

Che 321: INSTRUMENTAL ANALYSIS

John Jay College of Criminal Justice

City University of New York

524 W 59th Street, New York, NY 10019

Department of Sciences

Instructor: Mr. Dale K. Purcell, M.Phil., M.S.
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Lecture: Tuesday / Thursday 0925 – 1040 hrs, Room 1.107NB

Office Hours: Tuesday / Thursday 1045 – 1130 hrs (walk-in)
Any other time by appointment

Prerequisites: Eng. 102, Che 103-104, 201-202, and 220; Phy 203-204; Mat 241-242

Co-requisite: Che 302

Course description:

Instrumental Analysis (Che 320-321) introduces the theory and application of analytical instruments commonly employed in forensic science, criminalistics, and other medical and industrial, qualitative and quantitative laboratories. The first semester (Che 320) will concentrate on data treatment, analytical calibration methods, instrument performance and evaluation characteristics, quality control and quality assurance validation, sample preparation techniques, and spectroscopy based instrumental techniques and methods such as, molecular and atomic spectroscopy, ultraviolet-visible spectroscopy, infrared spectroscopy, Raman spectroscopy, and mass spectroscopy. The second semester (Che 321) will concentrate on chemical separation apparatus and methodologies such as gas chromatography, liquid chromatography, capillary electrophoresis, ion exchange chromatography, size-exclusion chromatography, x-ray spectroscopy, and associated forensic science procedures. The primary focus and objective of this course is to prepare the student for forensic laboratory operations based on fundamental theory and applications of forensic methodologies. Forensic science ethical issues will be integrated into lecture and laboratory discussions.

Course objective:

During the Che 320-321 course series, students are expected to perform both qualitative and quantitative analysis in laboratory exercises to solve fundamental analytical problems using techniques learned during this course. Students are expected to demonstrate mastery of hands-on laboratory skills through experimental assignments and basic scientific writing skills through completing laboratory reports, and a term paper (Che 320 only, see term paper outline below). Che 321 will require a formal written report for your final laboratory project, a General Unknown.

Course outline:

Week / Meeting	Topics	Required Readings Read before Class
1	Conclude FT-IR Spectroscopy	Ch. 16 & 17; Handouts
2	Introduction to Sample Pretreatments	SPE, SPME, Ch. 26
3,4	Introduction to Chromatic Separations	Ch. 26
5,6	Introduction to Liquid and Gas Chromatography	Ch. 27, 28; supplemental reading
7	1-hour midterm exam	
8,9	Mass Spectroscopy/Spectrometry	Ch. 20, supplemental reading
10	HPLC and HPLC-MS	Ch. 28, supplemental reading
11	GC and GC-MS	Ch. 27, supplemental reading
12	1-hour midterm exam	
13 & 14	X-ray Spectroscopy, XRF, XRD	Ch. 12, supplemental readings
15	Introduction to Capillary Electrophoresis	Ch. 30
16	Review of materials	
17	Final Exam	

In addition to attending lectures and performing laboratory experiments, students are expected to spend a considerable amount of time every week studying for this course. Students are encouraged to study in small, well organized groups. Peer-based teaching has proven to be a very valuable experience that results in a deeper understanding of course materials, which is reflected in higher individual performance and course grade.

Check the Academic Calendar:

January 28, 2013, first day of classes Spring 2013
 February 1, 2013, last day to register for Spring 2013
 February 12, 2013, Lincoln's Birthday, College is closed
 February 14, 2013, classes follow Tuesday schedule
 February 18, 2013, Presidents' Day observed, College is closed
 February 20, 2013, classes follow Monday schedule
 March 25 through April 2, 2013, Spring Recess, no classes scheduled
 April 12, 2013, last day to withdraw without academic penalty
 May 17-24, 2013, Final Examinations

Course and Curriculum Enrichment:

Students are encouraged to attend, at a minimum, the following professional conference:

(1) American Academy of Forensic Sciences, February 18-23 in Washington, DC.

