CHEM2110J/VC211 Spring 2023 Chemistry Lab Memo

Experiment E1

Acids and Bases

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This is for TAs ONLY. DO NOT write in this table.

Grades				Grader/s
Post-lab (100+10 pts)	Observation (30 pts)			
	Data Analysis (30 pts)			
	Discussion (30+10 pts)			
	Data Sheet (10 pts)			
	Total			

POST-LAB

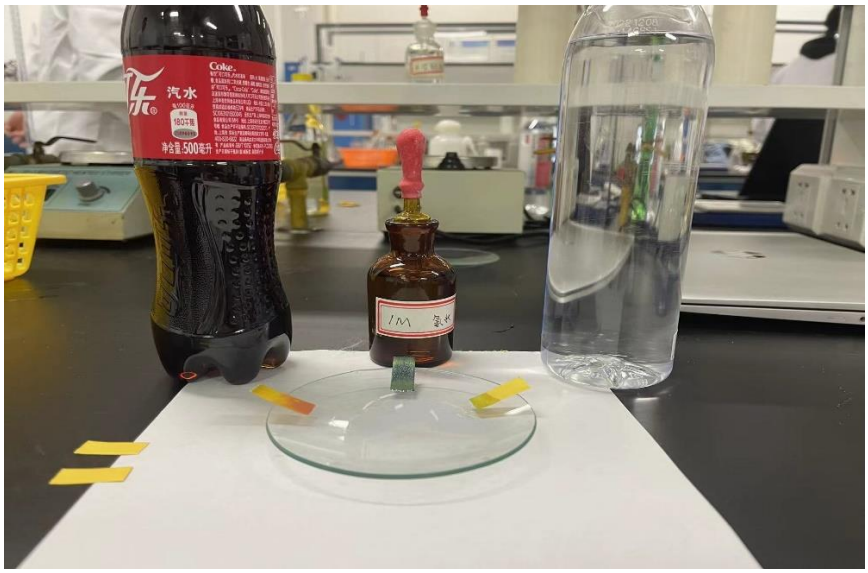
*Please finish (hand-written or typed) this memo during and/or after the lab and submit it through canvas (pdf file name convention: LASTNAME+last four digits of your student ID) before due time, typically 10 min before the next experiment. This memo consists of OBSERVATION, DATA ANALYSIS, DISCUSSION, and DATA SHEET, and are worth a total of 100 points, counted as **6%** of the total course grade. This is an individual assignment and your own work is expected. The sample DATA SHEET is for recording of raw data **during** your lab work and shall be submitted as it is (the very original copy you filled in during lab). Calculations and data analysis shall use the original data you obtained in the lab. Any alteration to raw data is a serious violation of **HONOR CODE** and you will receive '0' point for Post-Lab Memo.*

***Note:** This memo first describes experimental observations, then analyzes data, finally discusses the results. Although a frame is provided with useful tips, you are **encouraged** to conduct critical thinking on your own and try to write a coherent and complete report by yourself (passive piecing together tips is not considered to be a complete memo). Bonus is available for outstanding points as mentioned in detail below.*

OBSERVATION

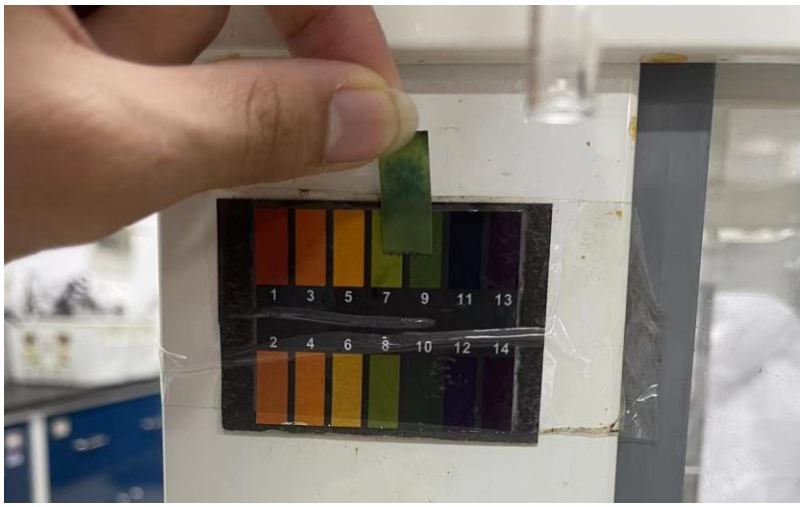
Part A. Relative Acidity/Basicity of Common Household Products

