Practicing Physics – Matter, Heat, and Motion Syllabus

Phys1125

Course Information

- **Course times:** Mondays 110 minutes, Tuesdays and Thursdays 80 minutes; times TBD
- **Credit hours:** 4
- **Mode of delivery:** In-person, Smith Lab room 2082
- **Textbook:** All readings, videos, etc. will be provided in the classroom and on Carmen
- **Mode of delivery:** This course is in-person. Attendance and participation during class activities are expected.
- **Pace of activities:** In-class activities are self-paced, and students are expected to keep pace with weekly and monthly deadlines.
- **Credit hours and work expectations:** This is a 4 credit-hour course that includes 3 credit hours of lecture/recitation and 1 credit hour of laboratory work. According to Ohio State bylaws on instruction (go.osu.edu/credithours), students should expect around 5 hours per week of time spent on direct instruction in addition to up to 6 hours of homework (reading and assignment preparation, projects) to receive a grade of C average.

Instructor

- **Name:** TBD
- **Email:** TBD
- **Office phone number:** TBD
- **Office location:** TBD
- **Student hours:** TBD
- **Preferred means of communication:**
    - My preferred method of communication for questions is **TBD.**

Course Description

Students work in groups to perform investigations on density, motion, and thermodynamics and develop simple models to make and test quantitative predictions. Through discussions with instructors and peers, students consider the effects of science in society and apply their scientific skills to everyday situations. Intended for non-science majors, especially those contemplating a teaching career.

Learning Outcomes

By the end of this course, students should successfully be able to:

- Gather and analyze data related to the topics of density, buoyancy, calorimetry, and one-dimensional motion
- Develop models on density, buoyancy, calorimetry, and one-dimensional motion and use these models to make quantitative predictions
- Make a relevant plot of the data, obtain a linear best fit line and equation, and interpret the slope and y-intercept
- Write operational definitions and explain and justify the need for standards
- Solve density, calorimetry, and linear motion problems using proportional reasoning
- Use multiple representations to describe situations related to density, buoyancy, calorimetry, and one-dimensional motion and translate between these representations
- Interpret the meaning of compound quantities, such as gram per centimeter cubed, and correctly use the information contained in them
- Relate position, velocity, and acceleration graphs for an object moving in one dimension with a constant acceleration
- Present measurements with appropriate uncertainty and use error propagation to obtain calculated values with appropriate uncertainty
- Use uncertainty to critically evaluate claims that two values are the same
- Evaluate the social and ethical implications of scientific claims in the media, using uncertainties, interpreting data presented in tables, figures, and graphs
- Recognize that, while current scientific models and practices are productive, science is an ongoing, iterative process for building and refining methods and models of the world and provide examples

General Education (GEN) Goals and Expected Learning Outcomes

As part of the Natural Sciences Foundations of the General Education curriculum, this course is designed to meet the goals and learning outcomes listed below. We include some details of the how the learning outcomes are applied to this course.

General Education (GEN) Goals:

- Successful students will engage in theoretical and empirical research study within the natural sciences while gaining an appreciation of the modern principles, theories, methods, and models of inquiry used generally across the natural sciences.
- Successful students will discern the relationship between the theoretical and applied sciences while appreciating the implications of scientific discoveries and the potential impacts of science and technology.

General Education (GEN) Expected Learning Outcomes:

- Explain basic facts, principles, theories and methods of modern natural sciences, and describe and analyze the process of scientific inquiry.

Through the activities presented in the course materials, students will design and perform simple experiments that allow them to observe and explain basic physical concepts and develop and test models related to mass, volume, density, buoyancy, calorimetry, and motion in one dimension.

- Identify how key events in the development of science contribute to the ongoing and changing nature of scientific knowledge and methods.

Students will identify how scientific reasoning has shaped the course of history and how physics, and science in general, is an ongoing process by discussing the need for standards and operational definitions throughout the course and working on a semester-long project on the impact of science and technology on a historical event and how the historical circumstances pushed the development of scientific models and technology in a particular direction.

- Employ the processes of science through exploration, discovery and collaboration to interact directly with the natural world when feasible, using appropriate tools, models and analysis of data.

