General Information

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Teaching Assistants: Sarah Guy (sguy@wustl.edu), Joe Marmerstein (marmersteinj@wustl.edu), Clark Ingram (clark.ingram@wustl.edu)

Lab: Tues 8:30 – 11:30 am, Brauer 2011  
Dr. Vikesland’s office hour: By appointment/email

Textbook: “Molecular Driving Forces: Statistical Thermodynamics in Biology, Chemistry, Physics, and Nanoscience,” Second Edition by Dill and Bromberg (the 320B text), as well as materials provided by instructor

Required Materials: Lab notebook with carbon copies (the General Chemistry lab notebook, available at bookstore) and lab safety glasses. Close-fitting clothing covering arms and legs, as well as closed-toe shoes, must be worn in the lab at all times.

Introduction

This course is designed to give you a hands-on opportunity to ask questions, explore ideas, and design and test solutions. In the initial weeks of the course, groups will perform a set of lab exercises, learning about the procedures and materials for each lab. You will spend the later weeks of the course refining your work on just one of those original exercises, by designing and executing further tests on one of the systems. Your chief aim will be to explore—within a supportive and collaborative atmosphere—not to simply follow a set of step-wise instructions.

The lab exercises in this course are based on fundamental principles related to the role of thermodynamics in physical science, specifically biologically relevant engineering. While the experiments may at times seem simple, remember that what seems trivial on the surface seems more and more complicated as you continue to ask questions and pursue answers. In addition, the experiments are chosen to facilitate you designing and executing your own experiments.
Grading of the course is designed to foster creativity, collaboration, and curiosity. The goal of designing your own experiments is to work as a team to use a creative approach in coming up with ideas, trying out your ideas, and interpreting your results. The emphasis is not simply on getting “right answers,” but on defining the problem/question, designing a solution, testing the solution, and analyzing and presenting the results.

Because this is a fairly new course, you have the opportunity to make a meaningful contribution to future students in this department through your efforts. As in an engineering team or research group, data can and should be shared, as the class works collaboratively to refine questions, optimize procedures, test ideas, and propose new solutions.

**Learning Objectives**

- Make observations of physical phenomena related to material covered in 320 B (though concurrent/previous enrollment is not required)
- Read, interpret, and communicate results from published scientific literature
- Optimize procedures to obtain maximally accurate and precise results
- Collaborate with fellow classmates in solving problems in the laboratory
- Gain confidence exploring variables related to experimental questions
- Use experimental results to identify questions for further testing
- Design experiments to address specific questions
- Present a report of experimental findings

**Grading**

On-time attendance at lab is mandatory. Any emergency absences will be handled on a case-by-case basis. Points will be deducted from reports for students arriving late to lab.

Specifications will be available in Bb for many of the assignments.

- **5 non-mastery wet labs**, each worth 9% of final grade
  - Before lab: Pre-lab reading assignment and brief in-class quiz at start of lab period (no quiz on first day of lab)
  - During lab: Effort, creativity, precision, and problem solving
  - Report

- **1 computational lab exercise**, worth 5% of final grade
• 1 mastery lab, worth 50% of final grade
  o Rough draft of proposal and materials list, worth 3% of final grade: done as a group, and turned in by end of mastery lab planning lab period
  o Specific proposal, worth 5% of final grade: done as a group, must be revised until instructor approves, score will increase with iterations but a penalty per iteration also applies
  o Introduction, worth 3% of final grade: done individually, due in early weeks of mastery lab
  o Data summary, worth 5% of final grade: done as a group, must be revised until instructor approves, score will increase with iterations but a penalty per iteration also applies
  o Experimental skills (attendance, effort, technique, creativity, precision), worth 4% of final grade: graded by your lab partner(s), TAs, and instructors
  o Procedure, worth 5% of final grade: done as a group, must be revised until instructor approves, is written as if for a BME sophomore to follow in the next semester of this course; must be clear, specific, and easy-to-follow; must include any unique instructions for data analysis
  o Report, worth 15% of final grade: done individually, due last week or class; includes revised Introduction turned in earlier in semester
  o Presentation, worth 10% of final grade: done as a group, presented to class

Labs will be graded with attention to the details of good scientific writing, per specific guidelines available on Blackboard. Lab reports for these labs must be the work of each individual.

Grading for the mastery lab will be based on logic and creativity of the experimental design, thoroughness of background research, collaborative approach, and precision and clarity in written report and oral presentation.

Lab report submission and grading will be through Blackboard.

