PHYS115: Inquiry into Physics – Spring 2014

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Science is more than just a body of knowledge about the world; it is about the process of figuring things out. Most science courses (including physics) tend to focus on the content, relegating instruction of the *practices* to a single chapter at the beginning of the book. In this course, we will focus on this process: we will discover, construct, and refine our ideas about physics by theorizing and experimenting as a class. We will play with our scientific ideas in ways that give us a sense of what scientists actually do.

Although this course would be beneficial to a wide variety of students, we are generally going on the assumption that you are majoring in elementary education and childhood education. It is not necessary for you to have taken physics courses in high school. We will be learning about physics by starting with your own thoughts, observations, and experiences about the world around you. We will have small-group and whole-class discussions, try out different experiments, and document our findings to develop our understanding of physics together. We will build on our ideas that help us understand the phenomena and chip away at the parts that get in the way or that do not match up with the experiments we conduct in class. Much like scientists, then, we will be collaboratively building the content as we go. This process requires that you tap into the following:

1. Your questions and curiosity about the world around you
2. Your willingness to reflect upon, share, and refine your thinking process
3. Your willingness to be responsive and responsible to your classmates

The main idea of this course is to offer opportunities to take part in the practices of science, particularly the work of physicists. This work involves collaborative theory-building and experimentation. Also, we hope that you will incorporate these practices into your own teaching. We also want you to have fun exploring the creative and playful side of physics. We hope you come away with:

1. Deeper understanding of the physics of motion, heat, and electricity
2. Deeper understanding of how physics is done by generating and evaluating ideas—sense making—through argumentation and empirical testing
3. Enriched confidence in your own abilities to learn and teach science
4. Appreciation of the pleasure in figuring things out

Class Meetings

Section 0101: Monday, Tuesday, and Wednesday, 2:00 PM – 3:50 PM, Room 3316
Section 0201: Monday, Tuesday, and Wednesday, 10:00 AM – 11:50 AM, Room 3316

Textbook

There is no required text for this class. There may be occasional reading assignments, which will be provided. You will be asked to keep a lab notebook and participate in Discussions on ELMS.

Course Activities

Participation – Since this process of learning physics is inherently collaborative, it is critical that you be present (both physically and mentally) during class meetings. We ask that you contribute your own thoughts, experiences, and observations, as well as listen to, refine, and build on those of your classmates.

Lab Notebook – A critical part of science is documenting your thoughts, ideas, findings, and progress. We ask that you keep an individual notebook to record your observations, the observations of your peers, your ideas, the ideas of your peers, and the evidence for and against each idea. This notebook will be for you; it will not be graded, but you will be able to use it on exams.

Daily Summaries – At the end of each class, we will ask you to write a short summary (2-3 paragraphs) of the activities and findings that day. In the first part you will summarize what progress we have made as a class. In the second part we ask you to reflect on your individual ideas about both the phenomena and our progress. These summary sheets are to be entered into the PHYS115 course page on ELMS at the end of each class. A “Daily Summary” can be found in the Campus Pack.

Course Discussion– One group each week will be assigned the role of “Lab Recorders.” Instead of completing the daily summaries, they document our progress as a class each day in the “Course Discussion” portion of the Campus Pack. While one group will have primary responsibility to update the discussion each week, we encourage all students to review and contribute. We will start each class by reviewing the discussion, deliberating our ideas and how to best communicate and document them.

Weekly Homework – Every Wednesday (approximately) we will ask you to complete several essay-type questions. These questions will ask you to think more about what we’ve discussed in class and push you to use the foothold ideas in new ways. They will typically be due on Mondays, and you may be asked to revise and resubmit them, especially during the start of the semester.

Exams – At the end of each unit, we will take stock of what progress we have made as a class in understanding a given phenomenon and how to approach related physics questions. Parts of the exams will ask you to make predictions, observations, and explanations about physical phenomena using new materials, while others will consist of essay questions asking you to use the foothold ideas we develop in class.

Assessment

Your grade will be based equally on your in-class participation, daily summary sheets/discussion participation, weekly homework, and exams. We will be assessing your work with how well it lines up with the central elements of good scientific inquiry, which we have distilled into several principles below.

Causal stories – Scientific explanations and predictions are based on understanding what *causes* physical phenomena, producing what can be thought of as “causal stories.” A causal story explains or predicts a phenomenon by piecing together the chain of events that makes it happen. A good causal story clearly describes all the important causal “characters” and what roles they play in bringing about an outcome.

Example: Why does a balloon rise when you inflate it?

Q: If someone answered by saying, “Because it’s lighter than the air around it,” does that count as a good causal story?

A: It is a good *start*, but it is not yet clear what ‘lighter’ means, or what *makes* a balloon lighter than air, or why *air* plays any role in it at all — and this is one sort of feedback you will be getting from us. What would you say?

We will be looking for how well you seek out and incorporate causal stories in your work, focusing less on correctness and more on linking cause-and-effect.

Coherence – Scientific explanations also have to make sense, meaning they must account for different observations, connect to previous ideas and experiences, and/or recognize when something is unexplained

Foothold ideas are something we will arrive at as a class: ideas we think we can accept as true, at least for the time being. We will use these ideas as building blocks for further investigations, by making attempts to reconcile new ideas and findings with our footholds. If it becomes too difficult to reconcile any contradictions, we will have to search for new foothold ideas on which to base our understanding

.As we as a class establish foothold ideas, you will be asked to make connections and build on these to develop other scientific explanations. We’ll be looking for how well you make connections to other ideas, spot inconsistencies, reconcile them, account for our foothold ideas, and identify unexplained phenomena.