<http://www.aafs.org>

Learning outcomes:

Reasoning

- Collect and properly analyze and interpret data from analytical procedures. Solve problems based on obtained information and critical thinking. Use modern instrumental techniques to solve qualitative and quantitative analytical problems.
- Use acquired data to solve appropriate problems related to analysis of various materials.
- Interpret analytical data and relate the information to identification of different materials.
- Formulate accurate opinions to present and defend in court of law and other public venue.

Knowledge

- Outline the theory and operation about various advanced analytical instruments; Synthesize related scientific literature.
- Describe physical and chemical principles involved in instrumental analysis.

Practical skills

- Apply knowledge of instrumentation to the analysis of various materials encountered in forensic science and pursue research in analysis of various types of evidence.
- Explain the importance about accuracy and reliability of the results
- Apply statistical methods to obtained data as a test of accuracy and reliability; maintain accurate record and documentations for all procedures carried out in the laboratory.
- Explain the principles of objective and unbiased interpretation of data and recognize the misuse or improper or inaccurate use of data.

Communication

- Present scientific facts and opinions in a clear and logical oral and written manner; Describe analytical procedures and results using discussion, written assignments, and exams.

Grading:

The final course grade is comprehensive and contributed by laboratory experiments (40%), final project General Unknown and formal written report - paper (10%), two 1-hour quizzes and unannounced quizzes (30% total), and a final exam (20%). During all quizzes and exams, other than a scientific calculator, absolutely no electronic devices are allowed, this includes cell phones. You must silence your cellphone prior to the start of a quiz or exam. If your cell phone rings during any quiz or exam, you will be required to immediately turn in you exam and exit the room.

The course grade depends solely on each student's individual performance, rather than any other personal reason. If the student misses a quiz due to an emergency, a make-up quiz or equivalent assignment must be requested in writing within one calendar week and must be accompanied by an official document and statement to prove the emergency; otherwise there will be no make-up quiz and the grade will be zero. There is no compromise of the grade for a verifiable emergency (medical or other) situation. All students must attend the final exam. Missing the final exam will lead to either a failing grade or an incomplete, but only due to an emergency. No make-up final exam will be given.

Cheating:

Each student is expected to complete the laboratory work independently. Submission of identical lab report or sharing data is treated as cheating. Cheating on an exam, homework or lab assignment will result in a zero for that particular assignment, or lead to a stricter penalty based on official John Jay College of Criminal Justice, CUNY, policy.

Statement of College Policy on Plagiarism:

Plagiarism is the presentation of someone else's ideas, words, or artistic, scientific, or technical work as one's own creation. Using the ideas or work of another is permissible only when the original author is identified. Paraphrasing and summarizing, as well as direct quotation all require proper citation to the original source.

Plagiarism may be intentional or unintentional. Lack of dishonest intent does not necessarily absolve a student of responsibility for plagiarism.

It is the student's responsibility to recognize the difference between statements that are common knowledge (which do not require documentation) and restatements of the ideas of others. Paraphrase, summary, and direct quotation are acceptable forms of restatement, as long as the source is cited.

Students who are unsure how and when to provide documentation and proper citation are advised to consult with their instructors. The Library has free guides designed to help students with questions pertaining to proper documentation and citation.

(Adapted in part from the John Jay College of Criminal Justice Undergraduate Bulletin)

Required and Suggested Textbooks, Book Chapters, and Articles

Required Textbook:

D. A. Skoog, F. J. Holler, S. R. Crouch, (2007), Principles of Instrumental Analysis, 6th ed, Thomson, ISBN-13: 978-0-495-01201-6; or ISBN-10: 0-495-01201-7

Required Laboratory Textbook:

Kubic, T.A., Petraco, N., and Miranda, M.D. (2012) Instrumental Analysis for Forensic Scientists: A Laboratory Manual. Kendall Hall, ISBN: 978-1-4652-0781-4.

