Pre-lab Experiment 20-Acid-Base Titration: Standardization of KOH and Determination of the Molarity and/or Percent Composition of an Acid Solution

Format & Clarity of the Report: See lab report checklist. (Handout #6)

Before class starts: Read the lab for the week carefully before you start writing your pre-lab. The purpose and procedure should be neatly written in your lab book before class starts. Pre-lab questions need to be correctly answered.

Spacing: You will need 1 pages for the purpose & pre-lab. The procedure usually takes about 2 pages. Leave space, you are collecting a lot of data. You have at least 6 data trials. Data tables will use 1page. Most students need 2 pages for calculations. The results table is short and will only use 0.5-1 page. The questions are about 2 pages.

Purpose: Address the following in your purpose: What will you ultimately determine in this lab? Each step has you determine some value or an observation leads you to a conclusion, but not all observations and calculations are suitable for the purpose.

Introduction: None, write the **METHOD** here. Summarize the steps for the lab in about 5 sentences.

Pre-lab questions: Pre-lab questions are designed to help you do the lab. Put your pre-lab questions after the METHOD and before the PROCEDURE. You should thoughtfully answer the questions clearly and concisely using complete sentences, good grammar, and in Standard English. The answers should be easy to read and follow. They will serve as a reference for YOU when you do your calculations for lab. The answers should address the main thrust of each question.

(Remember, ALWAYS show your work and explain your reasoning.)

1. What would happen to the standard solution concentration if water was inadvertently introduced?
2. Should the reaction vessel be dry?
3. Once the mass of the vinegar is known, is it okay to add water to the reaction vessel?
4. What is the purpose of a titration?
5. What is an indicator used for? (You might need to use the index in your textbook.)
6. What is the difference between an endpoint and an equivalence point?
7. Calculate the approximate mass of KHP you will need to weigh out to make 250 mL of 0.10 M KHP solution. The formula of KHP is $KHC_8H_4O_4$.

Procedure Notes:

Part 1:

- Use an analytical balance to weigh the KHP.
- Make your solution carefully.
- Do not go over the mark on the neck of the flask.
- Transfer this solution to a clean, dry 250-mL Florence flask (To distinguish between an Erylenmyer and a Florence flask, remember: My aunt Florence has a round bottom!)

Part 2 & 3:

- For all the titrations, rinse your burette with solution three times before using it.
- Put white paper under the reaction flask when doing a titration so that you can see the color change.
- Use 1-2 drops of indicator to visualize the endpoint.
- Use the same bottle of indicator for each trial.
- During the titration, be sure to rinse the walls of the titration flask with distilled water.
- KEEP YOUR BASE SOLUTION UNTIL EVERYONE IN CLASS IS DONE WITH THE EXPERIMENT. WE USUALLY NEED EXTRA BASE.
- **Allow space in your procedure area for the initial volume of acid, the initial and final volumes of base used, and any other data. In total, each group should have no less than 6 titrations. More is better!**
- Read the burette to 0.00mL. Make sure that there are no leaks or air bubbles in the burette tip.

Part 2:

- Use several erylenmyers. 125 mL erylenmyers are under the hood. If you prepare 3 at one time, the titration process is fast.
- You will use two burettes in **Part 2**
- Collect your base in a DRY ***500*** mL Florence flask.
- You will do as many titrations [at least 6] as you need to be within 1.5% agreement. Do this calculation on scratch paper. You can transfer it to your calculation section later.

Part 3:

- You will useone burettes in Part 3
- You need the mass of the vinegar for each trial.
- The vinegar will be set up in a 'Vinegar station'. Read the initial and final volumes to determine the volume of vinegar delivered.
- Preweigh 3-4 erylnemeyers for titration, and subsequent delivery of vinegar.

Qualitative Observations/Data Collection:

YOU WILL NEED TO DO SOME MODIFIED CALCULATIONS DURING THIS LAB. THESE CALCULATIONS CAN BE DONE IN THE DATA/OBSERVATION SECTION SO THAT YOU CAN MOVE THROUGH THE PARTS OF THE LAB.

All significant figures and units are correct. The appropriate numbers of trials were done for each section in the lab. Data collection needs to be done with care, use this section to look beyond the obvious observations:

Show the actual, not the rough or estimated, calculation section of the report for each part. Don't mix the data streams.

PART 1-mass of KHP, moles KHP, Molarity KHP solution.

PART 2-change in volumes, % difference to get to <1.5%. Hint: $M_1V_1=M_2V_2$!

Hint: The concentration of the acid is constant; therefore, you can use the ratio of the volumes to get a rough estimate of your % differences.

- Use this data to determine if you need more titrations. Once you determine your 'working' data set, calculate the individual molarities of the KOH (or OH^-) solution, and the average molarity. You can do the other calculations in the Calculations section.

PART 3: Calculate the volume changes of the vinegar and the base solution. Hint: $M_1V_1=M_2V_2$!

Hint: M_{OH} and molar mass acetic acid are constant; compare ratio of Volume of KOH^- used to grams of vinegar used to estimate of your % differences. Once you determine your 'working' data set, calculate the individual % compositions and molarities, % error in the calculation section.