There are no exams in this course.

**Late Policy**

The penalty for a late lab report will be 1/24 of the student’s grade for each of the first three hours late, or for reports later than 3 hours, 1/8 of the student’s grade per day. (Note: this is the same policy as in Quantitative Physiology Lab).
Showing up late to lab will result in a penalty on the lab report grade, and reduced/no time to take the pre-lab quiz. **There are no makeup or excused pre-lab quizzes, except for genuine emergencies that prevent a student from attending that entire lab period.**

**Lab Exercises**

1. **Equation of State for Air**
   
   Use pressure and temperature sensors to observe the relationships between temperature, volume, pressure, and moles of gas.

2. **Osmosis/Dialysis**
   
   Observe the effects of gradients across a dialysis membrane in glucose solutions, quantifying the temperature-dependence of the effects.

3. **Phase Transitions in Polymers**
   
   Observe the cloud point transition in solutions of PEG/water/salt.

4. **Force, Temperature, and Length Relationships in a Rubber Band**
   
   Observe the balance between enthalpic and entropic forces on a rubber band.

5. **Calorimetry**
   
   Observe the thermodynamics of solutions using a solution calorimeter.

**Academic Integrity**

Students are encouraged to work together to share ideas, design experiments, and troubleshoot problems. Engineering research and work often requires people to work closely together, and so this experience is seen as a valuable part of the course. However, written lab reports for the first six wet lab exercises and computational lab must be your individual work, and the final mastery lab presentation must be the work of only the lab group.
On your lab reports, you are free to use the resources available to you through the library, internet, or your peers, so long as you clearly cite all references/sources consulted. We live in the age of information, and I expect you to utilize and synthesize the information available to you.

It is acceptable to include/reference data from other students in your lab report so long as there is a clear citation to the student(s) who collected that data. You must make your data figures/tables and write any computer code individually. You are encouraged to share ideas as you plan mastery labs in the later weeks of the course, but again, please reference by name anyone who contributed to your data/results.

Violations of academic integrity by any student will be handled according to the guidelines laid out for all Washington University students:
http://www.wustl.edu/policies/undergraduate-academic-integrity.html

Exceptions to any of the policies outlined in this syllabus for an individual student (e.g., due dates and times) will be handled on a case-by-case basis.

Course Schedule (subject to change at instructor discretion; students will be notified of any changes)

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<thead>
<tr>
<th>Day &amp; Date</th>
<th>Number</th>
<th>Description</th>
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<tbody>
<tr>
<td>Tuesday 01/14/14</td>
<td>Lab 1</td>
<td>1. Equation of State for Air</td>
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<td>Tuesday 01/21/14</td>
<td>Lab 2</td>
<td>Reports for Lab 1 due</td>
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<td>2. Osmosis/Dialysis</td>
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<td>Tuesday 01/28/14</td>
<td>Lab 3, part 1</td>
<td>3. Polymers I</td>
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<tr>
<td>Tuesday 02/04/14</td>
<td>Lab 3, part 2</td>
<td>Resubmit reports for Lab 1 due</td>
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<td>3. Polymers II</td>
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<td>Tuesday 02/11/14</td>
<td>Lab 4, part 1</td>
<td>4. Elasticity I</td>
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<td>Reports for Lab 2 due end of week</td>
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<tr>
<td>Tuesday 02/18/14</td>
<td>Lab 4, part 2</td>
<td>4. Elasticity II</td>
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<td>Tuesday 02/25/14</td>
<td>Lab 5</td>
<td>Reports for Lab 3 due</td>
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| Tuesday 03/04/14 | Planning for mastery lab project | Plan mastery lab  
First draft of mastery lab proposal (with materials list!) due end of class  
Report for Lab 4 due end of week |
| Tuesday 03/11/14 | NO CLASS | Spring Break |
| Tuesday 03/18/14 | Mastery lab work | Reports for Lab 5 due  
Work on mastery lab  
Final draft of mastery proposal due end of week |
| Tuesday 03/25/14 | Mastery lab work | Mastery lab introduction due  
Work on mastery lab |
| Tuesday 04/01/14 | Mastery lab work | Work on mastery lab |
| Tuesday 04/08/14 | Mastery lab work | Mastery lab procedure due  
Work on mastery lab  
Mastery lab data summary due end of week |
| Tuesday 04/15/14 | NO CLASS | Mastery lab reports due |
| Tuesday 04/22/14 | Mastery lab presentations | Mastery lab presentations |