Science Education 201: Matter and Energy in Physical Systems

Western Washington University, Fall 2022

Class meetings: MWF 12:00 pm – 1:50 pm in SL 240
Instructor: Dr. Andrew Boudreaux (andrew.boudreaux@wwu.edu)
Instructor office hours: TBA
Teaching assistant: Jack Brady (bradyj3@wwu.edu)
Course Canvas site: Access to Canvas is required. Students should check the Canvas site daily.

Overview

Physics is perhaps the oldest and most foundational of the sciences. In physics, we develop models to explain and account for our observations of how objects behave. For example, we try to explain

- why a dropped ball speeds up continuously as it falls to the floor
- why a rolling ball tends to slow down and stop, and
- why the brakes on my bicycle become hot when I use them going down a long hill.

Foundational concepts like *energy* and *force* are a main focus in physics. Other sciences, such as geology and biology, draw on these concepts. For example, geologists use the physics of waves to figure out the location at which an Earthquake occurred, and biologists use the physics of energy transfers and transformations to understand metabolism.

Even if you are not going on to major in a science field, studying physics can help you develop powerful ways of thinking. For example:

- Studying physics can help you build skills tackling complex, novel problems.
- Studying physics can help you, as a world citizen, make informed decisions about challenges facing society, such as energy generation and climate change.
- Studying physics can fascinate, inspire, and delight you!

Course topics: We will develop and apply an energy-based model for motion and interactions, as well as a force-based model for motion and interactions. These models represent different ways to explain the motion and interactions of everyday objects. The models, while separate, have overlap and connections with one another. Specific concepts and principles within these overarching models will include kinetic and potential energy, the law of conservation of energy, and Newton's laws of motion. An emphasis will be applying the model to make predictions about real-world situations and phenomena.

Required course materials: This course uses a curriculum called *"Next Generation Physics and Everyday Thinking"* – or "NextGen PET" for short. There are required written materials that can be purchased at the campus bookstore as shrink-wrapped units (not a traditional textbook). The NextGen PET curriculum is organized in units, and we will be using four different units this quarter, in the following order:

1. Unit EM (Energy-based Model for Interactions)
2. Unit PEF (Potential energy and Fields)
3. Unit FM (Force-based Model for Interactions)
4. Unit CF (Combinations of Forces)

Please obtain all four of these units, and bring the first one, Unit EM, with you to class starting the first week. The pages come hole punched. You may find it convenient to keep the pages in a 3-ring binder. The pages are more like a workbook than a textbook – you will be writing in the pages as you do experiments and participate in small group discussions and full class discussions. In addition to the written materials, NextGen PET has a comprehensive website, *nextgenpet.activatelearning.com,* that we will use in and outside of class.

Approach to Learning and Teaching
This is a student-centered, lab-based physics course intended primarily for students pursuing a career in K-8 teaching. There will very little traditional lecturing in this course. Instead, students will generate knowledge through their own work and discussion. The instructor will serve as a facilitator, or "learning coach", rather than the source of knowledge and answers. This approach may differ from other courses you have had. I hope you find it engaging and valuable for your learning. I also acknowledge that this approach can take some getting used to, and can be uncomfortable or even frustrating at first. The course is intended to provide a science learning experience that will serve as a good model for the way K-8 teachers are expected to teach science.

Learning outcomes. There are two major learning outcomes:

> **Physics content**: *Students develop scientific models based on their own investigations. Students apply these models to explain real world phenomena.*
>
> **Learning about learning:** *Students develop awareness of how their own ideas change and develop, and reflect on specific ways the curriculum and instruction facilitates these changes.*

What to expect during class
During class, you will alternate between working in small groups and participating in full-class discussions. During small group work, you will make predictions, conduct experiments, complete exercises, and work with computer simulations. You and your partners will collaborate to make sense of ideas and create explanations. During the full-class discussions, groups will share ideas and explanations, allowing you to check, verify, and perhaps modify the ideas from your small group work. Learning is student directed. *The course has little to no lecturing.*

Instructors in the course will act as "learning coaches," providing guidance, and facilitating your work. Some specific roles include: reflecting student ideas back to the class for further discussion, asking questions to draw out and clarify student ideas, summarizing ideas that have emerged in class discussion, and providing feedback on students' work. The instructors will not in general be a source of answers – but instead will try to provide feedback on student ideas and guide next steps in learning.

