

**Special Topics in Bioengineering: Biological Thermodynamics for Engineers
Spring 2009**

MODULE 3: Phase Transitions

For the final deliverable for this module, you may choose to write either an experimental research paper (similar to what you did for the first module) or an experimental research proposal (similar to what you did for the second module.) Below we present proposed outlines for both of these deliverables that you may want to use as guidelines when developing your final documents for this module.

A. Outline for an Experimental Research Paper

Abstract:

In no more than 150 words describe general goals, findings, and significance of your work. Usually the following sequence is used:

- (i) questions you investigated;
- (ii) experimental design and methods used;
- (iii) major findings including key quantitative/qualitative results and major trends;
- (iv) interpretations and conclusions.

In general, it is helpful to complete the paper before finalizing your abstract.

Introduction:

Briefly describe your research question, place your paper within the context of existing literature, explain why this is an important piece of work (why should we care); conclude by describing the layout of your paper. The following structure may be used for an effective introduction:

- (i) clearly identify the subject of interest to you and your potential audience;
- (ii) provide the context by giving a brief yet balanced review of relevant literature;
- (iii) clearly state the purpose/hypothesis that you are interested in investigating;
- (iv) explain the rationale for your approach to experimental design;
- (v) you may want to conclude with the layout of the paper but this is a not necessary step.

Materials and Methods:

Briefly describe how you carried out your experimental work using the following general structure:

- (i) the system studied and the handling and care of the system prior to the experiment; include info on where the system was purchased and how it was stored prior to your work;
- (ii) the experimental design (e.g., controls, treatments, variables, number of samples collected, storage conditions, etc.);
- (iii) data collection protocol (e.g., how experimental procedure was carried out);
- (iv) data analysis protocol (e.g., qualitative/quantitative methods used);

Results:

As objectively as possible, present your key results. Do not interpret your results yet. Using your hypothesis/research questions as a guideline, present your answers in a logical way first through a series of figures and tables and then write the relevant text around these visuals. Present both “positive” and “negative” results as the latter are important data that may lead to interesting and important interpretation of your findings.

Discussion and Conclusions:

Interpret your results using the existing frameworks, knowledge, experimental evidence, etc. Explain how your findings add to the current understanding of the problem. Reflect on and connect with the Introduction section through hypothesis/research questions and the literature cited. Explain how your study moved science forward from the point where you left the reader in the Introduction section. Suggested questions you may want to answer here are¹:

- (i) “Do your results provide answers to your testable hypotheses? If so, how do you interpret your findings?”
- (ii) Do your findings agree with what others have shown? If not, do they suggest an alternative explanation or perhaps a unforeseen design flaw in your experiment (or theirs?)
- (iii) Given your conclusions, what is our new understanding of the problem you investigated and outlined in the Introduction?
- (iv) If warranted, what would be the next step in your study, e.g., what experiments would you do next?”

¹ <http://abacus.bates.edu/~ganderso/biology/resources/writing/HTWsections.html#discussion>

Conclusions:

You may want to either fold this section into your Discussion section, as suggested above, or leave it as a separate part. This is your opportunity to tie the entire paper together. Briefly summarize your major findings (a “take-away” message), their importance and significance; conclude by describing any potential future directions your work may take.

Acknowledgements:

Include as needed or appropriate.

References:

Very important. Please, follow the IEEE formatting.

Appendices:

Include as needed.

B. Outline for an Experimental Proposal

The proposal is a plan for you to estimate what you intend to do, what you intend to accomplish.

Your proposal should include the following:

Abstract:

In no more than 150 words describe general goals, findings, and significance of your work. Usually the following sequence is used:

- (i) questions you investigated;
- (ii) experimental design and methods used;
- (iii) major findings including key quantitative/qualitative results and major trends;
- (iv) interpretations and conclusions.

In general, it is helpful to complete the paper before finalizing your abstract.

Goals and Significance:

In no more than 1/2 page, state your goals and significance based on the class discussion. Be sure to address the following points:

- (i) *Overall and specific objectives of your module;*
- (ii) *Educational significance:* State clearly what you expect to learn from this experience. How does it tie into your background, and your educational goals?
- (iii) *Intellectual impact:* Why is this an important, deep problem?
- (iv) *Broader impacts:* What benefits might this work have beyond your own edification? Could this be useful to others?

Work to Be Performed:

Based on the class discussion, in no more than 1 page, lay out your plans for how data will be collected and analyzed:

- (i) *Pre-existing Data:* What data sets will you be using? Why/how is this an appropriate choice for exploring the questions of interest in your project?
- (ii) *Available Code/Simulations/Software:* Are there useful code libraries, simulation packages, or software you can use or extend via your proposed module?
- (iii) *Timeline:* Discuss how your activities will lay out in time. State concrete milestones, with dates, you expect to accomplish for the duration of the semester. This must include both the preparation of the modules and their performance. You should also state a contingency plan in case you cannot meet your original commitments

Related Work:

In no more than 1/2 page, discuss any prior, related work (not already mentioned above).

- (i) State any existing connections to your own prior background or previous experience that may help you perform your work;
- (ii) Find and cite explicitly (at least one) published work that comes most close to what you intend to do. How will your work relate to this this knowledge?

Budget and Resources:

In no more than 1 page, list all the required resources, including equipment, room requirements, facilities, rental of equipment, use of facilities at other colleges/organizations, etc.

- (i) *Existing Resources:* State all resources that are available to you or you have access to free of charge.
- (ii) *Resources to be Obtained:* List all resources that you need to arrange for. For each item in this section, include budget justification, in which you should include explanation for why you need to use the proposed equipment. If there are additional resources outside of the ICB that you feel your project requires, then you need to include:
 - *Additional Equipment:* Equipment that needs to be purchased or rented, services to be hired, etc. For each item in this section, include the name(s) of vendor(s), name(s) of contact person(s) for the vendor(s), contact information for vendor(s), any information on warranty, delivery time, etc. You should include several different vendor(s) for one and the same item. Additionally, and why you choose to work with a specific vendor.
 - *Additional Facilities:* If you intend on using additional facilities at Olin, you need to describe the amount of time needed for each facility, written permission (e-mail is fine) from the manager of that resource granting you permission based on your request. Requests of additional time need to be committed in writing. Note that advice from other Olin faculty members not involved directly with the ICB Mathematics/Physics portion is also an additional resource: you will need to itemize the time needed with other faculty toward this project and a written commitment by that faculty member to your project.
 - *Experimental Methods:* What specific measurement techniques does your module require? How can your results be compared to earlier/similar experimental data available? These methods must be presented to any manager of an Olin resource in order to receive their permission. Note that if you propose methods that violate the safety standards during this project, you will be required to meet your commitments made in the proposal *without* access to the resource. This will affect your grade in the project.

- *Budget:* How much additional resources are needed to complete the project beyond the resources available from ICB Mathematics/Physics? There is **no** funding for experimental projects in the Fluids portion, so you need to provide information on where the financing for this portion of the project will come from, and letter of commitment from the financing officer of the project with a statement of his/her requirements on you for your receipt of the financing.

References:

Include all references used in creation of this proposal. You should also list at least five (5) references of work related to the proposed project. This includes the original reference above that is the basis for the project. Note that Olin College does not have access to all journals in fluid mechanics, so you may need to budget additional time to receive these references through Interlibrary Loan, where receipt of the material can take as long as 2 weeks from your request.