Syllabus

"PHYSICS IS EVERYWHERE; FIND WHY AND HOW HERE"

Art of Physics Education

Session: Mechanics 1 and 2

Summer and Fall 2021

Instructor: Professor Man, Ph. D. in physics from Princeton University, an award-winning college physics professor.

Prerequisites: No physics background is needed. Pre-algebra math skills are required for all of our courses. Algebra and a little bit of trigonometry are needed for our Mechanics and Electromagnetism course. The skills of solving linear and quadratic equations are needed.

Textbook: Professor Man created this unique inquiry-based course series from scratch and will provide written lecture notes. In the market, there is no such inquiry-based textbook that facilitates the active learning activities we will use. Hence, no textbook is required.

If you really want a reference book, among many algebra-based college physics (AP physics) textbooks, Professor Man recommends *"Physics"* by Cutnell and Johnsons or *"Physics"* by James Walker. She used both in her college teaching. The second one is harder (beyond AP C requirements). (Any previous version is fine. New versions simply get more expensive every year.)

Goals:

1. Students will systematically study and **deeply UNDERSTAND general physics** in the field of Mechanics.

2. Students will **build up habits and acquire abilities** in observing natural phenomena in daily lives, designing and performing research experiments, asking original and creative questions, and solving problems independently.

3. Students will be **capable of answering SAT II and AP physics questions** in the field of Mechanics. (Not including AP C physics, the calculus-based AP physics).

4. Students will develop comprehensive knowledge in mechanics-related concepts and phenomena and **be well-prepared to apply that knowledge in other science and engineering studies.**

Format of the course:

Asynchronous learning part: (Flexible participation time)

Weekly pre-edited concentrated video of main lectures (including introduction, animations, recorded experimental demos, critical thinking questions, the guidance of hand-on experimental assignments, detailed discussions on each physics concept and physics law, and SAT sample questions). (45-55 minutes each). (One per week)

Weekly pre-edited video lectures (for assignment explanation and review) (15-30 minutes each).

Weekly hands-on experiment assignments and guided research projects.

(1-2 hours per week)

Weekly homework assignments (most of them are open-ended questions that require comprehensive critical thinking and test sample questions are also practiced) (1 hour per week)

Synchronous learning part: (Live lectures online)

Biweekly live online lectures: every other Saturday. (1.5-2 hours each) (for more advanced topics, applications, clarifications, problem-solving, Q-A, and discussions). **Recordings are provided.**

Mechanics 1:10:30 AM or 4:30 PM (California time) on Sat. You can attend either one of them.

Mechanics 2: To be determined. We will at least keep the one that is more popular (either 10:30 AM or 4:30 PM). We will try to open another live meeting.

Checklist of what you should do every week:

1. Watch the main lecture of that week. (Stick with the schedule)
2. Perform the experimental assignments/research projects as instructed, using easy-to-access household materials or some inexpensive individual experimental tool kits. (Instructions will be given during the class).
3. Finish the critical thinking assignments and problem-solving practices for each lecture.
4. Ask more original questions of your own.
5. Watch the assignment explanation lecture every week.
6. Attend the online live lecture every two weeks (or watch the recording).

This course is an inquiry-based one emphasizing active learning. The more you dig into it, the more you will get out.

Long Term Student Learning Outcomes:

1. Build the habit to learn all STEM courses actively instead of receiving information passively. Build confidence and strong self-motivation in STEM courses. Be good at asking questions and finding solutions.

2. Explain the steps in the scientific method of inquiry, which involves designing experiments, gathering observable, empirical, and measurable evidence subject to specific principles of reasoning, and recognizing that reproducible observation of a result is necessary for a theory to be accepted as valid by the scientific community;

3. Analyze specific examples of how the scientific method has been used in the past to collect data through observation and experimentation and to formulate, test, and reformulate hypotheses about the physical universe; evaluate scientific information from a variety of sources and use that information to articulate well-reasoned responses to scientific concerns;

4. Recognize the utility of alternative scientific hypotheses in the development of scientific theories, research, and applications and understand how scientific evidence is used to develop hypotheses and theories;

5. Use scientific theories to explain phenomena observed in laboratory or field settings as well as in daily lives. Use fundamental physics laws to explain phenomena in biology and chemistry systems. Discuss the relevance of major scientific theories and research to their lives.

Table of content:

Mechanics table of content:

Mechanics 1: Unit conversion, dimension, Newton's three laws, force analysis, characteristics and calculations of different types of forces, two-dimensional motion, vector synthesis and decomposition, work, energy, kinetic energy theorem, conservation of mechanical energy.

Mechanics 2: Center of Mass Motion, Momentum, Impulse, Momentum Theorem, Moment, Moment balance, angular momentum, angular momentum theorem, circular motion, centripetal force, and a variety of simple mechanical principles

Electromagnetism will be offered after mechanics.

Synchronous and asynchronous lectures are arranged as the following.
We recommend watching the main lectures and review lectures on these dates.
We have two lectures to watch every week. It is very hard to catch up once falling behind.
It is important to watch the videos at a fixed time each week so that you are on pace.

For suggested experimental tools details, please read the following link.

https://docs.google.com/document/d/1Lj73XVtucedLlPtOFJAIpYNQam3vxgiuCg3PhXU6isw/edit