What about a textbook? The course materials – NextGen PET – are not a traditional textbook. Instead, they are more like a workbook, with sequences of questions and experiments. As you work through these in your small groups, you will record your ideas, predictions, and observations. You will add more to this "lab notebook" during the full-class discussions – to describe how you are modifying or expanding your thinking based on the ideas of other students in the class. The questions in the NextGen PET units, together with your written answers and explanations, form the "textbook" for the course and will be the primary written resource for your learning. A high-quality lab notebook will contain clear statements of the consensus scientific ideas the class has developed, as well as the steps that you personally took to come to an understanding of these ideas. You will draw on your lab notebook when completing homework, studying for exams, and writing a learning reflection paper (more on that below).

Course policies

Attendance. Due to the collaborative nature of this class, it is important to attend class meetings and arrive on time. Your learning depends on participating. In addition, your partners are depending on you. A missed class cannot easily be made up by getting notes from another student. *Attendance is required.*

Although attendance is crucial for supporting your learning in this course, I do recognize that valid reasons sometimes come up that make it impossible to be in class. For an absence to be considered excused, you must communicate your situation to me prior to class. Valid reasons for an excused absence include: illness, family or personal emergency, or a school related trip (for example, if you are on a Viking sports team that is traveling to a match). Absences that will NOT be counted as excused include: scheduled dentist or doctor appointments, scheduled family vacations, attending office hours for another class, registering for classes for next quarter, or attending a Woodring admissions interview. *Each unexcused absence will drop your course grade by 3%.* In addition, a pattern of repeated late arrivals or leaving class early will negatively impact your grade.

A student who misses more than 3 classes, regardless of whether excused or unexcused, may not be eligible to receive course credit for SCED 201. In this situation, the student must meet with the instructor to discuss the situation.

Cell phones. Please monitor your cell phone use, to prevent it from disrupting your group's collaborative work during class. Repeated disruptive cell phone use will result in deduction of course credit.

Course work

Inclass participation. You and your partners together will build understanding through a process of inquiry. Active engagement is the main way in which this happens. This includes asking questions, responding to the questions of classmates, and offering your own ideas. Engagement is important both during small group work, in which you will conduct experiments and develop explanations, as well as in the full-class discussions, which occur at the end of each activity. Participation credit is based on active participation in small group work and in full class discussions. Participation credit will include a combination self-evaluation and evaluation by instructors. (Details TBA.)

Homework. Written HW will be regularly assigned. The HW will ask you to apply the key ideas developed in class to new situations, with a focus on constructing scientific explanations. In these explanations, you will apply the concepts developed in class to explain a new observation or make a prediction about a new experiment. The HW is to provide you with opportunities to practice the ideas and get feedback on your thinking. HW will be graded based on accurate and complete physics explanations, in order to provide you with feedback on how well you are understanding the course content. Each assignment will include an opportunity for you to revise and resubmit the HW if you did not initially get full credit. The goal is to remove stress over grades, keeping the focus of the HW on helping you move forward in your learning. ***NOTES:*** *Late HW is not accepted, except in the case of an excused absence from class (see Course Policies above). To be eligible to resubmit a HW that did not initially receive full credit, the original HW submission must have been turned in on time. Details on the HW resubmission procedures will be announced.*

Quizzes. While the HW is focused on assessment for learning (sometimes called *formative assessment),* there will also be *summative* assessments – assessments for mastery of the ideas. This will be where you demonstrate your understanding of the content. There will three regularly-spaced quizzes during the quarter. Each quiz is comprehensive, covering all the material of the course up to that point, but with an emphasis on the new material covered since the previous quiz. (The purpose of this structure is to encourage you to steadily review and integrate your learning as the course progresses.) The quizzes are

take-home, open note, and will be done through Canvas. Students will be asked to work individually, without discussing the quiz questions with anyone else, but will be allowed to use their completed Next Gen PET activities, as well as their graded HW assignments, as notes when working on the quiz. The take home quizzes will posted on Canvas no later than 5pm on one class meeting day, and due by noon the following class meeting day. The quizzes are scheduled as follows:

