CHEM 3452

QUANTITATIVE ANALYSIS LAB

Fall 2026

Revised August 31, 2026

CHEMISTRY 3452 Quantitative Analysis Lab*

***Note: QA Labs starts on 24th Aug 2026**

Course Description: The CHEM 3452 lab course accompanies CHEM 3451 Quantitative Analysis. Various experiments are designed to utilize statistical treatment of data, sampling and transfer techniques, gravimetric and volumetric methods, titration analysis, electroanalytical and introductory instrumental analysis.

Course Objectives:

- To cultivate students' hand-on operation skills in field of quantitative analysis
- To introduce quantitative measurements in gravimetric, volumetric, electroanalytical and chromatographic separation.
- Understand factors that affect accuracy and precision of measurements and apply statistical analysis.

Lab Instructors

1) **Shyam Nair** **(QA Lab Coordinator)**
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2) **Khanh Tran**
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3) **Anushka Perera**
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Lab Manual Lab Manual will be provided electronically. There will be a brief discussion of each lab at the beginning of the period. **The student will be expected to have read the lab manual and prepared relevant lab operation notes on the lab notebook before coming to class, since the pre-lab discussion will focus on why, not how, the lab is done.**

Materials: Besides this lab manual, you will also need a lab notebook for class. You must have a writing utensil (**pencil is not allowed**) to record your data in ink. And eye protection, either safety glasses or goggles, is mandatory. Notebooks will be inspected at the end of lab session, and unannounced times during the semester, and graded according to completeness and organization.

Lab Reports: The last page of each lab handout is the lab report sheet, on which you will report your lab results. This information will come directly from your lab notebook (see

below, lab TA will verify this at the end of each lab), and any blanks on the report must be filled in or explained. The completed lab report that gives concise summary of the results, correction and discussion are due at the beginning of the next lab period. **Late lab reports will be penalized by five point/day (75 points/lab), and no lab report will be accepted more than two weeks after the date due.**

Lab Notebook: All students will use a lab notebook to record all data obtained in this lab. The notebook must be one in which the pages are permanently attached -- loose leaf notebooks are not acceptable. **Recording data on scratch paper, paper towels, etc. before transfer to the notebook is expressly forbidden.** Any student found using such scratch paper will have their lab grade for that lab lowered by 1 point (75 points/lab), and the scratch paper will be discarded.

Missing Lab: Arriving **late over 15 minutes will be counted as an absence.** Missing lab will receive zero grade. **No make-up lab unless permission is obtained *in advance*. Medical absence requires proper doctor's statement.**

Grading

The lab grade of CHEM 3452 will be calculated as follows

Laboratory report and notebook	75% (30% Pre -lab, 45% Lab report)
2 Quizzes	20% (In-Class Only)
TA Evaluation	5%

Notebooks will be inspected at the end of lab session, and unannounced times during the semester, and graded according to completeness and organization. The "TA Evaluation" portion of your lab grade will reflect your attitude, preparedness, and safety-consciousness during lab. **Notice: Canvas posted grade is for bookkeeping only, correction and adjustment may be needed, final grade is based on above 75%/20%/5% calculation.**

Grading Scale

Final percent Average	Letter Grade
90 - 100 %	A
80 - 89 %	B
70 - 79 %	C
60 - 69 %	D
Below 60 %	F

Grade Reporting on Canvas: Canvas grade is for your convenience to check your course standing on lab reports and quizzes. Canvas reported grade may not be the final official grade reported to UNT Registrar, since other factors may need to be considered.

Course Policies

Attendance:
Students are expected to attend lab class meetings regularly per specified lab schedule. It is important that you communicate with your lab instructor prior to being absent, so you and the instructional team can discuss and mitigate the impact of the absence on your attainment of course learning goals.

Academic Integrity Policy
Academic Integrity Standards and Consequences. According to UNT Policy 06.003, Student Academic Integrity, academic dishonesty occurs when students engage in behaviors including, but not limited to cheating, fabrication, facilitating academic dishonesty, forgery, plagiarism, and sabotage. A finding of academic dishonesty may result in a range of academic penalties or sanctions ranging from admonition to expulsion from the University.