- *Describe your observations in the experiment briefly. Please provide the pictures of the standard color chart and the used pH strips corresponding to each product you selected.*
- *Attach a table summarizing the colors of the universal indicator paper that you used to test the pH of the selected household products. Your table should include a column that correlates the color of the universal indicator paper with the pH of the solution (this information is found on the box of the universal indicator paper or on a chart placed at the work benches).*

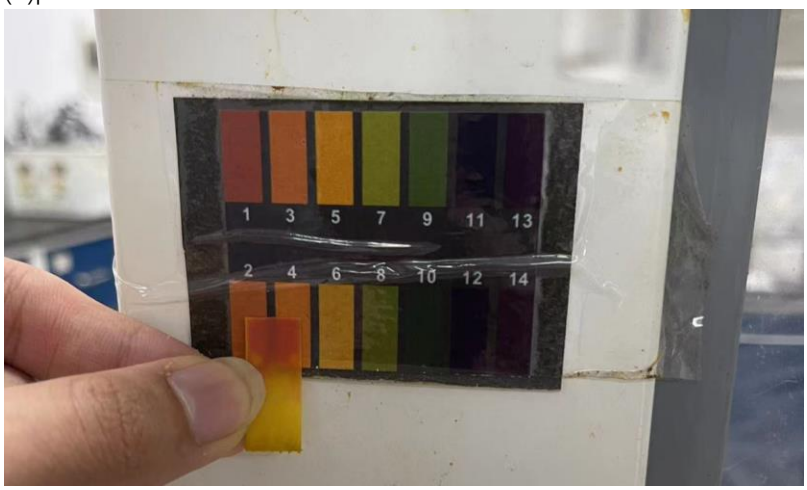


(1)pH of the tested liquids

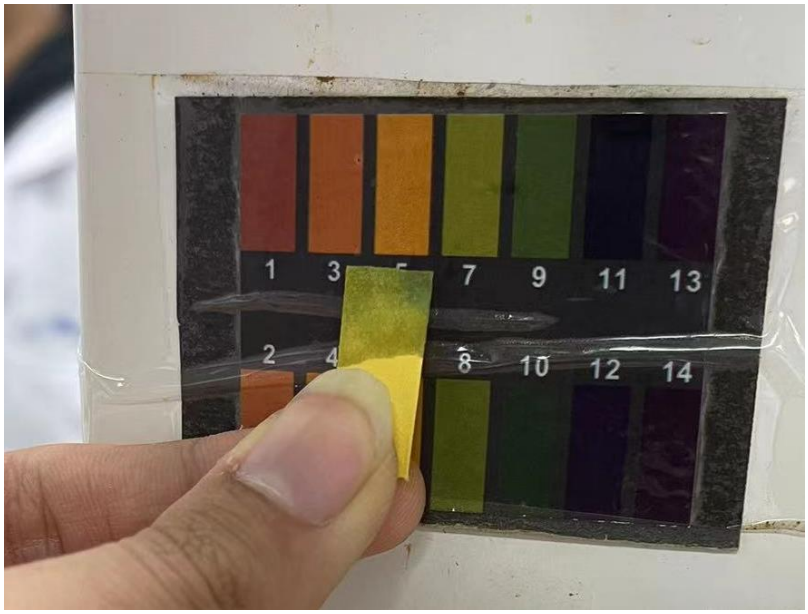
We use the universal indicator paper to test the pH of three kinds of liquid, coca cola, ammonia and mineral water (1). According to our observation, the pH of coca cola is 2(2); the pH of ammonia is 9(3); the pH of mineral water is 7(4).



(2)pH of ammonia



(3)pH of coca cola



(4)pH of mineral water

pH	color
1	red
2	orange-red
3	orange
4	yellow-orange
5	yellow
6	pale yellow
7	green
8	dark-green
9	blue-green
10	dark-blue-green
11	dark-blue
12	purple
13	dark-purple
14	very dark-purple

Part B. Concentration of Unknown Molarity of NaOH Solution

- *What is the signal for us to determine whether the endpoint is reached? Give your explanation. Provide a picture of the solution around the endpoint.*
- *Why do we do the experiments for three times? Explain.*

The signal for us to determine whether the endpoint is reached is that the color of the solution with phenolphthalein turns from colorless to pale pink and this color can last at least 30 seconds.

