

# Physics, Semester B

## Course Overview

Physics is one of the three main fields of science, along with biology and chemistry. If asked what biology and chemistry deal with, most of us can come up with a one-word answer: life and chemicals respectively. Physics though, often seems like a grab bag of topics, including motion, magnets, machines, light, sound, and electrical circuits.

The common thread running through all these things is that they each illustrate some basic mathematical laws in our physical world. In brief, physics is the scientific study of matter, energy, and their most fundamental physical interactions, including attractions, repulsions, and collisions.

In Physics B, you will use your physical understanding of motion, forces and energy and apply that knowledge to some important, specialized topics in physics: the behavior of waves, applications of wave theory to light and optics, the interaction of electrical and magnetic forces, and the special “non-Newtonian” properties of energy and matter described by quantum theory.

## Course Goals

By the end of this course, you will be able to do the following:

- Learn about the behavior and special properties of waves, such as the ability to bend and to reflect the direction of waves as they travel.
- Investigate electromagnetic radiation, including x-rays, visible light, and radio waves.
- Explore electric charges and their interactions with each other.
- Learn about simple electric circuits and be able to determine important values related to that circuit, including current, resistances, power, and energy.
- Find out about the relationship between electricity and magnetism, and explore some of the special mathematical relationships and applications in which magnetic forces and electrical forces and charges interact.
- Explore the “non-Newtonian” world of quantum physics, including the quantum interpretation of light and a modern understanding of matter, especially regarding nuclear forces and interactions.

## Math and Science Skills

Successful completion of Algebra 1 and high school Geometry provide the prerequisite mathematical skills for Physics B.

Successful completion of Physics A (or its equivalent) is required for Physics B. This includes the study of motion, forces, energy, and momentum.

Finally, you should have a good working understanding of inquiry science methods, including:

- Experimental design, including the importance of experimental controls.
- Basic data analysis skills, including the ability to interpret mathematical patterns from data tables and graphs.
- The ability to use experimental results and/or real data sets to propose general rules.

## General Skills

To participate in this course, you should be able to do the following:

- Complete basic operations with word processing software, such as Microsoft Word or Google Docs.
- Perform online research using various search engines and library databases.
- Communicate through email and participate in discussion boards.

*For a complete list of general skills that are required for participation in online courses, refer to the Prerequisites section of the Plato Student Orientation document, found at the beginning of this course.*

## Credit Value

Physics B is a 0.5-credit course.

## Course Materials

- Computer with Internet connection and speakers or headphones
- Microsoft Word or equivalent
- Physics Test and Study Reference found at the end of this syllabus, which provides a table of physics formulas used in the course.
- Notebook

# Course Pacing Guide

This course description and pacing guide is intended to help you keep on schedule with your work. Your course instructor may modify the schedule to meet the specific needs of your class.

## Unit 1: Waves

### Summary

In this unit, you will learn about waves, which include—or can help describe—a wide range of physical phenomena, including earthquake waves, sound waves, and electromagnetic waves. You will learn about the behavior and special properties of waves, such as the ability to bend and to reflect the direction of waves as they travel.

Day	Activity/Objective	Type
1 day: 1	<b>Syllabus and Plato Student Orientation</b> <i>Review the Plato Student Orientation and Course Syllabus at the beginning of this course.</i>	Course Orientation
2 days: 2–3	<b>Introduction to Waves</b> <i>Learner will define a wave, distinguish between mechanical and electromagnetic waves, and describe transverse and longitudinal mechanical waves.</i>	Lesson
2 days: 4–5	<b>Wave Characteristics</b> <i>Learner will describe waves in terms of their fundamental characteristics of velocity, wavelength, frequency (period), and amplitude.</i>	Lesson
2 days: 6–7	<b>Universal Wave Equation</b> <i>Learner will use the universal wave equation to solve problems involving speed, frequency (period), and wavelength.</i>	Lesson
2 days: 8–9	<b>Wave Behaviors</b> <i>Learner will describe reflection and interference of both sound and light waves and the refraction and diffraction of light waves.</i>	Lesson
2 days: 10–11	<b>Resonance and the Doppler Shift</b> <i>Learner will describe and give real-world examples of resonance and the Doppler shift.</i>	Lesson
2 days: 12–13	<b>Transmission of Sound</b> <i>Learner will describe the production and transmission of sound</i>	Lesson

	waves.	
2 days: 14–15	<b>Detecting and Perceiving Sound</b> <i>Learner will describe the detection of sound.</i>	Lesson
3 days: 16–18	<b>Unit Activity and Discussion—Unit 1</b>	Unit Activity Discussion
1 day: 19	<b>Posttest—Unit 1</b>	Assessment

## Unit 2: Optics

### Summary

In this unit, you will investigate electromagnetic radiation, including x-rays, visible light, and radio waves. You will also investigate special properties and mathematical relationships that enable us to manipulate these waves in telescopes, microscopes, and a variety of electronic devices.