UNT Lab Safety Notice

Important ! Finished Lab Safety Module on Canvas before first lab meet,
No safety training = No lab access

While working in laboratory sessions, students enrolled in CHEM 3452 Quantitative Analysis Lab are required to follow proper safety procedures and guidelines in all activities requiring lifting, climbing, walking on slippery surfaces, using equipment and tools, handling chemical solutions and hot and cold products. **Students should be aware that UNT is not liable for injuries incurred while students are participating in class activities**. All students are encouraged to secure adequate insurance coverage in the event of accidental injury. Students who do not have insurance coverage should consider obtaining Student Health Insurance. Brochures for student insurance are available in the UNT Student Health and Wellness Center. Students who are injured during class activities may seek medical attention at the Student Health and Wellness Center at rates that are reduced compared to other medical facilities. If students have an insurance plan other than Student Health Insurance at UNT, they should be sure that the plan covers treatment at this facility. If students choose not to go to the UNT Student Health and Wellness Center, they may be transported to an emergency room at a local hospital. Students are responsible for expenses incurred there.

UNT Emergency Notification & Procedures
UNT uses a system called Eagle Alert to quickly notify students with critical information in the event of an emergency (i.e., severe weather, campus closing, and health and public safety emergencies like chemical spills, fires, or violence). In the event of a university closure, please refer to the UNT Learning Management System (LMS) for contingency plans for covering course materials.

ADA Policy
UNT makes reasonable academic accommodation for students with disabilities. Students seeking accommodation must first register with the Office of Disability Accommodation (ODA) to verify their eligibility. If a disability is verified, the ODA will provide a student

with an accommodation letter to be delivered to faculty to begin a private discussion regarding one's specific course needs. Students may request accommodation at any time; however, ODA notices of accommodation should be provided as early as possible in the semester to avoid any delay in implementation. Note that students must obtain a new letter of accommodation for every semester and must meet with each faculty member prior to implementation in each class. For additional information see the ODA website (https://disability.unt.edu/).

Acceptable Student Behavior

Student behavior that interferes with an instructor's ability to conduct a class or other students' opportunity to learn is unacceptable and disruptive and will not be tolerated in any instructional forum at UNT. Students engaging in unacceptable behavior will be directed to leave the classroom and the instructor may refer the student to the Dean of Students to consider whether the student's conduct violated the Code of Student Conduct. The University's expectations for student conduct apply to all instructional forums, including University and electronic classroom, labs, discussion groups, field trips, etc. Visit UNT's Code of Student Conduct (https://policy.unt.edu/policy/07-012) to learn more.

Unauthorized Aids During Examinations and Assessments

Students may use only those materials and resources that are expressly authorized by the instructor for a particular examination or assessment. Touching, holding, or accessing any unauthorized aid during the examination period constitutes a violation of the Student Code of Conduct, regardless of whether the aid is used.

Any item that may be considered an unauthorized aid must be kept out of view and in a closed container (e.g. zipped backpack, buttoned purse, etc.) during the entirety of the examination or assessment.

Unless specifically authorized in writing by the instructor, prohibited aids include, but are not limited to:

- Mobile phones and smartphones
- Smartwatches and fitness trackers with communication, recording, or internet capabilities
- Tablets, laptops, and other computing devices
- Earbuds, headphones, and other audio devices
- Smart glasses, cameras, recording devices, and wearable technology
- Artificial intelligence (AI) tools, chatbots, and other generative AI technologies
- Notes, textbooks, study guides, formula sheets, or reference materials
- Any other device, material, or resource not expressly permitted by the instructor Students are responsible for clarifying any questions about permitted materials before the examination begins.

Access to Information - Eagle Connect
Students' access point for business and academic services at UNT is located at: my.unt.edu. All official communication from the University will be delivered to a student's Eagle Connect account. For more information, please visit the website that explains Eagle Connect and how to forward e-mail Eagle Connect (https://it.unt.edu/eagleconnect).

Student Evaluation Administration Dates
Student feedback is important and an essential part of participation in this course. The student evaluation of instruction is a requirement for all organized classes at UNT. The survey will be made available during weeks 13, 14 and 15 of the long semesters to provide students with an opportunity to evaluate how this course is taught. Students will receive an email from "UNT SPOT Course Evaluations via IASystem Notification" (no-reply@iasystem.org) with the survey link. Students should look for the email in their UNT email inbox. Simply click on the link and complete the survey. Once students complete the survey they will receive a confirmation email that the survey has been submitted. For additional information, please visit the SPOT website (http://spot.unt.edu/) or email spot@unt.edu.