- Record any observations, errors, or difficulties that came up when carrying out the procedure (did not use an analytical balance, misread the burette, missed the endpoint, added more than one drop of indicator, did not rinse the sides down with distilled water)
- Note: You read the burette down. The burette shows the volume delivered into the flask not the volume contained in the burette. Watch for a drippy stopcock. This is a source of error.
- Make sure that all the glassware is primed with the solution that you will use for the lab. The burettes are primed with base.

Data (collected in the observation section):

Part 1: mass of the KHP

Part 2 the volume of base solution delivered for each titration, the burette reading before and after each titration, the volume of KHP solution used. **Record the data that you will use for final calculations; this means the data that is in the <1.5% margin.**

Part 3: The volume of base solution delivered for each titration, the mass of the empty Erlenmeyer flask, the mass of the flask with vinegar, the type, brand, and acidity of the vinegar. **Record the data that you will use for final calculations; this means the data that is in the <1.5% margin.**

Data Tables:. For this experiment, you should transfer your data with the correct significant figures and units from the observation section into a data table that is easy to understand.

Calculations:

Part 1: Calculate the molarity of the standard KHP solution.

Part 2: Calculate the volume of base used for each trial, the moles of base for each titration trial using the standard molarity of KHP from Part 1, and the molarity of the KOH solution. Calculate the average molarity of the KOH solution based on titration, and the % difference <1.5% of the KOH molarity.

Part 3: Calculate the volume of base for each trial, the moles of base for each titration trial using the average molarity of the KOH from **Part 2**, the mass of each sample of vinegar used, the mass percent of acetic acid in vinegar for each sample, the molarity of the acetic acid in the vinegar sample molar mass for each trial, and the percent difference within 1.5% using the percent mass values, the average molarity of acetic acid based on the mass percentages that in the error range.

Results Tables: Your results table should summarize the results of your calculations and support the purpose of the lab. Results should be displayed in a table that is easy to understand. The end-product of your calculations, with correct significant figures and units, are to be presented clearly in the result table. The results can also be the summary and conclusions drawn from observations of reactions.

Result Statement: none

SIDE NOTE: We take for granted that the water that we use is pH= 7 or neutral, so all the neutralization that is occurring is for the acid of interest, but is it neutral? Strong acids have a very low pH and the titration of an acid with a base have a neutralization point of pH 7 [in theory]. A dilute solution of acetic acid has a pH = 4.7, while KHP (potassium hydrogen phalate) has an endpoint at pH=5.432. The neutralization point is slightly higher than pH = 7. The endpoint is often not the equivalence point.

Post-lab questions: Answer the questions clearly and completely in your lab book. Write thoughtful answers to the questions in the lab manual using complete sentences, good grammar, and in Standard English. Consider typing these answers, as it will give you more time to think about the quality of the answer. (No credit if you did not show your work or explain your reasoning). The answers should address the main thrust of each question. Answers involving calculations should have the correct significant figures and units. **IF YOU PUT YOUR PRE-LAB QUESTIONS IN THE QUESTIONS SECTION, YOU WILL LOSE 50% OF THE POINTS FOR THAT SECTION. IT TELLS ME YOU DID THEM AFTER THE LAB WAS DONE**. Points will be deducted for circular reasoning, not clearly addressing the question, errors in math, sigfigs, units, and exponential notation. (No credit if you did not show your work or explain your reasoning.) you will lose points for answers that are written on binder paper.

1. In Part 1, if you used a scoopula to transfer the KHP out of the vial and some solid stuck to it, how would it affect your result for M_{KHP}? (Would the calculated (wrong) M_{KHP} be higher or lower than the actual M_{KHP}?)
2. In Part 1, if you added a little too much water to the volumetric flask, would the calculated M_{KHP} be higher or lower than the actual M_{KHP}?
3. In Part 2, if there was an air bubble in the tip of the KOH buret that came out during the titration, how would M_{KOH} be affected? (Would the calculated M_{KOH} be higher or lower than the actual M_{KOH}?)
4. Why is it acceptable to add water to the titration flask?
5. Why can't you add water to either solution at any time before they are transferred to the titration flask?
6. If 25.00 mL of a sulfuric acid solution (H_2SO_4) is titrated with sodium hydroxide, and if it requires 35.88 mL of 0.1127 M NaOH to reach the equivalence point, what is the molarity of the sulfuric acid solution?
7. A sample of 0.495 grams of solid KHP is weighed into an Erlenmeyer flask. This sample is titrated with a sodium hydroxide solution, and 28.56 mL of NaOH are required to reach the endpoint. The sodium hydroxide solution is then used to titrate a sample of phosphoric acid of unknown concentration. It requires 29.88 mL of NaOH to react with 10.33 mL of H_3PO_4 solution. What is the concentration of the phosphoric acid?
8. A 2.353-g sample of vinegar was titrated with 0.08751 M NaOH, and it requires 22.31 mL of NaOH to reach the endpoint. Calculate the mass percent of acetic acid ($HC_2H_3O_2$) in the vinegar sample.