Students will employ the process of science by performing explorations and measurements in the lab, while working collaboratively in small groups and reporting results to instructors and peers during class and in group presentations. Students will gather, analyze, and interpret data following activity prompts in the course materials, making relevant plots, obtaining a best fit equation, and interpreting the meaning of the fit parameters. Students will present data and calculated quantities with appropriate uncertainty and use multiple representations to form mathematical models. Students will then use these models and proportional reasoning to make quantitative predictions.

- Analyze the inter-dependence and potential impacts of scientific and technological developments.

Throughout the term, students will apply the scientific practices learned and practiced in class to real-world problems. In addition, students will complete a semester-long project where they will read a book or watch a movie where the topics of the course are used and write a reflection on how the events presented in the movie or book and the scientific concepts are related.

- Evaluate social and ethical implications of natural scientific discoveries.

Students will be able to use uncertainty to critically evaluate claims that two values are the same or different as presented in news reports and will discuss the ethical implications of news reports not using uncertainties in making claims. Students will be able to use the concepts explored in the motion unit to analyze and reason about quantities as a function of time in the real world, discuss how these quantities change with time, and discuss the implications to society of these changes.

- Critically evaluate and responsibly use information from the natural sciences

Through discussions with instructors and peer presentations and feedback, students will be presented with appropriate ways to use data and uncertainties to make scientific claims, such as whether two values are the same. Students will be able to explain whether a quantity can be used to determine an outcome of an action (causes) or simply influences a result (correlated). All assignments and assessments will have this component of critically evaluating and responsibly using information, from their own data collection and models or to evaluate others' claims about the natural world.

Grading

How Your Grade is Calculated

Assignment Category	Percentage
Questions of the Day	~ 20%
Homework assignments	~10%
Video HW group assignments	~ 5%
Lab checkpoints	~ 15%
Class checkpoints	~ 10%
Project	~ 10%
Quizzes	~ 10%
Exams	~ 20%
Total	100%

See Course Schedule for due dates.

Descriptions of Major Course Assignments

For most of the course assignments, students will work in small groups. Student groups are assigned by the instructor; new groups will be assigned at the beginning of each of the three units.

Questions of the day

Description: A short assignment at the beginning of each class period, due during class. Each question in the Question of the day will be graded using the Homework and Question of the Day rubric.

Academic integrity and collaboration: You are expected to discuss the solution to the question of the day with your group. However, each student must submit their own answer, in their own words.

Homework

Description: Due weekly as an online submission. Two problems that extrapolate the concepts and problems explored during class, or an essay reflecting on the concepts learned in class. Each problem in the Homework will be graded using the Homework and Question of the Day rubric.

Academic integrity and collaboration: You are encouraged to discuss the solution to the homework problems with your classmates and instructor. However, each student must submit their own answer, in their own words. Any information from external sources must be properly cited; include the name of the work and pages, or a link if it is an online source. If you worked together with someone doing the homework, you are expected to mention this in the citations.

Video Homework group assignments

Description: A short (at most 2 minutes) video produced by each group where a real-world application of the topics covered in class is discussed. The Video Homework submission will be graded using the Video HW rubric.

Academic integrity and collaboration: Video submissions are group assignments. One video will be submitted per group, all students must be seen actively participating in the presentation of the problem and solution, and all members of the same group will get the same grade. They are open notes, books, and internet; proper citation of sources is expected. Collaboration with other groups is allowed and encouraged.

Lab Checkpoints

Description: Discussion with instructor during lab, where you present your completed work and sufficiently explain your reasoning and conclusions, as well as answer questions about your data collection process, data analysis, and model building, including determining uncertainties and error propagation, where appropriate. Lab checkpoints are graded on a mastery level, either no credit or full credit; you get to try again to complete each checkpoint.

Academic integrity and collaboration: Everyone in the group is expected to participate in the discussion with the instructor. Group members are expected to help each other out and all members must demonstrate understanding for the entire group to get credit for the checkpoint.

