

# PHYS 233: Physics for Life Sciences 1

## Syllabus Spring 2025

### Course Information

- **Course number and title:** PHYS 23300 – Physics for Life Sciences
- **CRN:** 13026
- **Meeting day(s) and time(s).**
  - **Lecture:** TR 10:30-11:20am in PHYS 338 (in person)
  - **Recitations:** PHYS 154 (in person)
    - **011** – W 3:30-4:20pm (Sullivan-Wood)
  - **Labs:** PHYS 154 (in person)
    - **003** – R 11:30am-1:20pm (Balivada)
- **Instructional Modality:** All lectures, recitations, and labs will be face-to-face in class
- **Course credit hours:** 4
- **Prerequisites:** Two semesters of introductory biology (e.g. BIOL 110 & 110 or equivalent), two semesters of college level math including calculus (e.g. MATH 231 & 232 or equivalent), and one semester chemistry (e.g. CHM 109 or 115, or equivalent).

### Instructor(s) Contact Information

- **Name of the instructor:** Prof. Ian Arnold
- **Office Location:** PHYS 227
- **Office Phone Number:** N/A
- **Purdue Email Address:** [iarnold@purdue.edu](mailto:iarnold@purdue.edu)
- **Student Consultation hours, times, and location:** TBA
- **TA's names and contact information:**
- **Teaching Assistants:**
  - Aishwarya Balivada: [abalivad@purdue.edu](mailto:abalivad@purdue.edu)
  - Jignesh Mohanty: [jmohanty@purdue.edu](mailto:jmohanty@purdue.edu)
  - Jonathan Sullivan-Wood: [sulli391@purdue.edu](mailto:sulli391@purdue.edu)
  - Ananda Subedi: [subedi3@purdue.edu](mailto:subedi3@purdue.edu)
- **Help Center TAs:**
  - Sheng-Wen Huang: [huan1780@purdue.edu](mailto:huan1780@purdue.edu)
  - Varadrajan (Rajan) Muruganandam: [vmuruga@purdue.edu](mailto:vmuruga@purdue.edu)

### Course Description

Physics for Life Sciences I builds upon prerequisite knowledge in college level biology, chemistry, and mathematics to present introductory physics that will be useful for applying physical principles, insights, and problem solving approaches for students with life science majors. Content will feature the Newtonian framework with emphasis on friction, drag, and viscosity, random motion & diffusion, fluid flow, the Coulomb force, molecular forces and bonding, momentum, conservation of energy, entropy, and the first & second laws of thermodynamics.

## Learning Resources, Technology & Texts

- **Informed Learning resources such as**
  - **Required texts:** Online via Brightspace
  - **Additional readings:** College Physics: A Strategic Approach by Knight, Jones and Field (4th edition) is optional as a reference text.
- **Software/web resources:**
  - A video analysis program, download: <https://imagej.nih.gov/ij/>
  - An alternate version of ImageJ that comes preloaded with many of the necessary plug-ins is called “FIJI” and can be downloaded here: <https://fiji.sc/>
  - A spreadsheet program for labs: Microsoft office or Google sheets
- **Brightspace learning management system:** Access the course via Purdue’s Brightspace learning management system.

## Learning Outcomes

Students will understand how motion in realistic biological systems (e.g. cells, biomolecules) is governed by forces, how molecular binding is described in terms of energy, how diffusion is governed on a microscopic level, and will have insight into how the first and second laws of thermodynamics constrain basic processes in living systems.

### Outline of topics covered:

#### A. Modeling with Mathematics

Dimensions, units, measurements, making proper estimates, constructing models.

#### B. Describing Motion

Coordinates, vectors, how to read graphs, derivatives, instantaneous versus average motion, relating position, velocity, & acceleration.

#### C. What Causes Motion

Inertia, interactions, mass, Newton’s 1st & 2nd laws, system schemas, free body diagrams, the 3rd law (reciprocity).

#### D. Types of Forces

Normal force, weight, springs, tension, resistive forces, gravity, Coulomb force, polarization, electric & gravitational fields.

#### E. Coherent vs. Diffusive Motion

Momentum, conservation of momentum, random walks, diffusion, Fick’s Law, do forces drive diffusive motion?

#### F. Models of Matter

Density, Young’s modulus, mechanical properties of cells.

