.

Data/Observations

	TRIAL 1	TRIAL 2	TRIAL 3
Volume of Vinegar	20.00 mL	20.00 mL	20.00 mL
Volume of NaOH (initial)	0.60 mL	0.85 mL	0.45 mL
Volume of NaOH (final)	35.45 mL	34.30 mL	33.80 mL
Volume of NaOH (used)	34.88 mL	33.45 mL	33.35 mL
Molarity of Vinegar	0.87 M	0.84 M	0.83 M

Average = 0.85 M

$\frac{M_A (20\ mL)}{20\ mL} = \frac{(0.5\ M)(33.35)}{20\ mL} = 0.83\ M$

Calculations:

$$\frac{0.85-0.83}{0.83} \times 100 = 2.4\%$$

Conclusion:

Titrations allow us to find the unknown concentration of the analyte using a known concentration and amount of the titrant. Using the known to derive the unknown is what we accomplish in stoichiometry. Therefore, a titration is stoichiometry in action.

However, titrations are not infinitely precise. The endpoint and the equivalence point are, ideally, the same. In titrations, though, the endpoint is determined by the slight change in the indicator's color. This is a qualitative analysis and not quantitative. Therefore, it is not infinitely precise. In this titration experiment, we were looking for a color change of *slight* pink. A color change of a darker pink means the endpoint has been overshot and the result's inaccuracy increases. A titration carefully done with only a slight color change can result in an endpoint that is very near to the equivalence point and with a low % error, as ours did (only a 2.4 % error).

Indicators are helpful to determine endpoint but are not infinitely precise. A pH probe would be more accurate and closer to the equivalence point itself.

Vocabulary:

Titration – The slow addition of one solution of a known concentration to a known volume of another solution

Titrant – The solution of known concentration that is added to another solution to determine the concentration of a second chemical species.

Analyte- A substance who's chemical constituents are being identified and measured.

Endpoint – The point during a titration when an indicator shows that the amount of reactant necessary for a complete reaction has been added to a solution.

Equivalence Point – Point in titration at which the amount of titrant added is just enough to completely neutralize the analyte solution

Molarity (M) – A unit of concentration expressed as the number of moles of dissolved solute per liter of solution.

Indicator - Any substance that gives a visible sign, usually by a color change, of the pressence or absence of a threshol concentration of a chemical species in a solution