Class Checkpoints

Description: Discussion with instructor during class, where you present your completed work and sufficiently explain your reasoning and answers to the in-class exercises, as well as answer questions about your work. Class checkpoints are graded on a mastery level, either no credit or full credit; you get to try again to complete the checkpoint.

Academic integrity and collaboration: Everyone in the group is expected to participate in the discussion with the instructor. Group members are expected to help each other out and all members must demonstrate understanding for the entire group to get credit for the checkpoint.

Project

Description: An informal essay on the social and ethical issues that arise from scientific and technological developments, as presented in a book or movie. Students will read or watch a piece of media of their choice that presents the scientific concepts taught in class and their influence on society. This connection could be either through the work of professional scientists during key historical events, like the construction of the atomic bomb or space exploration, or through the work of everyday scientists applying scientific and engineering principles to solve a local problem, like building a wind-powered water pump for their small town. Students will summarize the content of the book or movie in an essay presentation (written or video) and reflect and comment on the social and ethical issues presented therein. Students will work on their essay in class, following prompts from the instructor, and receive guidance and feedback from the instructor and peers. Students will submit a first draft, receive feedback from the instructor, submit a second final draft, and receive feedback from their peers. As part of the project, students will provide feedback to at least three of their peers' first and final submissions. More details on the project assignment are on Carmen in the document "Guidelines for Student Projects".

Academic integrity and collaboration: The project is an individual assignment. Discussion with others (students and instructors) of the topics and issues raised in the reading / watching is encouraged. However, each student must submit their own essay. For grading and instructions, consult the Guidelines for Student Projects document.

Quizzes

Description: A combination of multiple-choice, short answer, and long answer questions related to the topics in the current unit. Each quiz will be in person during class time, and it should take no more than 60 minutes to complete.

Academic integrity and collaboration: Quizzes are group assignments. All students are expected to collaborate and contribute to the answers. However, each student must submit their own answer, in their own words. Quizzes are closed book. However, each student is allowed one piece of printer paper with handwritten notes.

Exams

Description: A combination of multiple-choice, short answer, and long answer questions, as well as data collection and data analysis, related to the topics covered in the unit. There will be an exam at the end of each unit. Each exam will be in-person during class time and will take no longer than 80 minutes to complete. There is no final exam for this course, instead the project takes the place of the final exam.

Academic integrity and collaboration: Exams consist of two parts: individual and group. The individual part of the exam is to be done individually. They are closed book. However, each student is allowed one piece of printer paper with handwritten notes and no collaboration is allowed. The group part of the exam will be done in groups. One submission per group is required and all members of the group will receive the same grade. Collaboration with your group is expected and all members of the group are expected to contribute to the answers. Collaboration with other groups is not allowed.

Rubrics

Homework and Question of the Day rubric
For examples on how the rubric is applied, see the Homework and Question of the Day Rubric Examples document.

Criteria	Ratings			Points
Main idea / Setup General statement of physical principle or definition relevant to the situation	2 pts Full Marks Present, correct, and complete	1 pts Partial credit Present, but incorrect or incomplete	0 pts No Marks Missing	2 pts
Explanation / application Logical step-by-step progression or application of main idea to specific situation	2 pts Full Marks Present, correct, and complete	1 pts Partial credit Present, but incorrect or incomplete	0 pts No Marks Missing	2 pts
Final Answer Statement of the final answer to the question posed	1 pts Full Marks Present, correct, and complete		0 pts No Marks Missing or incorrect	1 pts