Survivor Advocacy
UNT is committed to providing a safe learning environment free of all forms of sexual misconduct. If you or someone you know is experiencing sexual harassment, relationship violence, stalking and/or sexual assault, there are campus resources available to provide support and assistance. The Survivor Advocates can be reached at SurvivorAdvocate@unt.edu or by calling the Dean of Students Office at 940-565-2648

CHEM 3452

LABORATORY SCHEDULE
2026 Fall

Important ! Finished Lab Safety Module on Canvas,

No safety training = No lab access

No lab during 1st week of August 17th to August 21st

Week of 08/24- 08/27	**Exp 1**	**Check-in*/Safety-Use of Lab Equipment/Introduction to Titration**
Week of 08/31 – 09/03	**Exp 2**	**Gravimetric Determination of Calcium**
Week of 09/07- 09/10		**(NO QA LAB ON LABOR DAY)**
Week of 09/14 - 09/17	**Exp 3**	**Determination of Acid in Vinegar**
Week of 09/21 - 09/24	**Exp 4**	**Determination of Sodium Carbonate**
Week of 09/28- 10/01	**Exp 5**	**Determination of Water Hardness**
Week of 10/05 - 10/08		**Quiz (Labs 1-5)**
Week of 10/12 -10/15	**Exp 6**	**Potentiometric Determination of KHP**
Week of 10/19- 10/22	**Exp 7**	**Determination of Fe by $KMnO_4$**
Week of 10/26-10/29	**Exp 8**	**Determination of Iodine using Iodate**
Week of 11/02-/11/05	**Exp 9**	**Faraday's Law: Ni Electroplating**
Week of 11/09-11/12	**Exp 10**	**Gas Chromatography/Mass Spectrometry**
Week of 11/16 – 11/19		**Quiz (Labs 6-10)/ Check-out**

Lab Reports

The last page of each lab handout is the lab report sheet, on which you will report your lab results. This information will come directly from your lab notebook (see below), and any blanks on the report must be filled in or explained. The report sheets are due at the beginning of the lab period immediately following the completion of the lab. Late lab reports will be penalized by ten points, and no lab will be accepted more than two weeks after the date due.

Lab Notebook

All students will use a lab notebook to record all data obtained in this lab. The notebook must be one in which the pages are permanently attached -- loose leaf notebooks are not acceptable. Recording data on scratch paper, paper towels, etc. before transfer to the notebook is expressly forbidden. Any student found using such scratch paper will have their lab grade for that lab lowered by 10 points, and the scratch paper will be discarded.

Your lab notebook must always be up-to-date. Since you will not be recording data anywhere else, this should not be a problem. The TA will check notebooks during the lab period, and anyone found with an incomplete notebook for a previous lab will have their "Notebook" grade lowered by 5%.

The notebook will contain the following information in a clear, easy-to-read, understandable manner:

A) A brief description of experimental procedure, or a flow chart.
This should be written in advance of the lab period and is for your own use an organizational aid as you perform the lab.

B) All raw data, preferably recorded in data tables for easy reference.

C) At least one example of every calculation.

D) All conclusions (such as composition of unknown), and any reasons why lab results are not up to expectations (such as: "neighbor's experiment blew up all over my reaction vessel"). Results should be in tabular form, well labelled, and easy to understand by someone not familiar with your notebook.

E) If your notebook is illegible, all conclusions will be assumed to be incorrect and graded accordingly.

Leave an empty page at the beginning of your notebook for a "Table of Contents". Fill it in as you complete each experiment.

Lab Clothing and Eye Protection

Eye protection is required by state law for everyone in a laboratory, regardless of whether they are actually doing anything or not. Goggles are strongly recommended since they provide more adequate splash protection. Any person who refuses to wear eye protection will leave the laboratory and take an automatic "0" for that lab exercise.

We will be using large quantities of acids and bases this semester. These chemicals tend to dissolve clothing (and flesh) with which they come into contact. It is advisable to consider any garment worn to lab as potentially disposable -- dress accordingly. Also: since most liquids tend to follow gravity after a spill, long pants and closed shoes are recommended.

Exercise caution when touching anything. It is especially unwise to sit or lean on the lab benches. If an acid or base has been spilled and left to evaporate, it will have left a residue that could easily install air conditioning in any clothing it contacts.

