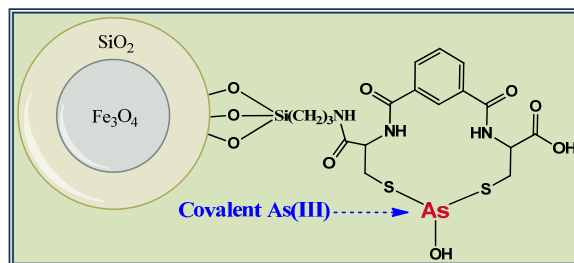


**CHE 412G**  
**Inorganic Chemistry**  
**Laboratory, Fall 2012**  
**SYLLABUS**



### I. Course Information

Sections: 412G-001, M, W (12:00-2:50p; CP-301)  
412G-002, M, W (3:00-5:50p; CP-301)

Instructor (Office Hours): David Atwood (T, R, 10-11a or email for appointment)

Teaching Assistants (Office Hours): John Walrod and Daniel Burriss (M, W, 10-11 am; CP-239)

Required Laboratory Notebook: Size: 11" x 9 1/4" with 100 Sheets and detachable carbon copies.

#### Blackboard Website

Access CHE 412G: Inorganic Chemistry Laboratory (Fall 2012) through your "My UK" account.

### II. Course Description

This laboratory will provide an introduction to the synthesis, isolation, and characterization of inorganic and organometallic compounds. The student will conduct basic synthetic laboratory procedures and utilize a variety of analytical characterization techniques. Each student will complete a series of structured, interconnected laboratory experiments derived from the current literature. The Laboratory Reports associated with the experiments will incorporate fundamental inorganic chemistry information from textbooks, reference works, and peer-reviewed journals. The experiments have two purposes: 1) provide an understanding of fundamental inorganic concepts (learned in CHE 410G), and 2) have you understand and experience important inorganic characterization techniques. The student will keep an appropriately formatted laboratory notebook to record the details of each experiment. Each student will write an American Chemical Society (ACS) formatted article based on the final multi-component experiment.

### III. Student Learning Outcomes

At the conclusion of this semester each student will have learned and experienced:

1. Basic synthetic laboratory techniques.
2. Important inorganic characterization techniques (with relevance to pharmaceutical R&D).
3. Experience maintaining a professional laboratory notebook.
4. The *safe* preparation of inorganic compounds and solid-state materials.
5. How to obtain and interpret safety and toxicity information for chemicals.
6. Interpretation, evaluation, and explanation of synthetic and analytical information.
7. Communication of laboratory results in written form.
8. How to place laboratory results in the context of the existing literature.
9. Working with collaboratively with peers on common projects.
10. Writing an original ACS publication.
11. Application of fundamental inorganic concepts to laboratory experiments.
12. Build and develop critical thinking skills for career and life.

#### **IV. E-Mail Capability**

You must have a UK U-Connect e-mail account for e-mail and electronic submission of assignments. You can obtain your account on-line at any student computing laboratory on campus. You are responsible for checking your e-mail on a regular basis. A communication from me through e-mail will be considered the same as one delivered orally or in writing in class. That is, you are expected to have read what has been transmitted by e-mail and taken the necessary action.

#### **V. Internet Access and Course Information on BlackBoard**

Internet access is required for this course. You will receive information from the instructor through email and must be able to access the Blackboard (Bb) website for the course (see I. above). The Bb website will contain the syllabus, background information for the experiments, and other useful documents. Each experiment will have three associated documents: 1) A Pre-Laboratory Notebook Guideline (containing a description of what you should write in your laboratory notebook before coming to the lab), 2) Background and Procedure (most often in two documents but some experiments combine the Background and Procedure into a single document), and 3) Laboratory Report Guidelines (these will provide specific instructions for each experiment). There are 19 experiments and 8 laboratory reports.

#### **VI. Attendance**

*Attendance at each class meeting is mandatory.* Arriving more than 15 minutes late will result in a 20 % reduction in the total points available for the experiment being conducted on that day. Excused absences will be granted only for the reasons listed in the Student Rights and Responsibilities code (S.R. section 5.2.4.2). For excused absences, you will be given an opportunity to make-up the missed class. You will not be given an opportunity to make-up an unexcused absence. Unexcused absences will result in a 50% reduction in the total points assigned for the experiment being conducted on the day that was missed.