Video HW rubric

Criteria	Ratings			Points
Problem quality Video analyses a real-life problem that is interesting and well-defined	1 point Full Marks Present and complete	0.5 points Partial credit Present, but incomplete	0 points No Marks missing	1 point
Participation All students in the groups are seen doing something or heard narrating something relevant to the presentation	1 point Full Marks All students	0.5 points Partial credit Some, but not all, students	0 points No Marks No or only 1 student	1 point
Timing Video is at most 2 minutes long	2 points Full Marks		0 points No Marks	2 points
Visual aids Visual aids are used, and they are appropriate for and helpful to understanding the problem and solution	2 points Full Marks Present, appropriate, and helpful	1 point Partial credit Present, but incomplete, inappropriate, or confusing; large blocks of text (as opposed to few bullet points and/or graphs, sketches)	0 points No Marks Missing	2 points
Solution Proposed solution solves the problem posed and is presented in a clear, easy-to-follow way	2 points Full Marks Solves the problem and is easy to follow	1 point Partial credit Solves the problem but presentation is confusing; OR does not solve the problem even though it is presented in a clear way	0 points No Marks Missing OR does not solve the problem and is confusing to follow	2 points
Presentation The content is presented in a conversational tone, with good flow and a logical path	2 points Full Marks Good flow, logical path, and conversational tone are all present	1 point Partial credit Presenter loses train of thought often, reads from text on slides, jumps around slides, among other things that interrupt flow	0 points No Marks Presentation is chaotic and statements do not follow each other logically or are unrelated to visual aids	2 points

Grading Scale

93–100: A
90–92.9: A-
87–89.9: B+
83–86.9: B
80–82.9: B-
77–79.9: C+
73–76.9: C
70–72.9: C-
67–69.9: D+
60–66.9: D
Below 60: E

Other Course Policies

Academic Misconduct

See Descriptions of Major Course Assignments for specific guidelines about collaboration and academic integrity in the context of this online class.

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-38.7 (B) (https://trusteed.osu.edu/bylaws-and-rules/3335-5)). For additional information, see the Code of Student Conduct (http://studentlife.osu.edu/csc/).

Disability Services

The university strives to maintain a healthy and accessible environment to support student learning in and out of the classroom. If you anticipate or experience academic barriers based on your disability (including mental health, chronic or temporary medical conditions), please let us know immediately so that we can privately discuss options. To establish reasonable accommodations, we may request that you register with Student Life Disability Services (SLDS). After registration, make arrangements with us as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion.

If you are ill and need to miss class, including if you are staying home and away from others while experiencing symptoms of a viral infection or fever, please let us know immediately. In cases where illness interacts with an underlying medical condition, please consult with Student Life Disability Services to request reasonable accommodations. You can connect with them at slds@osu.edu; 614-292-3307; or slds.osu.edu (https://slds.osu.edu/)

Religious Accommodations

Ohio State has had a longstanding practice of making reasonable academic accommodations for students' religious beliefs and practices in accordance with applicable law. In 2023, Ohio State updated its practice to align with new state legislation. Under this new provision, students must be in early communication with their instructors regarding any known accommodation requests for religious beliefs and practices, providing notice of specific dates for which they request alternative accommodations within 14 days after the first instructional day of the course. Instructors in turn shall not question the sincerity of a student's religious or spiritual belief system in reviewing such requests and shall keep requests for accommodations confidential.

With sufficient notice, instructors will provide students with reasonable alternative accommodations with regard to examinations and other academic requirements with respect to students' sincerely held religious beliefs and practices by allowing up to three absences each semester for the student to attend or participate in religious activities. Examples of religious accommodations can include, but are not limited to, rescheduling an exam, altering the time of a student's presentation, allowing make-up assignments to substitute for missed class work, or flexibility in due dates or research responsibilities. If concern arise about a requested accommodation, instructors are to consult their tenure initiating unit head for assistance.

A student's request for time off shall be provided if the student's sincerely held religious belief or practice severely affects the student's ability to take an exam or meet an academic requirement and the student has notified their instructor, in writing during the first 14 days after the course begins, of the date of each absence. Although students are required to provide notice within the first 14 days after the course begins, instructors are strongly encouraged to work with the student to provide a reasonable accommodation if a request is made outside the notice period. A student may not be penalized for an absence approved under this policy.

If students have questions or disputes related to academic accommodations, they should contact their course instructor, and then their department or college office. For questions or to report discrimination or harassment based on religion, individuals should contact the Office of Institutional Equity (equity@osu.edu). (Policy: Religious Holidays, Holy Days and Observances (https://oaa.osu.edu/religious-holidays-holy-days-and-obervances))

Course Schedule

Refer to Carmen for up-to-date due dates.