Clarity – In physics, progress is achieved by working as a community to develop shared understanding about terms, descriptions, explanations, and predictions. This shared understanding has been negotiated over hundreds of years through a process of introducing ideas, clarifying those ideas, testing them, and resolving any disagreements through respectful argumentation and discussion. We will be looking for how well you participate in this process in our course: how well you make your own ideas clear to us and your classmates, as well as how well you strive to understand others’ ideas and seek clarity in our discussions.

Creativity – Science is a creative process; you have to look at things in a new way, come up with innovative connections, or dream up an experiment to test an idea. Sometimes this will involve thinking up a “crazy” idea and refining it, or taking a leap on a hunch that you can’t quite articulate yet. We want you to bring your unique perspective to our class and group discussions, not just restate others’ ideas.

Reflection – Part of expertise in physics is having multiple ways of thinking about a phenomenon. Another aspect of expertise is *knowing* that you have multiple ways of thinking, and being able to evaluate yours and others’ thinking according to the inquiry guidelines mentioned above. Therefore, we ask that you reflect on your own, your groups’, and the class’ understanding of the phenomena under study. Particularly on daily summaries and exams, we will look for explicit reflections about your progress.

Course Policies

Academic Integrity

Honesty is the foundation upon which science is built. Academic dishonesty is particularly disgraceful in science, perhaps because it affects not just individuals the whole scientific community and any work that builds upon it.
We take academic integrity seriously. Please take a look at University policy regarding the Honor Pledge and if you have any questions about academic integrity relevant to this class please don't hesitate to ask.

Excused absences
Participation is really a crucial part of this course, and so we strongly urge you to make it to class. Of course, circumstances may arise that are out of your control that may keep you out of class, such as medical emergencies and religious holidays. Please let us know of any anticipated excused absence as soon as possible. Makeup exams will be made available for excused absences only. *NB*: We will still meet when the university has a delayed start, unless otherwise noted via email or on ELMS.

Special arrangements

If you have any special needs relevant to this course, please don't hesitate to let me know so we can figure out how to best accommodate them.

In case of emergency

We will update ELMS for plans if the University is closed for an extended period of time

Electricity & Magnetism

Exp # 01 Tue Jan 28 E01 Batteries and bulbs
Exp # 02 Wed Jan 29 E02 Good and bad conductors
Exp # 03 Mon Feb 03 E03 Batteries in series
Exp # 04 Tue Feb 04 E04 Size and direction of current
Exp # 05 Wed Feb 05 E05 Bulbs in series
Exp # 06 Mon Feb 10 E06 Parallel circuits
Exp # 07 Tue Feb 11 E07 Voltmeters, ammeters and power supplies
Exp # 08 Wed Feb 12 E08 Introduction to linear relationships
Exp # 09 Mon Feb 17 E09 Ohm's law, resistors and power
Exp # 10 Tue Feb 18 E10 Resistors in series and parallel
Exp # 11 Wed Feb 19 SE01 Electrostatics
Exp # 12 Mon Feb 24 E12 Magnets
Exp # 13 Tue Feb 25 E13 – Currents and magnetism

Wed Feb 26 Exam 1

Heat & Energy

Exp # 14 Mon Mar 03 H01 Heat and temperature
Exp # 15 Tue Mar 04 H02 Heat transfer and thermal equilibrium

Exp # 16 Wed Mar 05 H03 Mixing water at different temperatures
Exp # 17 Mon Mar 10 H04 Mixing unlike materials
Exp # 18 Tue Mar 11 H05 Specific heats of aluminum and copper
Exp # 19 Wed Mar 12 H06 Mixing ice and water – latent heat of fusion
Exp # 20 Mon Mar 24 H07
Exp # 21 Tue Mar 25 H08
Exp # 22 Wed Mar 26 H09 Condensing steam latent heat of vaporization
Exp # 23 Mon Mar 31 H10 – Temperature of liquid nitrogen

Tue Apr 01 Exam 2

Motion & Force

Exp # 24 Wed Apr 02 M01 - Introduction to motion detector
Exp # 25 Mon Apr 07 M02 - Predicting what a graph will look like
Exp # 26 Tue Apr 08 M03 - Reading a graph and making an equation for it
Exp # 27 Wed Apr 09 M04 - Instantaneous velocity and acceleration
Exp # 28 Mon Apr 14 M05 - Motion with a constant force
Exp # 29 Tue Apr 15 M06 – Relation between force, mass & acceleration
Exp # 30 Wed Apr 16 M07 – Force due to gravity
Exp # 31 Mon Apr 21 M08 – Simple pendulum
Exp # 32 Tue Apr 22 M09 - Motion of a ball thrown up vertically
Exp # 33 Wed Apr 23 M10 - Motion of a ball thrown in an arbitrary direction

Light & Optical Phenomena

Exp # 34 Mon Apr 28 L01 - Light propagation and geometrical optics
Exp # 35 Tue Apr 29 L02 - View through a pinhole camera (magnification)
Exp # 36 Wed Apr 30 L03 - Reflection and images
Exp # 37 Mon May 05 L04 - Refraction, ray diagrams and Snell's law
Exp # 38 Tues May 06 L05 - Introduction to lenses
Exp # 39 Wed May 07 L06 - Lenses and ray diagrams
Exp # 40 Mon May 12 L07 - Eyes as an optical instrument (corrective lenses)

Tue May 13 Exam 3