Day	Activity/Objective	Type
2 days: 20–21	<b>The Electromagnetic Spectrum</b> <i>Learner will describe the electromagnetic spectrum.</i>	Lesson
2 days: 22–23	<b>Reflection and Refraction of Light</b> <i>Learner will describe reflection and refraction, relating them to light.</i>	Lesson
2 days: 24–25	<b>Snell’s Law</b> <i>Learner will use Snell’s law to relate the directions of the incident and the refracted ray, and the indices of refraction of the media.</i>	Lesson
2 days: 26–27	<b>Lenses</b> <i>Learner will interpret ray diagrams for concave and convex lenses.</i>	Lesson
2 days: 28–29	<b>Mirrors</b> <i>Learner will interpret ray diagrams for flat, concave, and convex mirrors.</i>	Lesson
2 days: 30–31	<b>Polarization of Light</b> <i>Learner will explain propagation of electromagnetic waves in two dimensions.</i>	Lesson
3 days:	<b>Unit Activity and Discussion—Unit 2</b>	Unit Activity

32–34		Discussion
1 day: 35	<b>Posttest—Unit 2</b>	Assessment

## Unit 3: Electrostatics

### Summary

In this unit, you will explore electric charges and their interactions with each other. You will also learn about electric fields and use that concept to make predictions about the total force and potential energy acting on a charge in that field.

Day	Activity/Objective	Type
2 days: 36–37	<b>Introduction to Electrostatics</b> <i>Learner will describe the types of charges, attraction and repulsion of charges, polarization, and induced charges.</i>	Lesson
2 days: 38–39	<b>Coulomb’s Law</b> <i>Learner will apply Coulomb’s law to analyze electric forces.</i>	Lesson
2 days: 40–41	<b>Electric Fields</b> <i>Learner will illustrate the electric field lines for one point charge, two point charges, and parallel plates.</i>	Lesson
2 days: 42–43	<b>Electric Field Calculations</b> <i>Learner will calculate the electric field of a single point charge and two point charges.</i>	Lesson
2 days: 44–45	<b>Electric Potential and Energy</b> <i>Learner will calculate electric potential, electric potential energy, and change in electric potential energy.</i>	Lesson
2 days: 46–47	<b>Unit Activity and Discussion—Unit 3</b>	Unit Activity Discussion
1 day: 48	<b>Posttest—Unit 3</b>	Assessment

## Unit 4: Circuitry

### Summary

In this unit, you will learn about simple electric circuits and be able to determine important values related to that circuit, including current, resistances, power, and energy.

Day	Activity/Objective	Type
2 days: 49–50	<b>Electric Current</b> <i>Learner will define conventional electric current and relate it to the direction of electron flow in a conductor and the potential difference across the circuit.</i>	Lesson
2 days: 51–52	<b>AC and DC Currents</b> <i>Learner will describe and compare alternating current (AC) and direct current (DC).</i>	Lesson
2 days: 53–54	<b>Resistance and Ohm's Law</b> <i>Learner will describe resistance and relate current and voltage for a resistor using Ohm's law.</i>	Lesson
2 days: 55–56	<b>Circuit Diagrams</b> <i>Learner will analyze circuit diagrams and describe how to measure voltage and current in a circuit.</i>	Lesson
2 days: 57–58	<b>Series and Parallel Circuits</b> <i>Learner will describe and analyze both series and parallel connections.</i>	Lesson
2 days: 59–60	<b>Electric Power and Energy</b> <i>Learner will describe the relationships among electric power, voltage, current, and resistance.</i>	Lesson
3 days: 61–63	<b>Unit Activity and Discussion—Unit 4</b>	Unit Activity Discussion
1 day: 64	<b>Posttest—Unit 4</b>	Assessment

## Unit 5: Magnetism

### Summary

In this unit, you will find out about the relationship between electricity and magnetism, and explore some of the special mathematical relationships and applications in which magnetic forces and electrical forces and charges interact.

Day	Activity/Objective	Type
2 days: 65–66	<b>Magnets and Their Fields</b> <i>Learner will understand the basic properties of magnets, including their interactions, field lines, and relationship to electricity.</i>	Lesson
2 days: 67–68	<b>Magnetic Forces</b> <i>Learner will apply the right-hand rule to determine the magnetic forces on single charges and current-carrying wires.</i>	Lesson
2 days: 69–70	<b>Magnetic Induction</b> <i>Learner will describe magnetic induction and relate it to a change in flux.</i>	Lesson
2 days: 71–72	<b>Ampère's Law and Faraday's Law</b> <i>Learner will define Ampère's law and Faraday's law and understand how they apply to electrical motors and generators.</i>	Lesson
2 days: 73–74	<b>Unit Activity and Discussion—Unit 5</b>	Unit Activity Discussion
1 day: 75	<b>Posttest—Unit 5</b>	Assessment

## Unit 6: Quantum and Nuclear Physics

### Summary

In this unit, you will explore the “non-Newtonian” world of quantum physics, including the quantum interpretation of light and a modern understanding of matter, especially regarding nuclear forces and interactions.