Suggested Reference Textbooks:

Pease, Burton F. (1980) Basic Instrumental Analysis, D. Van Nostrand Company, New York. ISBN: 0-442-24503-3

Bender, Gary T. (1987) Principles of Chemical Instrumentation, W.B. Saunders Company, Philadelphia, Pennsylvania. ISBN: 0-7216-1834-0

Required Supplemental Readings:

Perkins, W.D. "Fourier Transform-Infrared Spectroscopy, Part I. Instrumentation", *Journal of Chemical Education*, 63(1), (1986), A5-A10.

Perkins, W.D. "Fourier Transform-Infrared Spectroscopy, Part II. Advantages", *Journal of Chemical Education*, 63(1), (1987), A269-A271

Perkins, W.D. "Fourier Transform-Infrared Spectroscopy, Part III. Applications", *Journal of Chemical Education*, 63(1), (1986), A296-A305.

Please read it carefully**Laboratory Work Outline:**

The purpose of the Instrumental Analysis laboratory is to introduce the student to fundamental theory and application of chemical instrumentation with qualitative and quantitative analysis techniques, which are routinely employed by forensic science laboratories for the identification and quantification of evidence. In addition, an important goal is to require the student to acquire the necessary hands-on skills for proper sample preparation to demonstrate proficiency to work in an analytical laboratory. The course requires the completion of twelve experiments, which are designed to introduce the student to the importance of procedure qualification and technical validation. The final experiment second semester is a general unknown sample that requires a comprehensive knowledge of all techniques learned in both lectures and laboratory experiments. The experiments will be divided between two semesters, as outlined in Table 1.

Table 1: Experiment assignments for Fall and Spring semester:

Fall 2012	Spring 2013
UV Parameters	GC – Ethanol
UV Qualitative	X-Ray Powder Diffraction
IR Sample Preparation	UV Quantitative
Conway	IR Qualitative
GC – Arson	HPLC Qualitative
GC – Solvents	General Unknown

The instrumental laboratory organization consists of open labs with eleven different and individual sections, which are specifically reserved for undergraduate students. A specified instructor is responsible and in charge of that individual section. Section instructor and times are shown in Table 2. Due to laboratory safety reasons, **at most sixteen** students are allowed to occupy the laboratory at any time. **Maximally there are 8 primary time and 8 secondary time students** for each individual section. The student can choose his/her **primary and secondary working time** based on his/her convenience and availability of the section. Primary students have the highest priority to access instruments followed by Secondary students with the preferred priority, and all other students have open access priority (first come, first serve) during any given laboratory section. Students may occupy the laboratory to prepare solutions or prepare for an experiment without access to an instrument **with the section instructor's permission**.

Table 2: Sections and instructors for Instrumental Analysis for Spring 2013.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
09:00-13:00 Ashley Morgan	No Lab	09:00-13:00 Ron Prip	No lab	Graduate Section	9:00-13:00 Bruce Eng, Esq.
13:00-17:00 Nick Petraco	13:00-17:00 Dale Purcell	13:00-17:00 Ron Prip	13:00-17:00 Dale Purcell	Graduate Section	13:00-17:00 Bruce Eng, Esq.
17:00-21:00 Nick Petraco	Graduate Section	17:00-21:00 Dr. Marcel Roberts	17:00-21:00 Dale Purcell	NO LAB	NO LAB

Graduate Sections are for Graduate Students ONLY!

IMPORTANT:

All “Unknown – Question” and “Standard – Known” samples are to be treated as **Forensic Evidence** and each student is expected to safeguard their evidence. In addition, some Question and Known samples and solutions are unstable or volatile and, therefore, they should be prepared by each student at the time of analysis.

The student is required to keep a record of laboratory attendance in each laboratory notebook. Remember to ask the section Instructor/CLT (College Laboratory Technician) to initial your attendance log each day.

