

## Introduction: Mathematics

### Unit: Mathematics

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The purpose of this chapter is to familiarize you with mathematical concepts and skills that will be needed in physics.

- *Standard Assumptions in Physics* discusses what you can and cannot assume to be true in order to be able to solve the problems you will encounter in this class.
- *The International System of Units* and *Scientific Notation* briefly review skills that you are expected to remember from your middle school math and science classes.
- *Solving Problems Symbolically* discusses rearranging equations to solve for a particular variable before (or without) substituting values.
- *Solving Word Problems Systematically* discusses how to solve word problems, including determining which quantity and which variable apply to a number given in a problem based on the units, choosing an equation that applies to a problem, and substituting numbers from the problem into the equation.
- *Right-Angle Trigonometry* is a review of sine, cosine and tangent (SOH CAH TOA), and an explanation of how these functions are used in physics.
- *Vectors*, *Vectors vs. Scalars in Physics*, and *Vector Multiplication* discuss the use and manipulation of vectors (quantities that have a direction) to represent quantities in physics.

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- *Degrees, Radians & Revolutions* and *Polar, Cylindrical & Spherical Coordinates* explain how to work with angles and coordinate systems that are needed for the rotational problems encountered in AP<sup>®</sup> Physics.

Depending on your math background, some of the topics, such as trigonometry and vectors, may be unfamiliar. These topics may be taught, reviewed or skipped, depending on the needs of the students in the class.

### Standards addressed in this chapter:

#### NGSS Standards/MA Curriculum Frameworks (2016):

This chapter addresses the following MA science and engineering practices:

**Practice 4:** Analyzing and Interpreting Data

**Practice 5:** Using Mathematics and Computational Thinking

**Practice 8:** Obtaining, Evaluating, and Communicating Information

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#### AP<sup>®</sup> Physics 1 Essential Knowledge (2024):

**2.A:** Derive a symbolic expression from known quantities by selecting and following a logical mathematical pathway.

**2.B:** Calculate or estimate an unknown quantity with units from known quantities, by selecting and following a logical computational pathway.

**2.C:** Compare physical quantities between two or more scenarios or at different times and locations in a single scenario.

**2.D:** Predict new values or factors of change of physical quantities using functional dependence between variables.

#### AP<sup>®</sup> Physics 1 Learning Objectives & Essential Knowledge (2024):

**1.1.A:** Describe a scalar or vector quantity using magnitude and direction, as appropriate.

**1.1.A.1:** Scalars are quantities described by magnitude only; vectors are quantities described by both magnitude and direction.

**1.1.A.2:** Vectors can be visually modeled as arrows with appropriate direction and lengths proportional to their magnitude.

**1.1.A.3:** Distance and speed are examples of scalar quantities, while position, displacement, velocity, and acceleration are examples of vector quantities.

**1.1.A.3.i:** Vectors are notated with an arrow above the symbol for that quantity.

**1.1.A.3.ii:** Vector notation is not required for vector components along an axis. In one dimension, the sign of the component completely describes the direction of that component.

**1.1.B.1:** When determining a vector sum in a given one-dimensional coordinate system, opposite directions are denoted by opposite signs.

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**1.5.A:** Describe the perpendicular components of a vector.**1.5.A.1:** Vectors can be mathematically modeled as the resultant of two perpendicular components.**1.5.A.2:** Vectors can be resolved into components using a chosen coordinate system.**1.5.A.3:** Vectors can be resolved into perpendicular components using trigonometric functions and relationships.**Skills learned & applied in this chapter:**

- Identifying quantities in word problems and assigning them to variables
- Choosing a formula based on the quantities represented in a problem
- Using trigonometry to calculate the lengths of sides and angles of triangles
- Representing quantities as vectors
- Adding and subtracting vectors
- Multiplying vectors using the dot product and cross product

**Prerequisite Skills:**

These are the mathematical understandings that are necessary for Physics 1 that are taught in the MA Curriculum Frameworks for Mathematics.

- Construct and use tables and graphs to interpret data sets.
- Solve algebraic expressions.
- Perform basic statistical procedures to analyze the center and spread of data.
- Measure with accuracy and precision (*e.g.*, length, volume, mass, temperature, time)
- Convert within a unit (*e.g.*, centimeters to meters).
- Use common prefixes such as milli-, centi-, and kilo-.
- Use scientific notation, where appropriate.
- Use ratio and proportion to solve problems.

***Fluency in all of these understandings is a prerequisite for this course.*** Students who lack this fluency may have difficulty passing the course.

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