Students anticipating absence for a major religious holiday during the fall semester must notify me in writing or email prior to the last day for adding classes. Information regarding dates of major religious holidays may be obtained through the religious liaison, Mr. Jake Karnes (jkarnes@email.uky.edu, 257-2754).

#### **VII. Academic Offenses**

All work must be the original product of your own efforts, and all materials quoted from others must be properly credited. Using pre-written work constitutes academic dishonesty and could result in your being expelled from the university. A link to a paper "Plagiarism: What is it?" may be found at the Ombud website (<http://www.uky.edu/Ombud/Plagiarism.pdf>). The Ombud Web site also includes a link to a Prentice Hall Companion Website "Understanding Plagiarism" ([http://wps.prenhall.com/hss\\_understand\\_plagiarism\\_1/0,6622,427064-,00.html](http://wps.prenhall.com/hss_understand_plagiarism_1/0,6622,427064-,00.html)).

Submitting someone else's work as your own constitute a serious academic offense that could result in expulsion from the University. The University Senate Rules describing penalties for academic offences can be found at: <http://www.uky.edu/USC/New/SenateRulesMain.htm>. You can also access the rules through UK's main Web site, <http://www.uky.edu>. Select the "Site Index,"

choose the letter "S" and then select "Student Rights and Responsibilities." Once there, look under "Student Conduct".

### VIII. Disability Statement

Any students with disabilities who need accommodation in this course are encouraged to speak with the instructor as soon as possible to make appropriate arrangements.

### IX. Safety

Each student must complete the **four** online safety training modules listed here:

- 1) Chemical Fume Hood
- 2) Chemical Hygiene Plan/Laboratory Safety
- 3) Fire Extinguisher Training
- 4) Hazardous Waste.

The training modules can be accessed at the UK Environmental Health and Safety website: <http://ehs.uky.edu/classes/>. For the hazardous waste training module, you will need to include the building number, **0055**, and the department number, **8E030**. Save the transcript page indicating you completed the four training modules by printing it to a pdf file or copy as a screen-capture. Email the transcript to the Instructor (datwood@uky.edu). *The training modules must be completed before you enter the laboratory on August 27<sup>th</sup>.*

Safety goggles must be worn, *at all times*, within the laboratory (CP 301, CP 303, and CP 302). Failure to wear safety goggles will result in one of the following: a first offense results in a verbal warning, a second offense, will result in a 10% reduction in the total points available for the experiment being conducted at the time of the offense, and a third offense will result in expulsion from the laboratory and a 50% reduction in the total points available for the experiment being conducted. No make-up time will be allowed for a third offense. Subsequent offenses will result in discussions with the Instructor, student, and Chair of the Chemistry Department to decide the appropriate measures to be taken.

Shorts, dresses, tank tops, and open-toed or highly-breathable shoes are not permitted within the laboratory. Laboratory coats and/or aprons are not required but are highly recommended. Food, drink, and cell phone use are forbidden in the laboratory.

### X. Laboratory Experiments

#### A. General Guidelines

Read the MSDS (Manufacturers Safety Data Sheet) on all reagents used in the lab. This information will be incorporated into the Pre-Laboratory Quizzes and a component of some of the Laboratory Reports. You should include important information from the MSDS in your laboratory notebook and your reports (toxicity, handling precautions, solubility in water and other solvents). These two websites, as examples, could be used to obtain MSDS information:

Dept	Class	Taken	Trainer	Certificate
8E030	FUMEHOOD	2012-02-10 19:28:00.000	Course, Online	<input type="button" value="Get"/>
8E030	FIRESAFECCLASS	2012-01-27 10:29:22.000	Course, Online	<input type="button" value="Get"/>
8E030	HAZWASTE	2012-01-27 10:21:52.000	Course, Online	<input type="button" value="Get"/>
8E030	LABSAFECCLASS	2012-01-27 09:40:20.000	Course, Online	<input type="button" value="Get"/>

<http://www.msds.com/> and <http://www.ilpi.com/msds/index.html>. Another good resource for safety data on chemicals and a great deal of other useful chemical information is:

<http://www.chemspider.com/SimpleSearch.aspx>

## **B. Glassware Cleaning Procedure**

Develop the habit of cleaning glassware while you are conducting each experiment. If possible, glassware from a previous experiment should be cleaned before beginning a new experiment, or shortly after completing an experiment. There is a strong detergent solution in a plastic container near your sink. When you finish an experiment wash the glassware with the solvent that will dissolve the reagent or compound. You will have determined the most appropriate solvent for cleaning your glassware before you began the experiment. The MSDS sheets for the chemicals will usually indicate which solvents the compound or reagent is soluble in. However, you might have to find this information from another source. You will also save time by being able to more quickly clean your glassware. The procedure is listed out in Appendix A. You will be given a copy of the procedure and it will be posted in the laboratory.