Phenolphthalein is a kind of indicator to test base. When the solution is basic it shows red and when the solution is neutral it has no color. Therefore, when the color of the mixed solution turns into pale pink, the mixed solution is near to be neutral. Besides, the color should last for at least 30seconds because it shows the pH of the solution is stable enough.

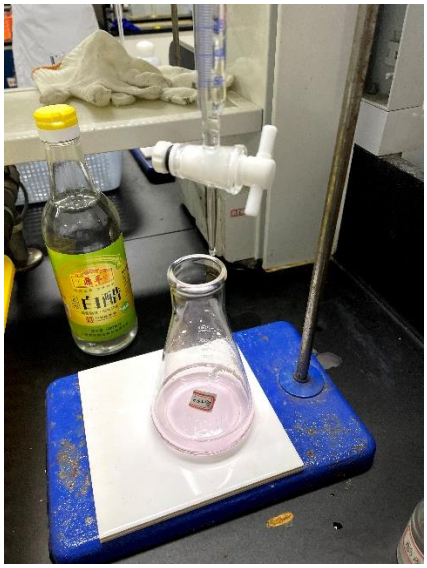
 (5)solution around the endpoint

We should do the experiments for three times to reduce error and draw a more accurate conclusion.

Part C. Acid – Base Titration of Vinegar

- *Provide a picture of the solution before the endpoint and a picture of the solution at the endpoint. Briefly describe the phenomenon around the endpoint.*
- *Explain in detail why we need to dilute the vinegar before the titration.*

(6) solution before the endpoint



(7) solution at the endpoint

When the solution is near endpoint, we find that some parts of the solution becomes pale pink but after wobbling the color disappears. This phenomenon repeats for several times until the pale pink color becomes stable.

The vinegar should be diluted because the molarity of the original vinegar is much higher than the one of the standard NaOH solution. According to the result, if the vinegar hadn't been diluted, about 200ml of NaOH solution will be needed to make the solution neutral. That volume exceeds the maximum range of a buret. Besides, vinegar has color, so diluting it can fade its original color so as to reduce experimental error when looking for the color changing endpoint.

DATA ANALYSIS

Part B. Concentration of Unknown Molarity of NaOH Solution

Show your work for the calculation of the concentration of the unknown NaOH and compare to the value on the label of the used NaOH bottle. Briefly analyze the result.

Trial	1	2	3
m_{KHP}(g)[35ml]	0.4685	0.4617	0.4491
Total Vol. of NaOH (mL)	23.4	23.1	23.5
$C_{NaOH}(mol/L) = m_{KHP} \times 1000 / (M_{KHP} \times V_{NaOH})$	0.098	0.098	0.093
Average C_{NaOH}(mol/L)	0.096		

According to the label, the concentration of the unknown NaOH is 0.1mol/L, but our result is 0.096mol/L, which is smaller than the label. This is probably because the buret is not cleaned with deionized water thoroughly, so the NaOH solution is diluted and the volume of NaOH used to neutralize the solution increases.

Part C. Acid – Base Titration of Vinegar

Show your work for the calculation of the molarity of acetic acid vinegar. Show your work for the calculation of the % by mass of acetic acid in vinegar. How does this value compare to the value on the bottle of vinegar? Briefly analyze the result.

	Initial Vol. of NaOH V_0 (mL)	Final Vol. of NaOH V_1 (mL)	Total Vol. of NaOH V_1-V_0 (mL)
Trial 1	0	23.10	23.10
Trial 2	0	23.22	23.22
Trial 3	23.22	45.54	22.32
		Average (mL)	22.88

$HAC + NaOH \rightarrow NaAC + H_2O$

$C_{NaOH} = 0.1\ mol/L$

$V_{NaOH} = 22.88\ ml$

$n_{HAC} = n_{NaOH} = C_{NaOH} \cdot V_{NaOH} = 0.1 \times 0.02288 = 2.288 \times 10^{-3}\ mol$

$C_{HAC} = \frac{n_{HAC}}{V_{soln}} = \frac{2.288 \times 10^{-3}}{0.025} = 0.0915\ mol/L$

$\%_{mass\ HAC} = \frac{m_{HAC}}{m_{soln}} = \frac{60 \times 2.288 \times 10^{-3}}{25} = 0.0055 = 0.55\%$

$\%\ HAC = \frac{m_{HAC}}{V_{soln}} = \frac{60 \times 2.288 \times 10^{-3}}{25} = 0.55\ g/100\ ml$

Since the acetic acid vinegar has been diluted for ten times, the molarity of acetic acid vinegar is 0.915 mol/L, and the % by mass is 5.5 % and 5.5g/100 ml

According to the label, the % by mass of acetic acid in vinegar is 6g/100ml, but our result is5.5g/100ml, which is smaller than the label. This is probably because the volumetric flask is not cleaned by deionized water thoroughly, so the acetic acid solution is diluted, costing less NaOH to neutralize.

