

Transition of Introductory Physics Labs to an Inquiry Based Format

- **Overview of current introductory physics labs at Pitt**
- **Educational goals for lab courses**
- **Pros and cons of traditional labs**
- **What are inquiry based labs?**
- **Pros and cons of inquiry based labs**
- **Course Transformation Award – Plans**
- **Long term plans**

Three Introductory Physics Lab Courses

- **PHYS 0212 – *Introduction to Laboratory Physics***
 - **2 Credit hours**
 - **Algebra based**
 - **Co-requisite PHYS 0111 *Introduction to Physics 2***
- **PHYS 0219 – *Basic Laboratory Physics for Science and Engineering***
 - **2 Credit hours**
 - **Calculus based**
 - **Co-requisite PHYS 0175 *Basic Physics for Science and Engineering 2***
- **PHYS 0520 – *UHC Modern Physics Measurements***
 - **3 Credit hours**
 - **Calculus based**
 - **Pre-requisite PHYS 0175 or 0476 *Introduction to Physics, Science and Engineering 2***

The Structure of PHYS 0219

PHYS 0219 meets twice each week:

50 Minute Recitation – All of the students meet for a lecture on the basic theory and how the theory will be tested.

3 Hour Lab – The students work in groups of 2 or 3 to complete the experiments. The lab sessions have a maximum of 24 students and are run by a TA.

Normal Schedule for PHYS 0219

Due to university holidays, the labs only meet for 13 weeks during the fall and spring semesters.

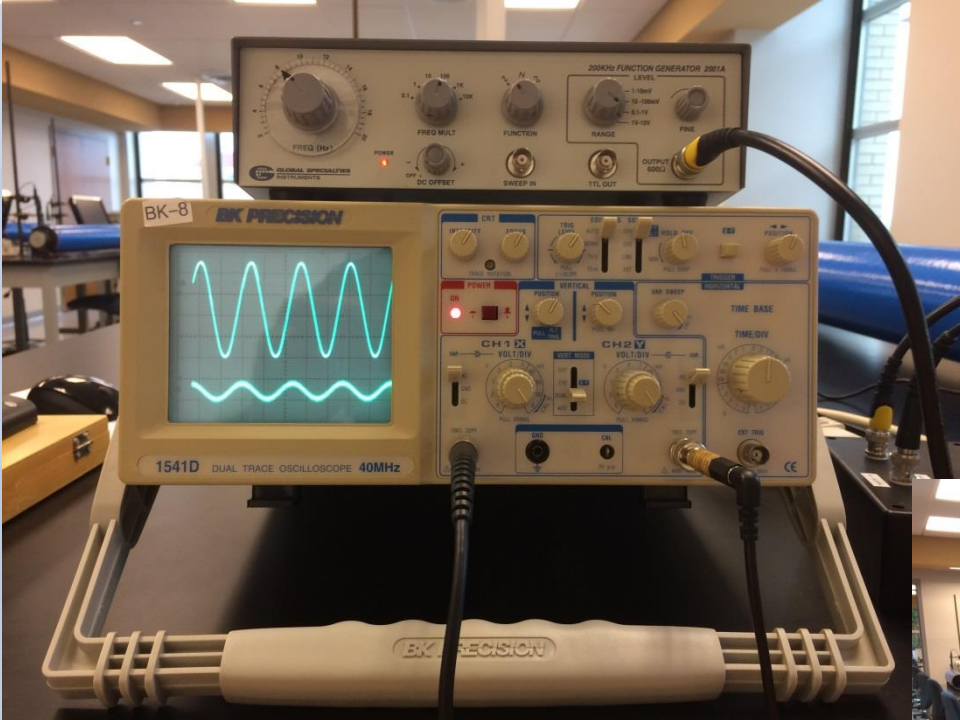
- **Week 1 – Acceleration in one dimension**
- **Week 2 – Simple harmonic motion**
- **Week 3 – Equilibrium of a rotating fluid**
- **Week 4 – Velocity of sound and harmonics**
- **Week 5 – Direct current circuits**
- **Week 6 – The equivalence of heat and mechanical and electrical energy**
- **Week 7 – Magnetic fields and the charge to mass ratio of the electron**
- **Week 8 – Geometrical optics**
- **Week 9 – Physical optics (diffraction)**
- **Week 10 – Optical spectroscopy**
- **Week 11 – Radiation and radioactivity**
- **Week 12 – Electromagnetic induction**
- **Week 13 – Makeup labs**

Educational Goals for Introductory Lab Courses

- **Connect the theory to reality**
- **Reinforce the concepts from the lecture**
- **Teach experimental techniques**

The Pros of a Traditional Lab Course

- **Detailed, step by step procedure allows for efficiency**
- **Less confusion for the students**
- **Less work for the instructor**
- **Fewer safety issues**
- **More complex equipment**



The Cons of a Traditional Lab Course

- **The lab is an algorithm, not a learning experience.**
- **The students often don't see the connection between the experiment and the theory.**
- **Real research is about asking questions, not following instructions.**

What is an Inquiry Based Lab?

- **Real research starts with a falsifiable question.**
- **The theory is used to make a prediction of the answer.**
- **An experiment is designed and performed to test the prediction.**
- **The result leads to the next question.**

What is an Inquiry Based Lab?

An inquiry based lab is closer to the process of real research.