Unit 1: Properties of Matter

Week	**Day**	**Assignment/Assessment**	**Classwork**
1	1	Question of the day #1	Introduction to the class Lab 1: Balancing
1	2	Question of the day #2	Section 1 – Intro to balancing
1	3	Question of the day #3 HW 1 due Friday	Section 2 – Advanced balancing
2	4	Question of the day #4 Video 1 due Project media selection due	Lab 2: Advanced balancing
2	5	Question of the day #5	Section 3 – Measurement of mass Section 4 – Uncertainty
2	6	Question of the day #6 HW 2 due Friday	Section 5 – Operational definitions
3	7	Question of the day #7 Video 2 due	Lab 3: Volume
3	8	Question of the day #8	Section 6 – Volume Section 7 – Changes in mass, volume 1
3	9	Question of the day #9 HW 3 due Friday	Section 7 – Changes in mass, volume 2 Section 8 – Distinguishing mass and volume
4	10	Question of the day #10 Video 3 due	Lab 4: Measurement of density
4	11	Question of the day #11	Section 9 – Proportional reasoning Sections 10 & 11 – Density
4	12	**QUIZ 1** HW 4 due Friday	None

5	13	Question of the day #12	Lab 5: Sinking and floating 1
5	14	Question of the day #13 Project read / watch due	Project outline Section 12 – Sink/Float 1
5	15	Question of the day #14 HW 5 due Friday	Section 12 – Sink/Float 2
6	16	Question of the day #15 Video 4 due	Lab 6: Sinking and floating 2
6	17	Question of the day #16	Section 13 – Graphing mass and volume
6	18	**EXAM 1** HW 6 due Friday (extra)	None

Unit 2: Heat and Temperature

Week	**Day**	**Assignment/Assessment**	**Classwork**
7	19	Question of the day #17	Lab 7: Temperature and changes in temperature
7	20	Question of the day #18	Project: peer feedback on outline Section 1 – Temperature
7	21	Question of the day #19 HW 7 due Friday	Section 2 – Changes in temperature
8	22	Question of the day #20 Video HW 5 due	Lab 8: Heat transfer
8	23	Question of the day #21 Project first draft due	Section 3 – Heat transfer
8	24	No class – Autumn Break	No class – Autumn Break
9	25	Question of the day #22	Lab 9: Heat capacity and specific heat
9	26	Question of the day #23	Sections 4 & 5 – Heat capacity / specific heat
9	27	Question of the day #24 HW 8 due Friday	Section 6 – Proportional reasoning
10	28	Question of the day #25 Video HW 6 due Project Peer Feedback due	Lab 10: Phase changes

10	29	Question of the day #26	Section 7 – Phase changes
10	30	**EXAM 2** HW 9 due Friday (extra)	None

Unit 3: Motion and Forces

Week	**Day**	**Assignment/Assessment**	**Classwork**
11	31	Question of the day #27	Lab 11: Uniform Motion
11	32	Question of the day #28	Section 1 – Uniform Motion
11	33	Question of the day #29 HW 10 due Friday	Section 2 – Position and time
12	34	Question of the day #30 Video HW 7 due	Lab 12: Non-uniform motion 1
12	35	No class – Election Day	No class – Election Day
12	36	Question of the day #31 HW 11 due Friday	Section 3 – Non-uniform motion
13	37	Question of the day #32 Video HW 8 due	Lab 13: Non-uniform motion 2
13	38	Question of the day #33	Section 4 – Velocity
13	39	**QUIZ 2** HW 12 due Friday Project Final Draft due	None
14	40	Question of the day #34	Lab 14: Acceleration 1
14	41	Question of the day #35	Section 5 – Acceleration
14	42	Question of the day #36 HW 13 due Friday	Section 6 – Motion and graphs 1
15	43	Question of the day #37 Video HW 9 due	Lab 15: Acceleration 2
15	44	Question of the day #38	Section 6 – Motion and graphs 2
15	45	No class – Thanksgiving	No class – Thanksgiving

16	46	Question of the day #39	Lab 16: Forces Section 7 – Forces
16	47	**EXAM 3** HW 14 due (extra) Project Peer Feedback due	None

Brief Lab Descriptions

Lab 1: Balancing
Students will work with a simple balance to develop a model of how to tell whether a balance is balanced and what it means for different objects to balance each other.