DISCUSSION*

This part is very important. The basic requirement is that you cover the outcome of the whole experiment. (You may choose to divide the section into several parts in accordance with the experiment.) Bonus can be earned by including the following aspects or showing creative ideas. (1page limit for the discussion part)

[Bonus]

1. What may mainly bring relatively huge errors to the results?

2. Recommendations for the improvement of the experiments if you have any.

3. Crucial experimental procedures during the experiment (Can other procedures work? Why or Why not?)

Part A: Relative Acidity Basicity of Common Household Products

In this experiment, we test the pH of three different liquids with universal indicator paper. Our result is the pH of coca cola is 2, the pH of ammonia is 9, and the pH of mineral water is 7. The result is basically as expected and can be supported by many research on the pH of household liquids, but it is not still very accurate.

For example, coca cola is a kind of dark-colored liquid so its original color may interfere the test result, causing the pH value to be smaller and the measurement of acidity is greater than the actual value.

Since this experiment is based on the color of the indicator paper, keeping the color away from interference is important. In order to improve our experiment, we can choose colorless liquids as possible as we can, so we can reduce the interference from liquids' original colors to the minimum.

I think in this experiment, the crucial experimental procedures include not wetting the indicator paper with water before testing and putting the indicator paper near the colorimetric card to read its color. The first one avoids diluting the sample to be tested and the second one enables us to read the accurate color as possible as we can.

Part B: Concentration of unknown molarity of NaOH solution using KHP titration

In this experiment, we repeat three times to explore the molarity of NaOH solution with KHP titration. The result of our experiment is 0.096mol/L, a bit smaller than the labeled value 0.1mol/L.

The experiment is based on reaction between KHP and NaOH, so it's very important for us to catch the endpoint and make sure that all the sample under test can participate the reaction. Therefore, the procedure of washing the inner surface of buret and volumetric flasks is crucial because only by doing this can the sample solution reacts thoroughly.

The reason for the error between measured and standard values may be the buret is not cleaned with deionized water thoroughly, so the NaOH solution is diluted and the volume of NaOH used to neutralize the solution increases.

Part C: Acid – Base Titration of Vinegar Solution

In this experiment, we repeat three times to explore the % by mass of acetic acid in vinegar. The result of our experiment is 5.5g/100mL, a bit smaller than the labeled value 6.0g/100mL.

The experiment is based on acid-base equilibrium, and the original concentration of acetic acid is much higher than the NaOH solution, about 10 times, so it's necessary to dilute the acetic acid sample to control the cost of NaOH solution at an reasonable level.

The reason for the error may be the volumetric flask is not cleaned by deionized water thoroughly, so the acetic acid solution is diluted, costing less NaOH to neutralize.

REFERENCE

- *List any source of reference.*

E1 Manual (Modified version of Kristen Spotz and University of Michigan General Chemistry Laboratory Manual)

CHEM2110J-VC211-SP23-Lecture-E1.pptx

https://short-fact.com/what-is-coca-cola-on-the-ph-scale/

DATA SHEET

Name: Xiao Luyan Section: 11

E1-A

Product	Coca cola	Ammonia	Mineral water	
Color	Orange-red	Blue-green	green	
pH	2	9	7	

E1-B

Trial	1	2	3
m_{KHP}(g)	0.4685	0.4617	0.4491
Total Vol. of NaOH (mL)	23.4	23.1	23.5
C_{NaOH}(mol/L) = $m_{KHP} \times 1000 / (M_{KHP} \times V_{NaOH})$	0.098	0.098	0.093
Average C_{NaOH}(mol/L)	0.096		

E1-C

	Initial Vol. of NaOH V_0 (mL)	Final Vol. of NaOH V_1 (mL)	Total Vol. of NaOH V_1-V_0 (mL)
Trial 1	0	23.10	23.10
Trial 2	0	23.22	23.22
Trial 3	23.22	45.54	22.32
		Average (mL)	22.88