

**KEY CONCEPTS:** simple harmonic motion, period, amplitude, pendulum length, oscillation

## **RELATED NEXT GENERATION SCIENCE STANDARDS (NGSS)**

### **MIDDLE SCHOOL:**

1. **MS-PS2-2:** Students who demonstrate understanding can plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
2. **MS-PS2-5:** Students who demonstrate understanding can conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
3. **MS-PS3-1:** Students who demonstrate understanding can construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
4. **MS-PS3-2:** Students who demonstrate understanding can develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
5. **MS-ETS1-4:** Students who demonstrate understanding can develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

### **HIGH SCHOOL:**

1. **HS-PS2-1:** Students who demonstrate understanding can analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

## **COMMON CORE STATE STANDARDS (CCSS)**

### **MATHEMATICS**

1. **CCSS.MATH.CONTENT.8.F.A.3** (Middle School – Functions)  
"Interpret the equation  $y=mx+b$  as a linear function, and identify the slope and y-intercept."
2. **CCSS.MATH.CONTENT.HSF-BF.B.3** (High School – Building Functions)  
"Identify and represent relationships between two variables."
3. **CCSS.MATH.CONTENT.HSS-ID.A.1** (High School – Interpreting Data)  
"Represent data with plots on the real number line (dot plots, histograms, and box plots)."

*(continued)*

## PHYSICS STANDARDS

### 1. Physics – Kinematics

- **Describing Motion:** The pendulum lab helps students understand how objects move under constant forces (gravity in this case).
- **Periodicity and Harmonic Motion:** Students can explore simple harmonic motion, learning that the period of a pendulum (for small angles) is independent of mass but dependent on the length of the string.

### 2. Physics – Forces and Motion

- **Newton's Second Law:** The motion of the pendulum can be analyzed using Newton's second law, where the force due to gravity causes the pendulum's acceleration, and this force is balanced by the tension in the string.
- **Energy Conservation:** The pendulum lab is a good example of the conservation of mechanical energy, where potential energy is converted to kinetic energy and vice versa as the pendulum swings.

## RELATED AP PHYSICS 1 LEARNING OBJECTIVES

### 7.1 Defining Simple Harmonic Motion (SHM)

- **7.1.A** Describe simple harmonic motion.
- **7.2.A** Describe the frequency and period of an object exhibiting SHM.

## AP PHYSICS SCIENCE PRACTICES

Students will use practices 1 (Creating Representations), 2 (Mathematical Routines), and 3 (Scientific Questioning and Argumentation) in their entirety in this activity.