Laboratory Notebook Documentation Guidelines:

1. The laboratory notebook must be bound so that the pages are not removable. A “marble” composition book with sewn bindings is ideal. **You need two notebooks.**
2. The outer front cover of bound laboratory book must contain the student’s full name (i.e., your full name), the student’s last for SSN, course (i.e., Che 321), semester (i.e. Spring 2013), primary section day/time (i.e., Primary Section – Tuesday, 1300 – 1700 hrs) , secondary section day/time (i.e., Secondary Section – Thursday, 1700 – 2100 hrs), primary instructor (i.e., Primary Instructor - Mr. Purcell), group designation (i.e., Group C), and book number (i.e., Book 2).
3. All entries must be in black or blue ink, which is not water-soluble and not erasable. A sketch may be penciled in initially, and then immediately inked in. Do not continue until the sketch has been inked in.
4. All pages must be numbered consecutively, prior to use. Place the page number in the extreme upper right hand corner of the odd-numbered pages and on the extreme upper left hand corner of the even numbered pages. The last page number should be twice the number of sheets in the notebook. If it is not, carefully recheck the numbering, page by page. If the notebook does not contain the advertised number of sheets, an initialed and dated explanation to that effect should appear on the last page of the book. If pages were accidentally skipped during the numbering process, simply number the skipped pages A, B, etc. (i.e., 111, 111A, 111B, 112), and note the error on the last page of the notebook.
5. The first page, the table of contents, should be formatted as illustrated below.

Experiment Title	Pages	Report Page	Check-Out Factor	Gross Grade	Final Grade	Instructor, Date
<i>Student</i>	<i>Student</i>	<i>Student</i>	<i>Instructor</i>	<i>Instructor</i>	<i>Instructor</i>	<i>Instructor</i>
<i>Conway</i>	<i>1/3-1/8</i>	<i>1/9</i>	<i>1.00</i>	<i>Instructor</i>	<i>Instructor</i>	<i>Instructor</i>
<i>GC-Solvents</i>	<i>2/3-2/38</i>	<i>2/39</i>	<i>0.90</i>	<i>15</i>	<i>13.5</i>	<i>Instructor</i>
<i>UV Parameters</i>	<i>1/11-1/32</i>	<i>1/33</i>	<i>0.85</i>	<i>18.0</i>	<i>15.30</i>	<i>Instructor</i>

All exercises should begin on an odd-numbered page and contain the title, as illustrated in the below. Do not rewrite the title of the exercise each day of an entry.

Experiment Title: _____

Theory Grade: _____ Instructor: _____

Equipment Grade: _____ Instructor: _____

Average for Theory and Equipment: _____

Unknown ID: _____ Date: _____ Issued by: _____

Standards Requested:

- | | |
|----------|----------|
| 1. _____ | 4. _____ |
| 2. _____ | 5. _____ |
| 3. _____ | 6. _____ |

6. The data for each exercise must be entered contiguously, line-by-line without gaps.
7. Document your work in past or present tense. Do not document what you intend to do, just what you did or observed.
8. If a spelling error is made in the book, put one continuous line through it, insert the correction above or to the right of the error, and draw a circle around the abbreviation “sp” near the correction. Inserting corrections above an error is not permitted for an error which effect the meaning of the data. Unless a spelling or sentence structure error affects the meaning of the data it will not be penalized.
9. If a data error is made and noticed before any additional entry is made, simply put one continuous line through it, and write the correct to the right of the error—for example, ~~132.45 grams~~ 132.45 grams. Initial and date the line-out. If the data error is not noticed immediately, the format is slightly more involved. First, initial, date and line out the error. Second, place an asterisk about the error and indicate where (page #) the corrected data has been documented. Finally, document the correction contiguously on the next available unused line of the exercise, even if it is many pages later. Use an underlined heading and state “*Correction of data on page #”, where # is the page with the error. Explain the reason for the error, if it is not obvious. Use multiple asterisks (“***”, “****”, etc.) if more than one error is made on a page. If you wish for increased readability, you may also write the corrected data in the space above the error (if enough room permits) after this procedure has been followed. This procedure should be followed for all corrections, including date errors. If an error is made in writing the date, line out the incorrect date, write the correct date, and initial and date the correction. The reader cannot assume the corrected date is the date the correction was made.
10. All observations must be recorded in the notebook at the time they are made. There are no exceptions to this rule. Do not continue collecting additional data until previously acquired data has been recorded. Document observations, then conclusions. It is not acceptable to write “the Q and K spectra (or chromatograms) do not a match because...”, unless the observations leading to the conclusion were previously documented. An inspection of the notebook should reveal the last observation made. Never use scrap paper. The laboratory notebook is a workbook, its contents need not be aesthetically pleasing—penmanship, spelling, grammar, and punctuation does not affect the grade (unless the documentation is ambiguous, misleading, or illegible). Record all data directly into the notebook.
11. Use sketches where appropriate to illustrate text. Artistic talent is not required. Sketches should be large enough to illustrate appropriate detail. Sketching does not, however, negate the need to document observations in text form. Unlike contiguous text which cannot be altered without