Graphing

Several experiments in this lab will require the use of graphical methods of data analysis. When graphing continuous data (including most experimental results), a smooth curve should be drawn through the data points so that there are an equal number of points above and below the line. This is essentially a method of determining the average value of a function along the curve. A few other points to remember when graphing:

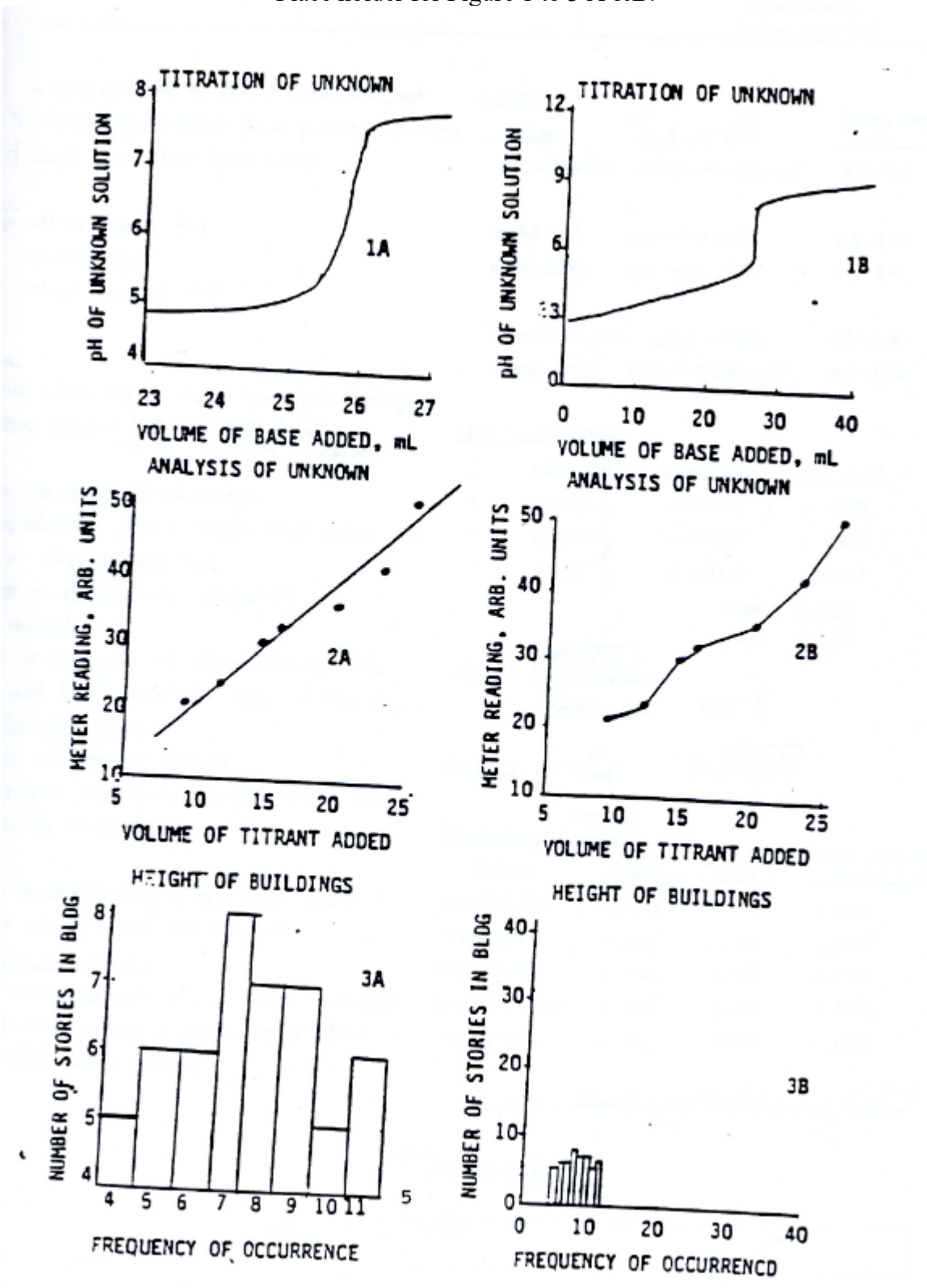
A) Use as much of the graph paper as possible. Your graphs will be more readable and more accurate.

B) If more than one curve is shown on the same sheet of paper, use different colored lines, different symbols for the data points (circles and stars, for example), or dotted versus continuous lines to differentiate the data sets. Make certain the difference is obvious, and provide a key to identify which is which.