## **C. Hazardous Waste**

If the reagent or compound must be handled as a *hazardous waste* do the solvent-rinse in one of the hoods with the solvent bottles located there and pour the solution into the appropriate aqueous or organic waste container. Before you begin each experiment you will identify which reagents and compounds must be handled as hazardous waste. You will also determine which solvent would be appropriate to remove the reagent or compound from your glassware. Aqueous (water solutions) and organic waste containers are located in the hood on the right side of the near the door to CP-302.

## **D. Non-Hazardous Waste**

If the reagent or compound is not hazardous then wash the glassware in the sink with dilute HCl solution or a non-hazardous solvent. Then wash with water using a brush. Rinse with acetone and let the glassware dry before putting it back in your drawer. If needed, you could put the glassware in the soap solution container located by each sink after removing any solids present. If this doesn't clean the glassware then it should be soaked in the base bath (KOH and EtOH). Talk to your TA or instructor before you use the base bath. You must wear thick, butyl-rubber gloves when working with a base bath (not the thin nitrile or latex gloves you use in the hood). Retrieve and rinse the glassware at the next laboratory period. If stored in the base bath the glassware must be rinsed with 5% HCl to neutralize the base.

## **XI. Laboratory Notebooks**

### **A. Required Notebook**

A laboratory notebook with carbon-copy duplicate pages is required for this course: TOPS Laboratory Research Notebook, 11" x 9 1/4", 100 Sheets (\$22.91 on Amazon).

OfficeMax: [http://www.officemax.com/office-supplies/paper/graph-paper/product-prod2840344?history=bov0aexz|prodPage~15^freeText~carbon+copy+notebooks^paramValue~true^refine~1^region~1^param~return\\_skus^return\\_skus~Y](http://www.officemax.com/office-supplies/paper/graph-paper/product-prod2840344?history=bov0aexz|prodPage~15^freeText~carbon+copy+notebooks^paramValue~true^refine~1^region~1^param~return_skus^return_skus~Y).

Amazon: [http://www.amazon.com/Laboratory-Research-Notebook-Numbered-35125/dp/B000FDPHLE/ref=sr\\_1\\_12?s=office-products&ie=UTF8&qid=1345042961&sr=1-12&keywords=laboratory+notebook](http://www.amazon.com/Laboratory-Research-Notebook-Numbered-35125/dp/B000FDPHLE/ref=sr_1_12?s=office-products&ie=UTF8&qid=1345042961&sr=1-12&keywords=laboratory+notebook)

## **B. How You Will Use Your Notebook**

1. Before the laboratory meets: write Pre-Laboratory Notebook entries: A) *Background* section for the experiment that includes the prelaboratory assignment and B) an *Experimental* section that outlines the experiment to be conducted. *Carbon copies of the pages containing 1) and 2) must be submitted to the instructor when you arrive to the laboratory (and before you begin any experiments).* Section C. contains the information that is required to be included in the Introduction and Experimental sections of your laboratory notebook.

2. During the laboratory: write your *Observations*, notes, and any other information obtained during the lab. Identify information that will be (or could be) included in the Laboratory Report for the experiment.

3. Notebook Grading: The carbon-copy pages submitted before beginning each experiment (1 and 2 above) will be graded. The entire laboratory notebook will be graded at the end of the semester.

## **C. Pre-Laboratory Notebook Entry Guidelines**

Before coming to the laboratory you must handwrite the information listed below for each experiment in the first two or three pages of your notebook. The first page should contain a heading with the Experiment # (1, 2, 3, etc.), Your title for the experiment (be creative!), name and date. The Pre-laboratory sections should be formatted as shown and contain the information listed. *Every experiment will have an associated MS Word version of the Pre-Laboratory Notebook Entry Guideline in Bb.* However, remember to handwrite this information into your Laboratory Notebook.