#### G. Forces and Motion in Fluids

Pressure, ideal gas law, buoyancy, continuity equation, surface tension, inertial drag force, viscous drag force, Reynolds number, Hagen-Poiseuille relation.

#### H. Energy – The First Law of Thermodynamics

Work and kinetic energy, potential energy (gravitational, electric, spring), conservation of mechanical energy, thermal energy, chemical bonding, heat and temperature.

#### I. Entropy – The Second Law of Thermodynamics

Heat transfer, heat capacity, counting statistics, the direction of time, micro to macro connection.

## Assignments

Your learning will be assessed through a combination of homework, exams, recitations and labs.

Assignment Type	Due	Percentage of Course Total
Homework	5pm on Friday	25%
Recitation	Weekly	10%
Lab	Weekly	15%
Quizzes	Weekly	10%
Midterm 1	Feb 13 <sup>th</sup> (in class)	10%
Midterm 2	Apr 1 <sup>st</sup> (in class)	10%
Final Exam	TBA	20%

### Grade components in detail

#### *Pre-lecture readings*

There are readings in this class, but we have chosen not to use a standard text. Our goal is to start with what you know from introductory biology and chemistry -- and your everyday experience! -- and teach you the physics that is most relevant for understanding living things. Before each class there will be a few (fairly short) web pages for you to read.

#### *Recitations*

In recitation, you will work through an extended multi-part problem often with a biological context. Points for Recitation are for attendance and participation. Show up and participate!

#### *Homework*

We are using **Mastering Physics** as our on-line homework platform. *You must purchase access to Mastering Physics to complete your homework assignments, although a short trial period is available to you at the beginning of the course.* A typical assignment will have some number of questions where you enter your answers online. Then there is also a lengthier problem where you must work out the solutions on paper (or digital tablet). The deadline for all problems is 5:00 pm on the Friday due dates. The hard copy assignments should be scanned (photographed) and uploaded in Gradescope.

You are encouraged to work on these with classmates but write up your solutions independently. Be careful: If two or more submitted answers are essentially identical, neither will receive credit. Solutions to the hard copy problem are to be written up nicely -- like a report. They can be expected to include equations, calculations, drawings, and graphs. The quality of the presentation will be considered in the score as well as the quality of the solution.

#### *Quizzes*

We will have (graded) short quizzes administered on Brightspace. Quizzes will focus on important -- and sometimes subtle -- fundamental issues (often from the previous week's material). Each quiz will be worth 10 points. The point of these quizzes is to help you see where you might still be confused. There will be 11

quizzes. The first quiz is weighted equally to the others but is an extra credit quiz. **The lowest grade will be dropped.**

### *Exams*

We will have two midterm exams and a final. Each exam will test how well you have learned to use and make sense of the material. As a result, you will be expected to think on exams. Exams typically have five problems, including one essay question and one estimation question. Although exams are important, they total only ~40% of your grade. See below for the rules for regrades and makeup exams.

### *Laboratories*

The laboratories in this class will let you experience and explore the topics of lecture and recitation in the real world. You also will learn techniques that are directly applicable to living things, for example how to characterize the motion of an object moving under a microscope.

**NOTE: You must complete all labs to get a passing grade in this class.** If you miss a lab, inform your TA. You must then attend the make-up lab session during the last week of class.

### *Excuses*

If you have a valid excuse for missing an exam, quiz, or homework, send an email to your instructor to arrange what to do about it, beforehand if possible. Specify the date and day you will be (or were) absent and the reasons. Ex post facto (after the fact) excuses will require validation and may not be acceptable. (Wanting to leave early before a holiday is NOT a valid excuse, even if it's for a friend's wedding.) You must contact your lead instructor. Your TA does not have the authority to excuse you from any required class activity.

## **Grading Scale**

The grading scale is according to the student's final percentage grade. The typical grading scheme will be as follows:

<b>Grade</b>	<b>Percentage</b>
A+	97%
A	93%
A-	90%
B+	87%
B	83%
B-	80%
C+	77%
C	73%
C-	70%
D+	67%
D	63%
D-	60%
F	<60%

This scale is subject to change but will do so only in the students' favor.

## Course Schedule

Available for download on Brightspace.