detection, sketches tend to have blank areas that an unethical person could fill in at a later date. Consequently, data documented in sketch form is somewhat less credible than contiguous text. Sketches are excellent for illustrating what is not observed (since erasures can be detected) for documenting minutiae.

12. Never conceal a page by taping something into the notebook in such a manner that the underlying page cannot be viewed. When taping something into the notebook, place it on an unused page, write “reserved for ... (whatever is being inserted)” in block letters half-way down the page, and draw a diagonal line from the top left to the bottom right across the page above and below (not through) the line with the writing. Initial and date the line. To insert material which is larger than the notebook page (i.e., an 8 ½” x 11” chart or form), turn the material horizontally, and tape the top edge of the inserted page along the margin of the unused notebook page, flip the inserted page over, and tape the underside of the top edge to the notebook. Fold the inserted page so that it does not protrude from the notebook. Use a separate page for each inserted page. Use a good quality transparent tape, such as 3M’s Scotch™ tape.
13. A signed copy of the laboratory safety rules must be taped into the inside rear cover of the notebook. Use the technique described above to tape the forms in place.
14. The only acceptable date format is dd-mmm-yy—(i.e., 01 Aug 12 or 01-Aug-12). Note that single digit dates must be preceded with a zero to prevent the possibility of alteration—(i.e., 8 to 18 or 28). This date format is to be used whenever a date is required. However, do not convert dates in other formats when documenting observations. Document exactly what you see. For example, “8/3/92” could mean March 8, 1892, or August 3, 1992 (notice the date could be in a different century). Never make assumptions when documenting observations.
15. The only acceptable time entry is the 24 hour format—(i.e., 0100 (1:00 AM), 1758 (5:58 PM)).
16. With the sole exception of the table of contents page, the top and left margins of each page are to be used solely for the date and/or time. No other entries should be made in these margins.
17. Do not use the bottom margin (the space below the last line) for data entry. Its use is limited to noting a “continuation” page. When working on *more than one exercise*, it will be necessary to estimate how many pages an exercise will require and then skip that number of pages before writing the title page of the next exercise (on an odd-numbered page). Many times the number of pages skipped is insufficient and the first exercise must be continued after the second exercise, *after* estimating the number of pages the second exercise will require. If this happens, write “continued on page #” in the bottom margin, where # is the page number where the exercise continues. On the continuation page, write the date in the top left margin, rewrite the title of the exercise on the second line, and write “continued from page #” on the third line, where # is the page number where the exercise is continued from.
18. All students will be required to have their laboratory notebook in their possession at all times when they are working in the lab and when requesting unknowns/supplies.
19. The standards and unknowns issued must be documented in the notebook.
20. The last entry for each exercise should be the report. It should begin at the top of a new page, so line out unused lines on the previous page if necessary. Be succinct (four lines or less) and unambiguous. “UV12-51 contains Aspirin”, for example would be an acceptable report for exercise IV. Sign (initials are unacceptable) and date the report and submit the notebook for evaluation. **Do not write or line out the area below the report, the space will be used for**

comments and instructions by the instructor. Since the report should be the last entry for the exercise, answer any required questions prior to writing the report.