C) The x- and y-axes need not start at zero. Use only the parts of the axes which contain the domain and range of your data.

The following graphs illustrate these points, with the graphs on the left showing good techniques and those on the right showing poor techniques. 1A and 1B show the benefit of graphing only that portion of the graph which is of interest. Graphs 2A and 2B illustrate the best way to draw a line through a series of data points (calculators can do this by a least squares program). Graphs 3A and 3B illustrate why you should use reasonable scales on both axes.

Place holder for Figure 1 to 3 A &B.



EXP. NUMBER	EXPERIMENT/SUBJECT	DATE	59
3.	Determination of Acetic Acid in Vinegar.	Sep. 12, 2007	
NAME	LAB PARTNER	LOCKER/DESK NO.	COURSE & SECTION NO.
			Chem 2452-301

1. Purpose: To study acid-base indicators in greater detail and need
2. Objective: To select an appropriate indicator for the quantitative determination of vinegar in an unknown liquid solution.

3. Equipment:
~~2. Objective:~~
- 50 ml volumetric flask
- volumetric pipet
- 250 ml Erlenmeyer flask

4. Procedure:

Use NaOH solution that has already been standardized against the primary standard KHP. (NaOH = 40 g/mol)
~0.2 g ~0.05 M ~ ~ kg NaOH

1. Obtain approximately 80 ml unknown.
2. Use a volumetric pipet to transfer 25 ml vinegar sample to a 250-ml volumetric flask.
3. Dilute to the mark with distilled H_2O. Mix thoroughly.
4. Pipet 50 ml aliquots into 250-ml Erlenmeyer flasks, and add 50 ml distilled H_2O and 3-4 drops of phenolphthalein indicator.
5. Titrate with the 0.05 M NaOH. (The endpoint signal is the first pink coloration that persists for 30 seconds.)
6. Repeat the titration using a fresh 50 ml aliquot of diluted unknown solution, this time using 3-4 drops of methyl red indicator.
7. Repeat the titration until all five indicators have used. (Note: it will be necessary to prepare a second 250 ml batch of the dilute unknown solution.)

5. Data:

Indicator	color Acid → Base	Transition range (pH)
phenolphthalein	colorless → faint pink	8.0 – 9.6
methyl red	red → yellow	4.8 – 6.0
methyl orange	red → yellow	3.1 – 4.4
bromocresol green	yellow → blue	3.8 – 5.4
alizarin yellow	yellow → orange-red	10.1 – 12.0

NaOH Standardization:

#	weight KHP	volume NaOH	M of NaOH
1	0.2071 g	0.0206 l	0.0493
2	0.2010 g	0.0195 l	0.0505
3.	0.2159 g	0.0210 l	0.0503
		mean =	0.0500
		RSD =	0.0063

$$M_{NaOH} = \frac{\left(\frac{\text{weight of KHP}}{204.23\ g/mol}\right)}{V_{NaOH\ (in\ liter)}} \qquad RSD = \frac{S}{\bar{x}}$$

FW of KHP = 204.23 g/mol. $\qquad S = \sqrt{\frac{\Sigma(x_i - \bar{x})^2}{n-1}}$

Determination of Unknown (Vinegar):

Indicator	volume (L)	M_{NaOH}	Acetic acid conc. wt-/vol.
phenolphthalein	0.0216	0.0502	0.1012
methyl red	0.0236	0.0502	0.0935
methyl orange	0.026	0.0502	0.0313
bromocresol green	0.0218	0.0502	0.0576
alizarin yellow	0.0294	0.0502	0.1133

$$\text{Weight \%} = \frac{M_{NaOH} \times V_{NaOH} \times 60\ g/mol}{25\ ml} \times \text{dilute factor} \left(\frac{10}{1}\right)$$

FW of CH_3COOH = 60 g/mol

SIGNATURE	DATE	WITNESS/TA	DATE

EXP. NUMBER	EXPERIMENT/SUBJECT	DATE	60
3.	Determination of Acetic Acid in Vinegar	Sep. 17, 2007	
NAME	LAB PARTNER	LOCKER/DESK NO.	COURSE & SECTION NO.
			Chem 3452 701

6. Formula & Calculations:

Buret 1 KHP = 0.2071 g

V_i = 0.2 ml NaOH

V_f = 20.6 ml NaOH

ΔV = 20.4 ml = 0.0204 l

$M_{NaOH} = \frac{(0.2071\ g / 204.23\ g/mol)}{0.0204\ l}$

= 0.0497085 M

≈ 0.0497 M

Buret 2.