Lab 2: Advanced balancing
Students will use the simple balance (without the pans) to explore how changing variables like mass, position, tilt, height, among others affect balancing. They will refine their model for how to tell whether a given configuration is balanced.

Lab 3: Volume
Students will explore some suggested definitions of volume and use them to measure the volume of several objects. Based on their results, students will develop an operational definition of volume, justifying their choices.

Lab 4: Measurement of density
Students will use their operational definitions of mass and volume to measure the mass and volume of several objects, with appropriate uncertainty, as well as pieces of those object. Students will explore the difference between homogeneous and inhomogeneous materials, calculate the mass-to-volume ratio of each material, including water and carbon dioxide, and conclude what that number means.

Lab 5: Sinking and floating 1
Students will explore whether several objects sink or float in water and develop an operational definition of sinking and floating. Combined with their results from Lab 4, students will write down a rule to determine whether a given object will sink or float in water.

Lab 6: Sinking and floating 2
Students will explore whether several objects sink or float in salt water and alcohol. Students will explore how the mass and volume of the liquid displaced depends on the mass of the object and whether the object sinks or floats in the liquid. Using these results, students will expand their rule to determine whether a given object will sink or float in an arbitrary liquid.

Lab 7: Temperature and changes in temperature
Students will examine an alcohol thermometer and use it to measure the temperature of water as it is heated then boiled for several minutes. Students will use the thermometer to measure

the temperature of several objects made of different materials and compare results. Develop an operational definition of temperature.

Lab 8: Heat transfer
Students will combine different amounts of hot and cold water with varying temperatures and measure the final temperature of the mixture. Develop a quantitative model for the relationship between mass, initial temperature, and final temperature of the hot and of the cold water.

Lab 9: Heat capacity and specific heat
Students will develop and implement a procedure to determine the heat capacity of an aluminum block and iron washers, as well as calculating the specific heat of aluminum and iron.

Lab 10: Phase changes
Students will determine the latent heat of fusion and of vaporization of water. Students will expand their model of heat transfer to include phase changes.

Lab 11: Uniform motion
Students will determine the uncertainty of measuring distance (position) and time of a ball rolling on a near-frictionless track by measuring the time it takes the ball to travel equal distance segments. Students will write an operational definition of uniform motion. Students will use tables and graphs of positions and times of an object in motion to show whether a given motion is uniform or not.

Lab 12: Non-uniform motion 1
Students will expand their analysis of motion by measuring the position and time of a ball rolling on a track at equal time intervals. The track will be flat (uniform motion) then elevated (non-uniform motion). Students will use tables and graphs of positions and times of an object in uniform and non-uniform motion.

Lab 13: Non-uniform motion 2
Students will expand their explorations of uniform and non-uniform motion by measuring the time and position of a battery-powered cart that moves at a constant speed and a cart that rolls downhill (frictionless) using ticker-tape timers. This improves the precision of the measurements and allows for better discerning between uniform and non-uniform motion.

Lab 14: Acceleration 1
Students will use a motion detector and computer software (LoggerPro or Vernier Graphical Analysis) to collect data and make plots of a person moving in several (simple) configurations. Students will explore the relationship between the position-versus-time, velocity-versus-time, and acceleration-versus-time graphs and will use the software to perform appropriate fits and extract the value of the (constant) acceleration of the cart in the different segments of the track.

Lab 15: Acceleration 2
Students will use a motion detector and computer software (LoggerPro or Vernier Graphical Analysis) to collect data and make plots of a cart moving in several configurations. Students

will explore the relationship between the position-versus-time, velocity-versus-time, and acceleration-versus-time graphs and will use the software to perform appropriate fits and extract the value of the (constant) acceleration of the cart in the different segments of the track.

Lab 16: Forces
Students will measure and analyze the motion of a cart as it is being pulled. Students will explore how changing the pulling force and/or the mass of the cart affects the cart's acceleration. Students will use graphs to develop a model of the relation between pulling force, mass of cart, and cart's acceleration.