21. Removable Report Pages can be found at the end of each experiment in the laboratory manual. The student will need to fill these pages out properly and hand them in as part of the experiment along with the laboratory notebook for grading. The Report Pages will be retained by the instructor for submission to Mr. Purcell. Any laboratory submitted without the required Report Pages will receive a grade of zero.
22. The notebooks must be submitted to the instructor upon request and at the conclusion of the exercise.

Laboratory assignment:

To most efficiently allot time equally to all students, the assignment of laboratory experiments will be divided amongst the students and in a specified order. DO NOT DEVIATE from this sequence of completing laboratory exercises without written consent from both the Primary Instructor and Mr. Purcell. The senior CLT will assign the Laboratory Schedule to each student according to Table 3.

Table 3: Experiment Assignment Sequence – Spring 2013

Group	1	2	3	4	5	6
A	IR Qualitative	HPLC	X-ray	UV Quantitative	GC Ethanol	General Unknown
B	HPLC	X-ray	GC Ethanol	IR Qualitative	UV Quantitative	General Unknown
C	GC Ethanol	IR Qualitative	UV Quantitative	X-ray	HPLC	General Unknown
D	UV Quantitative	GC Ethanol	IR Qualitative	HPLC	X-ray	General Unknown

Procedures for you to complete an experiment:

1. Follow the experiment sequence assigned to you.
2. It is important for the student to thoroughly read and understand the experiment packet materials, required readings, and all suggested reading materials especially for those topics that are not yet presented and discussed during lecture at the time you are scheduled to conduct the experiment.
3. Download the corresponding experiment packet, which contains required reading materials and instructions for that particular experiment. Read all packet materials, all appropriate laboratory manual sections, as well as all related textbook materials prior to oral exam (check-out) by your Primary instructor.
4. Provide your notebook prepared for oral exam to your Primary instructor, who will ask you theoretical and practical questions about the instrument and experiment for which you are preparing to conduct. The student is expected to be prepared for this oral exam. Do not expect to pass this exam without sufficient preparation. Your Primary instructor will require that you demonstrate proficiency prior to assigning access to the instrument. Upon successful completing of the oral exam, your Primary instructor will assign a check-out factor grade, which will be used to calculate your final experiment grade.

5. You are expected to work independently. Only a laboratory instructor (under extraordinary circumstances) may permit students to share experimental data. It is the student's responsibility to obtain written and signed permission in your laboratory notebook. Copying or unauthorized sharing another student's data will be treated as cheating and, at a minimum, the grade for that particular experiment will be a zero. The instructor may choose to elevate the offense to affect College Policy on Plagiarism.
6. Upon completion of each laboratory experiment, report your results to the CLT or instructor who will check your (unknown) report and record the correct answer in your laboratory notebook.
7. There is a due date for each experiment. You must report your results to the CLT or instructor on or before the due date. Experiments submitted after the due date will have a check-out factor reduction of 0.1 per day (10% off). Your laboratory will be graded separately by an appointed laboratory instructor.
8. Each individual laboratory experiment will be graded by an individual lab instructor. You can find the specific instructor who will grade a laboratory experiment in Table 4. A laboratory notebook drop-off mail box is available in the instrumental laboratory for each instructor. It is the student's responsibility to submit the appropriate notebook for grading upon completion of the experiment.
9. Submit your notebook for the final grade of the experiment.

The overall grade for each experiment depends on your preparation, observations, thorough documentation, experimental data, and your interpretation of the result and a correct report. If the check-out factor is 1.0, your report is correct, and your experimental documentation, data content, and interpretation is complete, they you may be eligible for a full grade, however, the final grade will be based on your work product. [Final grade = Experimental grade x Check out factor]

Table 4: Laboratory experiment instructor / grading schedule

Instructor	Lab report
Dr. Marcel Roberts	IR Qualitative Identification
Ron Prip	X-Ray Power Diffraction
Dale Purcell	General Unknown
Nick Petraco	GC Ethanol Quantitative
Ashley Morgan	UV-Quantitative
Bruce Eng, Esq.	HPLC Qualitative Identification

How to submit your laboratory notebook:

Submit your laboratory notebook on or before the due date by depositing your notebook in the appropriate "Drop Off" mailbox in instrument laboratory. You may obtain your laboratory notebook from the "Pick Up" mailbox after it has been graded. If you deposit your laboratory notebook in the wrong mailbox there will be a delay in the grading of your experiment.