- **Students are presented with a short introduction.**
- **They are asked to make a prediction.**
- **They are then asked to test their prediction.**
 - **The scaffolding may vary.**
- **Finally, they are asked to compare the outcome with their prediction.**

The Pros of an Inquiry Based Lab Course

- **Closer to the experience of real research**
- **More opportunity for the students to think**
- **More opportunity to explore alternate ways to test the theory**
- **Less complex equipment**

A Little Show and Tell

The Cons of an Inquiry Based Lab Course

- **More work for the instructor**
- **More opportunity for things to go wrong**
- **Vague guidance may be frustrating for some students**

Course Transformation Award - Plan

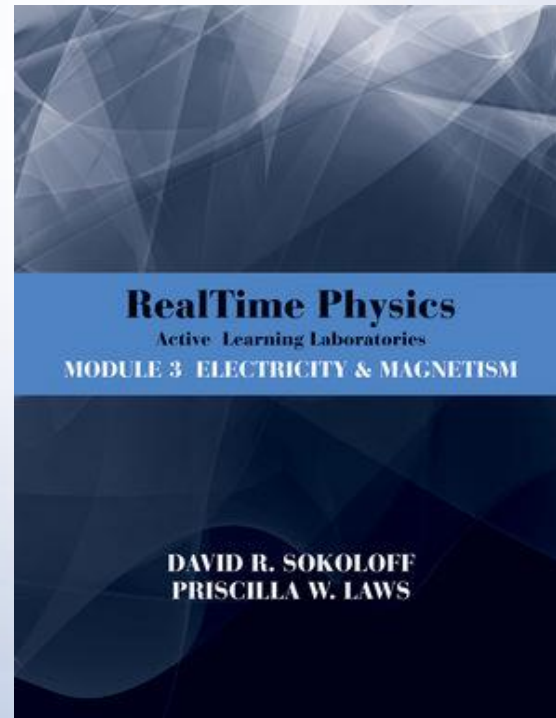
Rather than reinventing the wheel, we will implement a curriculum developed by:

David Sokoloff (University of Oregon)

Ronald Thornton (Tufts University)

Priscilla Laws (Dickinson College)

RealTime Physics
Active Learning Laboratories



New Schedule for PHYS 0219

Due to university holidays, the labs only meet for 13 weeks during the fall and spring semesters.

- **Week 1 – Acceleration in one dimension**
- **Week 2 – Simple harmonic motion**
- **Week 3 – Equilibrium of a rotating fluid**
- **Week 4 – Velocity of sound and harmonics**
- **Week 5 – Module 3-4 Batteries, Bulbs and Current**
- **Week 6 – Module 3-5 Current in Simple DC Circuits**
- **Week 7 – Module 3-6 Voltage in Simple DC Circuits and Ohm's Law**
- **Week 8 – Module 3-8 Introduction to Capacitors and RC Circuits**
- **Week 9 – Module 3-9 Magnetism**
- **Week 10 – Module 3-10 Electromagnetism**
- **Week 11 – Geometrical optics**
- **Week 12 – Physical optics (diffraction)**
- **Week 13 – Makeup labs**

The Questions We Want to Answer

- **Will the students be more engaged by the inquiry based curriculum?**
- **What are the most significant grading issues with the new curriculum?**
- **What are the logistics and costs for procuring or fabricating new equipment.**

Course Transformation Award - Plan

- **The students will complete a survey after the first set of traditional labs.**
- **A professor will observe both the traditional and inquiry based labs.**
- **They will complete the same survey after the six inquiry based labs.**
- **The TAs will keep track of the time that they spend grading both traditional and inquiry based labs.**
- **There will be a focus group with the lab students each semester to discuss both formats.**

Course Transformation Award

Long Term Plans

- **PHYS 0212 – *Laboratory Physics 1***
 - **1 Credit hour**
 - **Algebra and calculus based**
 - **Co-requisite PHYS 0110 or PHYS 0174**
- **PHYS 0219 – *Laboratory Physics 2***
 - **1 Credit hour**
 - **Algebra and calculus based**
 - **Co-requisite PHYS 0111 or PHYS 0175**
- **Both courses will be inquiry based using the *RealTime Physics* manuals**
- **The Course Transformation Award would then be a seed grant for an external agency such as NSF.**

Conclusion

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- **Educational goals for lab courses**
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Supplementary Materials

Survey Questions

STRONGLY AGREE AGREE NO OPINION DISAGREE STRONGLY DISAGREE

- 1) The experiments in this lab have reinforced the concepts that I have learned in my introductory physics lecture courses (PHYS 0174 and 0175).**
- 2) I should easily be able to earn an A or B in this course.**
- 3) The instructions in the lab manual are vague and difficult to follow.**
- 4) I find that working with a partner is very helpful in completing the lab experiments.**
- 5) My lab partner and I often have the opportunity to improvise our own way of testing the theory.**

Survey Questions

STRONGLY AGREE AGREE NO OPINION DISAGREE STRONGLY DISAGREE

- 6) My lab partner and I require a lot of assistance from the TA in order to complete the lab experiments.**
- 7) My lab partner and I often interact with other groups in the lab to come up with strategies to complete the experiments.**
- 8) The equipment in the lab is always in good working order.**
- 9) The equipment in the lab is complicated and very difficult to use.**
- 10) The lab reports/worksheets for the experiments are clear and easy to complete.**
- 11) Too much emphasis is placed on having the “correct” data.**

Focus Group

- **The students will be asked to participate, voluntarily, in a focus group after the completion of the inquiry based labs.**
- **The format will be open ended, but it will start with a discussion of what they found effective or ineffective in both the traditional and inquiry based labs.**

Lab Observations

The observer will be looking for following things:

- **The number of times that a student or a group requests help from the TA.**
- **The number of times that the TA spots a student or a group that is having difficulty and offers help.**
- **The number of times that a student or a group appears confused about the procedure.**
- **The number of times that a student or a group appears confused about the equipment.**
- **The number of times that a student or a group tries an experiment that is not in the procedure.**
- **The time for each group to complete the whole set of experiments.**