Pre/Corequisites: One of the following: Chemistry 1032, 1042 or 1952 as well as one of the following: Chemistry 1034, 1044, or 1954. Math 1042. Co-Requisite: Chemistry 3103.

COURSE Description: Introduction to the application of instrumental analytical methods, with emphasis on equilibria and volumetric acid-base techniques. Written scientific reports will require a quantitative analysis of collected data, including statistics and error analyses.

BOOK: The lecture book (Harris 9E) is required. Lab procedures are available online in Canvas.

ATTENDANCE: Attendance is mandatory. There will be NO make-up labs. Missing a lab will result in a zero for the experiment. You are expected to come to lab fully prepared – prelab written in notebook, amounts of reagents listed, calculator and safety glasses on hand. This is not your first lab course. We should not have to remind you about the basics, nor should we have to tolerate unprepared students. As such, those who come unprepared will be dismissed and receive a zero score for the day.

GRADING: Each lab is worth 100 points: 15% Notebook, 15% Lab Technique, and 70% Lab Report. The lab reports will be 75% of your course grade. The final exam will be 25% of your grade. Course grades will be based on a standard curve.

LAB TECHNIQUE: Your use of the proper laboratory techniques will be monitored for each experiment and will be reflected in your grade. The technique grade for the entire class will suffer if cleanliness of common areas is not maintained.

NOTEBOOK: A record of every experiment performed in the lab must be kept in your laboratory notebook. Appropriate notebooks contain sequentially numbered pages. The laboratory notebook will be signed by your TA at the end of each lab session and a copy of the pertinent pages should be attached to your lab report. ALL data and notes must be recorded first in the notebook using ink. Writing data on a scrap piece of paper and copying it to your notebook is unacceptable and a penalty will be assessed. You are expected to write a pre-lab and procedure in your notebook. This notebook should be separate from notebooks used in other courses this semester.

<table>
<thead>
<tr>
<th>Dates</th>
<th>Experiment</th>
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<tr>
<td>Jan 15</td>
<td>1 – Check-in, Safety, and Overview</td>
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<td>2 - Worksheet</td>
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<td>3 - Statistics Computer Assignment</td>
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<td>Feb 05</td>
<td>4 - Preparing and Standardizing NaOH</td>
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<td>5 - Standardizing Acetic Acid</td>
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<td>19</td>
<td>6 - Determination of unknown acid concentration</td>
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<td>7 - Following Titrations with pH Electrode</td>
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<td>Mar 12</td>
<td>8 - Preparation and Behavior of Buffer Solutions</td>
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<td>9 - Titration Calculations &amp; Simulations</td>
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<td>26</td>
<td>10 - Spectrophotometric Determination of Fe</td>
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<tr>
<td>Apr 02</td>
<td>11 - Spectrophotometric Determination of glucose</td>
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Lab Reports

The outline shown below is to be used. It is expected that the depth of content and analysis should be greater in this advanced course than in previous courses. Lab reports are due at the start of the following period. Late reports will lose 10 points per day (even if it is 5 minutes late, you will lose 10 points). Lab reports must be typed.

Outline

I. Keywords. Make a list of keywords for this experiment. Be sure to use them in your report.

II. Statement of application. “What” was done, “why” and “how” should be briefly described within a few sentences. Be sure to use keywords. The passive voice should be used throughout the report! Personal pronouns (I, you, we, they, etc.) may not appear in the report.

III. Brief procedure – do not copy/paste online procedures. Summarize with enough detail so that someone can reproduce your experiment.

IV. Data, calculations, and results – tables, figures, and plots
   a. The necessary raw data and calculated results for each replicate determination are presented here in tabular form. A properly constructed data table has the following features:
      i. The table has a title
      ii. It contains all data necessary for to verify calculations
      iii. Data which is common to all measurements (e.g., concentration of NaOH) is presented only once.
      iv. Each column is labeled with the name of the variable, symbol, and the units in parentheses
      v. The average calculated result and pertinent statistical information are presented at the bottom
   b. This section consists of a single sample calculation for each process in the experiment. Calculations must be labeled. If replicate determinations of the same quantity are performed, only one sample calculation should appear for that determination. In the sample calculation, all units and mole conversions are clearly shown. Calibrated glassware volumes are used whenever available. An extra significant figure is carried through intermediate calculations and the result is rounded per the usual rules.