### **I. Background**

A. Balanced Equation(s) for the Reaction(s)

B. List of reagents, solvents, and products that appear in the balanced equations. Include this information for each:

1. IUPAC nomenclature
2. Common name
3. Structure
4. Whether the reagents toxic, carcinogenic, teratogenic, or other (include definitions).
5. Health Effects, what are they?
6. Handling Requirements (what precautions must be taken)
7. Solubility (in water and specific organic solvents)
8. Melting point or boiling point
9. Disposal (as hazardous waste or not and necessary precautions)

C. Purpose of the experiment

### **II. Experimental (on a new page)**

A. Balanced Equations (again)

B. For the Reagents, Solvents, and Products, a Table containing:

1. Chemical formula
2. Molar mass
3. Amounts
4. mmol (millimoles)
5. Volumes (solvents and liquid reagents)

6. Sample calculations for the product yields based on the amounts of reagents listed in the procedure.
  7. Leave space in the table for the actual values you obtain for the experiment.
- C. A brief description of the procedure so that you can use your laboratory notebook to conduct the experiment.
- D. Sketch of how the glassware will be set up to conduct the reaction.
- E. What solvents you could use to clean the glassware (water is ideal).
- F. What analytical characterization techniques will be used? What information will these techniques provide about the experiment ?

## **XII. Laboratory Reports**

### **A. Experiments 1-12 (Reports 1-7)**

The Report instructions for each of these experiments will be provided on Blackboard prior to the first day of each experiment. These Reports will not have a uniform format and should be typed in MS Word with any spectra or other information scanned or copied into the document. The dates that the Reports are due are highlighted in yellow in the Semester Schedule.

### **B. Publication Writing Project for Experiments 13-19 (Report 8)**

For this list of related, sequentially reactions and characterization techniques you will write an ACS-style publication as Report 8. The format and guidelines for this publication are shown below. You should also read several *Inorganic Chemistry* articles related to the subject of this Writing Project to gain insight into the content and style of such a publication. You will need to incorporate peer-reviewed literature in your publication draft.

#### Publication Format and Guidelines:

**Page 1. Title** (brief and descriptive), **Your Name**, and **Abstract**. The abstract should succinctly describe the contents of the article. This would include what studies were conducted, what compounds were synthesized, how the products were characterized, and only the most important features of the molecules. Specific, routine, numerical data are not included, for example, bond lengths, chemical shifts, mass spectra. Examples of numbers that would be included in the abstract are unusual bond lengths (like the shortest example of a metal-sulfur bond), the % removal of a contaminant from water (using a reagent like AB9), or other very exceptional characterization data.

#### **1. Introduction**

- 1.1. The use of outline numbers will begin with this section. For simplicity and consistency we will use 1,2,3, etc. and 1.1, 1.2, 1.3, etc., as the headings for sections and sub-sections, respectively.
- 1.2. A brief description of the importance of the general research area
- 1.3. Importance of the specific research conducted
- 1.4. Description of the related work in the area, and how the new results relate to the previously published work.
- 1.5. The introduction provides the context for the new research and enough additional information to make the results understandable to a reader who may not be an expert in the area.

- 1.6. Use figures and schemes to support your introduction (numbered sequentially throughout the article and including a descriptive caption below the figure).
- 1.7. Refer to the figures in the text.
- 1.8. Locate the figures and schemes in an appropriate location within the text.

**2. Experimental.** This section contains the specific details, numbers, amounts, reagents, instruments, etc. that were used in the research. It provides the specific details necessary for another person to reproduce the research. It should include the subsections listed below. You should find an *Inorganic Chemistry* article that is relevant to the experiments and use it as an example of what information should be included in each section.

- 2.1. Instrumentation The synthesis and characterization equipment used, and how operated.
- 2.2. Reagents Starting materials, where obtained, purity, solvents, etc.
- 2.3. Subsections Specific to the research.
- 2.4. Synthesis and Characterization of X
- 2.5. Synthesis of Y
- 2.6. Characterization of Y Separately list the unique characterization results, like the results obtained with XRPD and ICP-OES characterization techniques.
- 2.7. Other needed information in additional subsections with relevant headings Other information specific to the research like metal capture studies, leaching studies, electrochemistry, stability testing, biological testing, etc.