## Attendance Policy

This course follows the [University Academic Regulations regarding class attendance](#), which state that students are expected to be present for every meeting of the classes in which they are enrolled. Attendance will be taken at the beginning of each class and lateness will be noted. When conflicts or absences can be anticipated, such as for many University-sponsored activities and religious observations, you should inform me of the situation as far in advance as possible. For unanticipated or emergency absences when advance notification is not possible, contact me as soon as possible by email or phone. For absences that do not fall under excused absence regulations (see below), this course follows the following procedures:

1. Do not come to class if you are feeling ill, but DO email me at [iarnold@purdue.edu](mailto:iarnold@purdue.edu), with the subject line: [PHYS 234] absence. I do not need details about your symptoms. Just let me know you are feeling ill and cannot come to class. If it is an emergency situation, please follow the University regulations on emergent medical care (see below).
2. Unless it falls under the University excused absence regulations (see below), any work due should be submitted on time via our course Brightspace.
3. If that day's class involves assessed work such as a test or presentation, you and I will plan if and how you can make up the work, following the assignment guidelines. This plan must be done before the next class period, so again, email me immediately when you know that you will miss class.
4. The most important consideration in any absence is how it will affect your achievement of the assignment objectives and the course learning outcomes.

For cases that fall under **excused absence regulations**, you or your representative should contact or go to the [Office of the Dean of Students \(ODOS\) website](#) to complete appropriate forms for instructor notification. Under academic regulations, excused absences may be granted by ODOS for cases of grief/bereavement, military service, jury duty, parenting leave, or emergent medical care. The processes are detailed, so plan ahead.

## Academic Integrity & Copyright

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing [integrity@purdue.edu](mailto:integrity@purdue.edu) or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available on our course Brightspace under University Policies and Statements.

See the University Policies and Statements section of Brightspace for guidance on Use of Copyrighted Materials. Effective learning environments provide opportunities for students to reflect, explore new ideas, post opinions openly, and have the freedom to change those opinions over time. Students and instructors are the authors of the works they create in the learning environment. As authors, they own the copyright in their works subject only to the university's right to use those works for educational purposes. Students may not copy, reproduce, or post to any other outlet (e.g., YouTube, Facebook, or other open media sources or websites) any work in which they are not the sole or joint author or have not obtained the permission of the author(s).

## **Nondiscrimination Statement**

Purdue University is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. A hyperlink to Purdue's full Nondiscrimination Policy Statement is included in our course Brightspace under University Policies and Statements.

## **Accessibility**

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: [drc@purdue.edu](mailto:drc@purdue.edu) or by phone: 765-494-1247. More details are available on our course Brightspace under Accessibility Information.

## **Mental Health Statement**

**If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try [Therapy Assistance Online \(TAO\)](#)**, a new web and app-based mental health resource available courtesy of Purdue Counseling and Psychological Services (CAPS). TAO is available to students, faculty, and staff at any time.

**If you need support and information about options and resources**, please contact or see the [Office of the Dean of Students](#). Call 765-494-1747. Hours of operation are M-F, 8 a.m.- 5 p.m.

**If you find yourself struggling to find a healthy balance between academics, social life, stress, etc.**, sign up for free one-on-one virtual or in-person sessions with a [Purdue Wellness Coach at RecWell](#). Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is free and can be done on BoilerConnect.

**If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students.** If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact [Counseling and Psychological Services \(CAPS\)](#) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours.

## **Basic Needs Security**

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students 8 a.m.-5 p.m. Monday through Friday.

## **Emergency Preparation**

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be

obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.

A link to Purdue's Information on [Emergency Preparation and Planning](#) is located on our Brightspace under "University Policies and Statements." This website covers topics such as Severe Weather Guidance, Emergency Plans, and a place to sign up for the Emergency Warning Notification System. I encourage you to download and review the *Emergency Preparedness for Classrooms document* ([PDF](#)) or ([Word](#)).

The first day of class, I will review the **Emergency Preparedness plan for our specific classroom**, following Purdue's required [Emergency Preparedness Briefing](#). Please make note of items like:

- The location to where we will proceed after evacuating the building if we hear a fire alarm.
- The location of our Shelter in Place in the event of a tornado warning.
- The location of our Shelter in Place in the event of an active threat such as a shooting.

## Disclaimer

Course requirements, deadlines and grading percentages are subject to changes that may be necessitated in the event of major campus emergency or other circumstances. You can get information about changes in this course in Brightspace.

Notes are considered to be derivative works of the instructor's presentations and materials and thus are subject to the instructor's copyright in such presentations and materials.