Laboratory equipment breakage points:

Points will be deducted for breaking any laboratory equipment or apparatus. A detailed list of laboratory equipment and corresponding points is posted on the information board in the instrument laboratory and on the door of the instructor's room.

Late report:

Failure to submit a completed laboratory experiment by the due date will lead to the deduction of 0.1 point/day from the check-out factor (**10% off**) for that particular experiment. If there is a delay due to an unexpected reason, for example, the instrument is down; sickness; family emergency, etc., the deduction doesn't apply. However, the student is responsible to **provide an official written statement and obtain a signature from the laboratory instructor in your laboratory notebook**. No lab report will be accepted after the day of the final exam, after which **any missing report will be treated as zero after final exam**. In addition to laboratory experimental work, the student is required to complete a term paper. The due date for each laboratory experiment report, choosing a term paper topic, and the final term paper submission is listed on Table 5.

Table 5: Important due dates for Spring 2013

Experiment:	Due date/ Time
1	19 Feb 2013 (Tue) 1600 hrs
2	5 Mar 2013 (Tue) 1600 hrs
3	19 Mar 2013 (Tue) 1600 hrs
4	16 Apr 2013 (Tue) 1600 hrs
5	30 Apr 2013 (Tue) 1600 hrs
6	15 May 2013 (Wed) 2000 hrs
Lab closing	15 May 2013 (Wed) 2100 hrs

IMPORTANT: Students are encouraged to check-out for their 2nd experiment a week after completing check-out for their 1st experiment, and then continue this sequence until all experiments are completed. The final General unknown must be completed in a separate laboratory notebook to be turned in with a formal written report. I will provide information about how to write the formal written report before the end of the semester.

Tips for a fruitful and collegiate instrumental laboratory experience:

1. Although the time assigned for you to complete the experiment is more than enough, **managing your time wisely** is still very important. Leaving everything to the last minute before the due date only **makes you feel very frustrated**.
2. Before check-out and beginning the lab work, you should spend enough time on reading lab manual and related book chapter carefully and thoroughly. Preparing the pre-lab report is very important. Make sure you understand what you are supposed to do and what results you are expected to obtain. Reading and writing in the lab only **wastes your precious instrumental time**.
3. Think and plan carefully before you start your experiment. Mistakes caused by carelessness- for example: solution is not prepared correctly; weighing mistake, etc., only slow down your work.
4. Maintain a good working habit. In instrumental analysis, working in a **neat and organized way** is very important to prevent contaminations and obtain good results. Remember to clean all your glassware right after your work and make sure that they are ready for use next time.
5. If you have questions, solve them promptly by **thinking independently** or asking the laboratory instructor. **DO NOT ask CLTs questions about your experiment; they are not your instructor.**
6. Be nice to your fellow students, laboratory CLTs, and instructors.

Cancelled laboratory session:

If your laboratory section is cancelled, you can make it up at any time (given no more than 15 students working simultaneously in the laboratory) within one week (7 days) from the cancellation. Holiday doesn't count if it is within this period of time. The make-up time is equivalent to your cancelled primary or secondary time. This opportunity will expire after 7 days. Ask CLT for a cancellation make up sheet and tape it into your notebook. This form should be signed by either the instructor who is in charge of the cancelled lab or by Mr. Purcell.

Grade for quantitative analysis (based on relative error):

Full points: error $\leq 5\%$

15~full points: $5\% \leq \text{error} \leq 10\%$

10 ~ 15 points: $10\% \leq \text{error} \leq 15\%$

5 ~ 10 points: $15\% \leq \text{error} \leq 20\%$

5 points: error $\geq 20\%$