Day	Activity/Objective	Type
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2 days: 76–77	<b>The Quantum Model of Light</b> <i>Learner will describe the dual nature of light in relation to the photoelectric effect.</i>	Lesson
2 days: 78–79	<b>Nuclear Forces</b> <i>Learner will describe strong nuclear force and calculate mass-energy equivalence, comparing it to the binding energy of the nucleus.</i>	Lesson
2 days: 80–81	<b>The Quantum Model of the Atom</b> <i>Learner will describe the quantum model of the atom with its subatomic particles.</i>	Lesson
2 days: 82–83	<b>Radioactive Decay</b> <i>Learner will identify naturally occurring radioactive isotopes and the ways that they decay.</i>	Lesson
2 days: 84–85	<b>Nuclear Fission and Fusion</b> <i>Learner will describe nuclear fission and fusion.</i>	Lesson
3 days: 86–88	<b>Unit Activity and Discussion—Unit 6</b>	Unit Activity Discussion
1 day: 89	<b>Posttest—Unit 6</b>	Assessment
1 day: 90	<b>End of Semester Test</b>	Assessment



# Physics Test and Study Reference

## Newtonian Mechanics

(Note: All vectors are expressed in terms of x-components only.)

### Kinematics

$$v_x = \frac{\Delta x}{\Delta t} \quad \text{and} \quad a_x = \frac{\Delta v_x}{\Delta t}$$

$$x = x_0 + v_{x0}t + \frac{1}{2}a_x t^2$$

$$v_x = v_{x0} + a_x t$$

$$v_x^2 = v_{x0}^2 + 2a_x x$$

### Dynamics and Periodic Motion

$$\sum F = ma \quad \text{or} \quad F_x = ma_x$$

$$F_f = \mu_s F_N \quad \text{and} \quad F_f = \mu_k F_N$$

$$F_g = mg \quad \text{or} \quad F_g = G \frac{m_1 m_2}{r^2}$$

$$F_c = \frac{mv^2}{r}$$

$$F = -kx \quad T = 2\pi \sqrt{\frac{m}{k}}$$

$$T = 2\pi \sqrt{\frac{L}{g}}$$

### Energy and Momentum

$$W = Fd \cdot \cos\theta$$

$$KE = \frac{1}{2}mv^2$$

$$PE = mgh$$

$$P = \frac{W}{\Delta t} = \frac{Fd}{t}$$

$$e = \frac{W_o}{W_i}$$

$$MA = \frac{F_r}{F_e} \quad \text{and} \quad IMA = \frac{d_e}{d_r}$$

$$p_x = mv_x$$

$$\text{impulse} = F_x \Delta t = \Delta p_x = p_f - p_i$$

## Mathematical Formulas

### Interpolation

$$y - y_0 = \left[ \frac{(y_1 - y_0)}{(x_1 - x_0)} \right] \times (x - x_0)$$

### Trigonometry

$$\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}} = \frac{a}{c}$$

$$\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}} = \frac{b}{c}$$

$$\tan \theta = \frac{\text{opposite}}{\text{adjacent}} = \frac{a}{b}$$

$$\arctan\left(\frac{a}{b}\right) = \theta$$

## Thermodynamics

$$C^\circ = (F^\circ - 32) \times \left(\frac{5}{9}\right) \quad \text{and}$$

$$K = C^\circ + 273$$

$$Q = mC(T_f - T_i)$$

$$W = P(V_f - V_i)$$

$$\Delta U = Q - W$$

$$W = Q_H - Q_C$$

$$e_c = \frac{T_H - T_C}{T_H}$$

$$\Delta S = \frac{\Delta Q}{T}$$

$$S = k \cdot \ln W$$

## Waves and Optics

$$v = f\lambda$$

$$T = \frac{1}{f}$$

$$n = \frac{c}{v}$$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$\sin \theta_c = \frac{n_2}{n_1}$$

$$v = 331 + (0.6 \cdot T)$$

## Quantum and Nuclear Physics

$$E = hf$$

$$E = mc^2$$

## Electricity and Magnetism

### Static Electricity

$$F = k \frac{q_1 q_2}{r^2}$$

$$E = \frac{F}{q}$$

$$E = k \frac{Q}{r^2}$$

$$\Delta V = \frac{W}{q}$$

### Circuits

$$V = IR$$

$$R = \frac{\rho L}{A}$$

$$P = VI$$

$$P = I^2 R$$

$$P = \frac{V^2}{R}$$

### Magnetism

$$F = qvB$$

$$F = qvB \sin \theta$$