**3. Results and Discussion.** This section is usually the most difficult to write and it is advantageous to begin with an outline of how you think the results should be presented. Then check the literature for related information and include it where appropriate in the outline. You could simply paste the abstracts from the literature into the document to use in creating your draft. Then, if you use the abstract information, re-write it in your own words. Then include the discussion you know is most important and in the last draft make sure the sentences and paragraphs are integrated (or “flows”). It is usually easiest to begin with the synthesis of a compound, then characterization, then derivative studies. *You must compare and critically evaluate the results you’ve obtained with related results found in the literature.* Include figures, schemes, and tables in their appropriate locations in the text.

**4. Conclusions.** This should never restate the abstract, or information in the results and discussion section (although this happens frequently). Rather, this section should contain a description of why the results are important and what implications they have.

**5. References.** Include at least two references not provided through Bb. List the references in ACS format. It would be useful to take this opportunity to learn how to use Endnote for managing references.

**6. Figures, Schemes, Tables, and Spectra.** Any graphical material should be located in the body of section 3. Resize the material and use text-wrapping (with the figure on the right) if possible. Use Chemdraw or another drawing program to create reaction schemes showing the reactants the structural formulae of the products. You could also use a free program called ChemSketch to draw your figures and structures (<http://www.acdlabs.com/download/>). If the graphical material cannot be

located within the text then place it in this Section. For example, if the lines on a spectrum are too faint when resized to fit within the text.

Each item of graphical material should have a descriptive caption listed beneath it. Use this format: **Figure 1.** description of figure, **Scheme 1.** description of scheme, etc.). Table captions should be listed above the table as **Table 1.** description of table contents. Make sure you refer to the graphical material in the text.

### C. Sources of Information for Laboratory Reports

#### 1. Science Library

- i. *Structural Methods in Inorganic Chemistry*, E.A.V. Ebsworth, D.W.H. Rankin, S. Craddock, CRC Press, 1991 (Science Library Reserves, QD95.E29 1991b).
- ii. *Inorganic Chemistry*, Huheey, Keiter and Keiter, 4<sup>th</sup> Edition, Harper Collins, NY, 1993 (Science Library Reserves, QD151.2.H84 1993).
- iii. *Encyclopedia of Inorganic Chemistry*, 2<sup>nd</sup> Ed. King (Editor), Wiley, 2005 (Science Library Reference Section, QD148.E53 2005).
- iv. *Synthesis and Technique in Inorganic Chemistry: A Laboratory Manual*, G. S. Girolami, T. B. Rauchfuss, and R. J. Angelici, University Science Books, 1999.
- v. *Inorganic Experiments*, 3<sup>rd</sup> Edition, J. D. Woollins, Wiley-VCH, 2010.

#### 2. Blackboard Website

The list shown below is an example of the articles that will be located on the website that can be used as background information to better understand the laboratory experiments and provide information that could be used in your Laboratory Reports. Items a-g are from *Applications of Physical Methods to Inorganic and Bioinorganic Chemistry*, R.A. Scott, C.M. Lukehart (Eds), John Wiley & Sons, 2007. Items 9 and 10 describe the need for the sustainable use of various elements from the Periodic Table.

- i. Circular Dichroism (CD) Spectroscopy
- ii. Electrochemistry
- iii. Metal Analysis (ICP-OES and ICP-MS)
- iv. Nuclear Magnetic Resonance (NMR)
- v. Vibrational Spectroscopy (IR and Raman)
- vi. X-ray Powder Diffraction (XRD)
- vii. Electronic Spectroscopy
- viii. FT-IR (ATR) Perkin Elmer, 2005
- ix. Endangered Elements, *Chemistry World*, January 2011, 50-54.
- x. The End of Cheap and Easy Supplies? *The Chemical Engineer*, 2011, **844**, 47-51.
- xi. IUPAC Periodic Table, 2009.
- xii. The instructor will put additional background information on Bb as it becomes available.

#### 3. Inorganic Chemistry Literature

1. *Chemical & Engineering News (C&EN)\** (This useful magazine is free with an ACS Membership)

2. *Inorganic Chemistry*\*
3. *Organometallics*\*
4. *Journal of the American Chemical Society Communications*\*
5. *Environmental Science & Technology*\*
6. *Industrial and Engineering Chemistry Research*\*
7. *Chemistry of Materials*\*
8. *ACS Nano*\*
9. *Nano Letters*\*
10. *Crystal Growth & Design*\*
11. *Chemical Communications* (Royal Society of Chemistry Publication)
12. *Science*
13. *Nature*
14. *Nature Materials*
15. *Nature Nanotechnology*
16. *Small*

\*American Chemical Society (ACS) Publications

### **XIII. Grading**

#### **A. Assignments**

Guidelines are provided for the Pre-Laboratory Notebook Entries (10 pts each), Laboratory Reports (10 pts each), and the final Laboratory Report written as an American Chemical Society Publication (50 points). The point total for each assignment will be determined by deducting 1 pt for each item in the guideline that is missing or incorrect in the assignment. The Final Exam will be conducted online through the Blackboard website and consist of multiple choice questions based on the course content.