V. Discussion of the data: You need to discuss your results, and if possible, compare them to the expected results. Report some values in the discussion. The sources of random and systematic error are discussed. Any questions or discussions that are listed in the Experimental Write-up are to be addressed. Do not assign any mistakes on human error. No scientist would ever report that. Instead, determine which steps have the greatest uncertainty and comment on that. For instance, comment on the ease or difficulty in obtaining a reproducible endpoint in a titration using phenolphthalein.
Details on format

Sample calculations should include the following:

- Symbolic mathematical expression and any necessary derivation(s) using symbols consistent with course materials (avoid making up your own formulas with your own symbols)
- One numerical computation with units and sig figs consistent with the raw data (as recorded in the laboratory noteboo). If the same set of data was used to obtain two different derived quantities, two sample calculations are expected, one for each different type of quantity. All work must be shown clearly in sequential steps.
- \( M = \frac{n}{V} = \frac{0.01500 \pm 0.00005 \text{ mol}}{0.02500 \pm 0.00007 \ L} = 0.6000 \ M \)
  
  absolute error in \( M \): \( \delta M = \sqrt{\left( \frac{\partial M}{\partial n} \right)^2 \delta n^2 + \left( \frac{\partial M}{\partial V} \right)^2 \delta V^2} = \sqrt{\left( \frac{1}{V} \right)^2 \delta n^2 + \left( - \frac{n}{V^2} \right)^2 \delta V^2} \)
  
  \( \delta M = \sqrt{\left( \frac{1}{0.02500 \ L} \right)^2 (5 \times 10^{-5} \text{ mol})^2 + \left( \frac{0.01500 \text{ mol}}{(0.02500 \ L)^2} \right)^2 (7 \times 10^{-5} \text{ L})^2} = 0.002 \ M \)
  
- Which term under the square root in the equation above is larger? What does that imply about improving the experiment?

Plots, charts, and graphs must be prepared using a spreadsheet or other software. Other formatting considerations include:

- Axis labels (with units) are required on all plots. All figures should include a caption (i.e. “Figure 1. Price analysis of...”)
- Both axes should be scaled so that the data spans a significant portion of the plot area (avoid placing all the data in one corner of the plot). In the figure below, the chart on the left is better than that on the right.
- If multiple sets of data are plotted on one chart, a clearly labeled legend must be used to identify the different data sets (distinct symbols and line styles should be used for each data set).

![Graphs](image)

The standard lab notebook is available in the bookstore. These notebooks are carbonless duplicating notebooks with numbered pages. Submit the duplicate pages with each lab report. All original notes must remain bound in the notebook. It is every student’s responsibility to sign his/her lab notes and then obtain the instructor’s signature upon completion of the experiment and clean-up of glassware and the work area(s).

Point deductions

The “learn from your mistakes” rule. Each deficiency may be penalized up to 3% per occurrence for experiments 1-4, then up to 5% for all the remaining experiments. Penalties increase for the same mistake in later reports because students are expected to learn and not repeat the same mistakes.
All reports are expected to be typewritten, double-spaced, including equations, tables, and special symbols. Tables, charts, and figures are to be labeled with symbols and units as applicable. NEATNESS COUNTS!

Electronic submission to TurnItIn is required. Some instructors may also require a hard copy of the same electronic file. Professional looking reports are expected. Reports with excessive amounts of text, figures, or tables, or that are poorly formatted and difficult to read may receive a score of zero. If hardcopies are submitted, low ink or toner density may lead to a score of zero.

Your report is to be entirely your own work. Although you may gather data with your group, you must do the calculations and write-up yourself. Evidence of plagiarism may result in a variety of penalties, including expulsion from the University.

Statement of Academic Integrity

- Enrollment in a course at Temple University requires adherence to the principles of academic integrity.
- Temple University believes strongly in academic honesty and integrity. Essential to intellectual growth and the university's core educational mission is the development of independent thought and respect for the thoughts of others. Academic honesty fosters this independence and respect. Every member of the university community is responsible for upholding the highest standards of honesty at all times.