KHP = 0.2010 g

V_i = ~~20.4~~ 0.3 ml NaOH

V_f = 19.8 ml NaOH

ΔV = 19.5 ml = 0.0195 l

$M_{NaOH} = \frac{(0.2010\ g / 204.23\ g/mol)}{0.0195\ l}$

= 0.05047 M

≈ 0.0505 M

Buret 3.

KHP = 0.2059 g

V_i = 19.8 ml NaOH

V_f = 39.8 ml NaOH

ΔV = 20.0 ml = 0.020 l

$M_{NaOH} = \frac{(0.2059\ g / 204.23\ g/mol)}{0.0200\ l}$

= 0.05034 M

≈ 0.0503 M

~~explanation for the weight~~

$M_{NaOH} = \frac{\sim 0.2\ g\ KHP / 204.23\ g/mol}{V_{NaOH}\ [l]}$

$\bar{x}$ = mean $M_{NaOH} = \frac{0.0497 M + 0.0505 M + 0.0503 M}{3}$

= 0.0501667 M

≈ 0.0502 M

$S = \sqrt{\frac{(0.0497 - 0.0502)^2 + (0.0505 - 0.0502)^2 + (0.0503 - 0.0502)^2}{3-1}}$

= 0.0004163333

$RSD = \frac{S}{\bar{x}}$ = 0.008335550481

Phenolphthalein:

V_{i_1} = 0.3 ml NaOH

V_{f_1} = 48.5 ml NaOH

(refilled)

V_{i_2} = 0.3 ml NaOH

V_{f_2} = 36.1 ml NaOH

$\Delta V_1 + \Delta V_2$ = 48.2 + 35.8 = 84.0 ml = 0.084 l

Weight % = $\frac{(M_{NaOH})(V_{NaOH}) \times 60\ g/mol}{25\ ml} \times 10$

= $\frac{(0.0502)(0.084) \times 60\ g/mol \times 10}{25\ ml}$ = 0.1012 g/ml

methyl red:

V_i = 0.1 ml NaOH

↓

49.0 ml NaOH

↓

0.1 ml

↓

29.0 ml NaOH

↓

ΔV = 78.8 ml = 0.0776 l

Weight % = $\frac{(0.0776\ l)(0.0502\ mol/l)(60\ g/mol)}{25\ ml}$

= 0.0935 g/ml

methyl orange:

V_i = 0.0 ml

V_f = 26 ml

ΔV = 26 ml = 0.026 l

Weight % = $\frac{(0.026\ l)(0.0502\ mol/l)(60\ g/mol)}{25\ ml}$

= 0.0313 g/ml

Bromocresol green:

V_i = 0.2 ml

V_f = 48 ml

ΔV = 48 - 0.2 ml = 47.8 ml = 0.0478 l

Weight % = $\frac{(0.0478\ l)(0.0502\ mol/l)(60\ g/mol)}{25\ ml}$

= 0.0576 g/ml

alizarin yellow

V_{i_1} = 0.2 ml

V_{f_1} = 50 ml

V_{i_2} = 0.3 ml

V_{f_2} = 44.5 ml

ΔV = (50 - 0.2) + (44.5 - 0.3) = 94 ml = 0.094 l

Weight % = $\frac{(0.094\ l)(0.0502\ mol/l)(60\ g/mol)}{25\ ml}$

= 0.1133 g/ml

SIGNATURE	DATE	WITNESS/TA	DATE

EXP. NUMBER	EXPERIMENT/SUBJECT	DATE	61
3	Determination of Acetic Acid in Vinegar	Sep. 17, 2007	
NAME	LAB PARTNER	LOCKER/DESK NO.	COURSE & SECTION NO.
			Chem 345 L 301

7. Discussion:

The indicator I feel the most appropriate for the quantitative determination of acetic acid in vinegar is the bromocresol green indicator. Because vinegar consists primarily of 4% to 6% solution of acetic acid, and the acetic acid content (4%) of the bromocresol green is about 5.76%, which is in an acceptable range.

Selection of an inappropriate indicator would be a determinant (systematic) error because each indicator has its pH range of detecting acid content. The far from the expected value the indicator you choose, the more systematical error you have, the higher the deviation from the true value.

good. 09/24/2007.

SIGNATURE	DATE	WITNESS/TA	DATE