#### **B. Total Points**

1. Pre-Laboratory Notebook Entries (19 @ 10 points each)	190 pts
2. Laboratory Reports (1-7 @ 10 points each)	70 pts
3. Laboratory Report 8: ACS Publication	50 pts
4. Final Examination (online)	50 pts

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Total = 360 pts

#### **C. Letter Grade for Course**

The final letter grade for the course will be based on the combined points for each of the items listed. The grade assignments will be: A (100-90%), B (89-80%), C (79-70%), D (69-60%), E (59%-below).

### **XIV. Semester Schedule** (on the following page)

## CHE 412 Inorganic Laboratory Semester Schedule, Fall 2012

\*For each Experiment see the Blackboard Website for: 1) Background Information, 2) Experimental Procedure, 3) Pre-Laboratory Notebook Entry Guidelines and 4) Laboratory Report Guidelines.

Exp	Date	Laboratory	Techniques and Learning Outcomes
0	8-22	Introduction and Check-In	Online Safety Forms, Safety Release Form, Check-in Sheet
1	8-27 8-29	Synthesis and Pyrolysis of Fe(II), Ni(II), and Mn(II) Oxalates	Thermogravimetric Analysis (TGA); Stoichiometry, Thermal Stability, Hydration, <i>1. Report 1 Due 9-1</i>
2	9-5	Thermal Properties of Hydrocarbons	Differential Scanning Calorimetry (DSC); Polymorphism; Thermodynamics, Crystal Growth <i>2. Report 2+3 Due 9-15</i>
3	9-10	Crystallization and Melting	
4	9-12 9-17	Bismuth Catalyzed Green Diester Synthesis	NMR, GCMS; Sustainable and Green Chemistry, Heavier Main Group Chemistry, Catalysis <i>3. Report 4 Due 9-22</i>
5	9-19 9-24	Synthesis and Characterization of Prussian Blue Inorganic Pigment Particles	X-ray Powder Diffractometry (XRPD), Magnetic Susceptibility, Inductively-Coupled Plasma Optical Emission Spectrometry (ICP-OES); Colloids, X-ray Structure Analysis, Nuclear Fall-out Mitigation <i>4. Report 5+6 Due 9-29</i>
6	9-26	Removal of Cesium from Water	
7	10-1 10-3	Synthesis, Optical Resolution of $[\text{Co}(\text{en})_3]^{3+}$	Cyclic Voltammetry (CV), Circular Dichroism (CD); Coordination Chemistry, Optical Isomers, Electrochemistry, Crystallization <i>5. Report 7+8 Due 10-20</i>
8	10-8	Electrochemistry: $[\text{Co}(\text{en})_3]^{3+}$ and $\text{K}_3[\text{Fe}(\text{CN})_6]$	
9	10-10 10-15	Synthesis and Characterization of Fluorescent Lanthanide Compounds	Fluorimetry, UV-Vis; Electronic Absorption Spectroscopy, Lanthanide Chemistry, Electronic Device Applications, Recycling and Sustainability <i>6. Report 9+10 Due 10-27</i>
10	10-22	Isolation and Reuse of Europium and Terbium	
11	10-24 10-29	$\text{CoAl}_2\text{O}_4$ Pigment Particles: Synthesis, Characterization, Coatings; Isolation and	Diffuse Reflectance, XRPD, Scanning Electron Microscopy (SEM), Particle Size Determination; High Temp. Synthesis, Recycling and Sustainability <i>7. Report 11+12 Due 11-10</i>
12	10-31	Isolation and Reuse of Cobalt	
13	11-5	AB9 Synth. and Isolation	Mp, NMR, IR, CV, Mass Spectroscopy; Disulfide redox
14	11-7	Nano- $\text{Fe}_3\text{O}_4$ Synthesis and Isolation	XRPD, Magnetic Susceptibility; Magnetic Separation
15	11-12	Coating Nano- $\text{Fe}_3\text{O}_4$ core with $\text{SiO}_2$ shell	SEM; Composite Characteristics <i>8. Report 13-19 Due 12-8</i>
16	11-14	Amination of $\text{SiO}_2$ shell on $\text{Fe}_3\text{O}_4$ core	IR; Nanoparticle Functionalization
17	11-19	AB9 Coupling to $\text{SiO}_2$ Surface	IR, ICP-OES (sulfur), TGA, CV; Reaction Kinetics
18	11-26	$\text{SiOH}$ Protection with $\text{SiMe}_3\text{Cl}$	IR, SEM; Surface Reactivity and Chemistry, Chemisorption
19	11-28 12-3	Use of Nano-Composite to Remove Metal or Metalloid Contaminant from Water	IR, CV, ICP-OES; HSAB Theory, remediation and mitigation technologies for water purification
	12-5	Laboratory Check-Out	Glassware Cleaned; Signed Check-Out Sheet
	12-12	Final Examination: Blackboard Online	Available Noon Wed. Completed by 5pm Friday (12-14)