- Quiz 1: Posted Wed, Oct 12th; due Fri, Oct 14th
- Quiz 2: Posted Wed, Nov 2th; due Fri, Nov 4th
- Quiz 3: Posted Fri, Nov 18th; due Mon, Nov 21st

The quizzes are weighted equally. (Note that if a student does not turn in a quiz, that will count as a zero.)

Learning reflection paper. There is one required written paper. In this paper, you will be asked to reflect on and retrace your learning of key physics ideas related to energy. You will be required to make specific references to your written lab notebook – another reason that you should take the time and effort during class to make good written records of your group's thinking! The paper assignment is intended as an opportunity for you to put together your physics understanding of energy into a coherent whole, and to provide an opportunity different from the traditional exam format for you to demonstrate your achievement. The paper will be between 4 and 8 pages in length. Details TBA.

Final exam. There is a comprehensive final exam. It will be similar in format to the quizzes. The final exam will be done through Canvas, and is take home, open note. Students are allowed to use their completed Next Gen PET activities as well as all graded HW assignments and quizzes for the final exam. The final exam will be posted on Sunday, Dec 4th by noon, and due Tuesday, Dec 6th by midnight.

Reasonable Accommodation. Reasonable accommodation for persons with documented disabilities should be established through Disability Resources for Students: 650-3083; drs@wwu.edu; http://www.wwu.edu/depts/drs/

Title IX and Sex Discrimination. Title IX makes it clear that violence and harassment based on sex which includes sexual harassment, gender-based harassment, and sexual violence (sexual assault, domestic violence, dating violence, stalking) is prohibited. Under Title IX, rape and sexual assault are forms of illegal sex discrimination. Survivors of sexual violence have the right to file a discrimination complaint or seek advice and assistance from the Equal Opportunity Office (EOO) in Old Main 345 (360) 650-3307; University Police (360) 650-3911 (emergency) or 650-3555 (report); Bellingham Police, 911 (emergency) or (360) 778-8800 (report). There are also confidential resources on campus such as Consultation & Sexual Assault Support (CASAS) in Old Main 585B, (360) 650-3700; Student Health Center, Campus Services, (360) 650-316; Counseling Center in Old Main 540, (360) 650-3164.

Inclusive classroom environment. Both myself and the SMATE program are firmly committed to equity in all areas of campus life, and supporting the work and achievement of all students. In this class I will work to promote an environment in which all students feel safe and welcome. The success of this policy relies on the support and understanding of the entire group. It is therefore the responsibility of every member of the class to not participate in or condone harassment or discrimination of any kind.

Religious accommodation. Western provides reasonable accommodation for students to take holidays for reasons of faith or conscience or for organized activities conducted under the auspices of a religious denomination, church, or religious organization. Details are found here: https://syllabi.wwu.edu/

Integrity. As a community, Western is committed to integrity in all aspects of academic and campus life. An excellent resource for guiding students is Western's Integrity website (www.wwu.edu/integrity). This site is a clearinghouse of resources that encourages and educates about integrity. Besides covering more common problems related to academic integrity, such as plagiarism and cheating on exams, it also addresses ambiguous areas, such as collaborative work, the use of language translators, and submitting the same paper in different classes. In addition to this site, the University Catalog in Appendix D—Academic Honesty Policy and Procedure—delineates rights and responsibilities.

Course grades are based on the following components and weighting:

Inclass participation	10%
Homework	30%
Quizzes	20% all together (lowest quiz score will be dropped)
Learning reflection paper	10%
Final exam	20%
Surveys	10%

The scale is as follows:

93% A	83% B	73% C	63% D
90% A-	80% B-	70% C-	60% D-
87% B+	77% C+	67% D+	< 60% Fail

This syllabus is subject to change. Changes will be announced in class. Students are responsible for all changes.