## Appendix A. Glassware Cleaning Procedure (Print copy provided for 3<sup>rd</sup> Drawer)

1. Clean all glassware while you are conducting and concluding each experiment.
2. Check your Laboratory Notebook to determine whether a reagent should be handled as **Hazardous Waste**.
3. Check your Laboratory Notebook to determine the appropriate cleaning solvent to use based on the solubility of the reagent or compound.
4. In the hood: pour hazardous waste solids and solutions in either the organic hazardous waste container or an aqueous hazardous waste container. The solvent you use in the reaction and in cleaning determines which container to use (aqueous or organic).
5. Use the hazardous waste containers located in your hood. When finished cleaning the glassware in the hood empty the aqueous and organic hazardous waste containers into the large hazardous waste containers located in **Hood B**.
6. **Aqueous hazardous waste:** In the hood, wash with **Tap Water** then **5% HCl Solution**, use a spatula or brush to remove solids from the glassware. Pour all wash solutions into the aqueous waste container in the hood. Take glassware to sink and follow procedure 8.
7. **Organic hazardous waste:** In the hood, wash with **EtOH** and/or **Toluene** depending on the polarity of the reagent. Use a spatula or brush to remove solids from the glassware. Other organic solvents are available in Hood B. Pour all wash solutions into the waste container in the hood. Take glassware to sink and follow procedure 8.
8. After removing hazardous material and any solutions or solids present, thoroughly wash all glassware in the sink with soap and tap water using brushes.
9. Rinse all glassware copiously with tap water, then distilled water, and finally with acetone. Wash bottles with distilled water and acetone are located near your sink.
10. If the glassware remains dirty soak in the soap solution bucket located by the sink.
11. If the glassware still is not clean soak it in the base bath (conc. KOH in EtOH). Talk to your TA about this first, heavy-duty gloves must be worn when using the base bath.
12. Rinse the glassware in the sink with 5% HCl to neutralize the base then go to step 8.
13. Dry the cleaned glassware on the drying rack or with a heat gun and put the glassware back into the appropriate drawer.

Appendix B. IUPAC 2009 Periodic Table (Resize and paste into Laboratory Notebook)

1	2											13	14	15	16	17	18				
1 H 1.0079	2 He 4.0026											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180				
3 Li 6.941	4 Be 9.0122											15 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.065	17 Cl 35.453	18 Ar 39.948				
11 Na 22.990	12 Mg 24.305	3 Bor 10.811	4 C 12.011	5 N 14.007	6 O 15.999	7 F 18.998	8 Ne 20.180	9 Na 22.990	10 Mg 24.305	11 Al 26.982	12 Si 28.086	13 P 30.974	14 S 32.065	15 Cl 35.453	16 Ar 39.948						
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.64	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.798				
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.96	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29				
55 Cs 132.91	56 Ba 137.33	57-71 Lanthanide series	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.39	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)				
87 Fr (223)	88 Ra (226)	89-103 Actinide series	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (264)	108 Hs (270)	109 Mt (268)	110 Ds (281)	111 Rg (272)	112 Cn (285)	113 Nh (284)	114 Fl (289)	115 Mc (288)	116 Lv (293)	117 Ts (294)	118 Og (294)				
		* Lanthanide series																			
		* Actinide series																			
57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97							
89 Ac (227)	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)							