Unit 5 Oscillations

Content Area: **Science**
Course(s): **AP Physics 1**
Time Period: **February**
Length: **6 weeks**
Status: **Published**

Enduring Understandings

- Classically, the acceleration of an object interacting with other objects can be predicted by using a = SUM F/m.
- A periodic wave is one that repeats as a function of both time and position and can be described by its amplitude, frequency, wavelength, speed, and energy.

Essential Questions

- How is simple harmonic motion connected to uniform circular motion?
- What properties determine the motion of an object in simple harmonic motion?
- What are the relationships between velocity, wavelength, and frequency of an object in SHM?
- How can oscillatory motion be represented graphically and mathematically?
- How is conservation of energy applied in simple harmonic oscillators?

Content

Vocabulary

- Linear restoring forces
- Simple harmonic motion
- Simple harmonic motion graphs
- Simple pendulum
- Mass-spring systems
- oscillation
- period
- displacement
- work
- amplitude
- cycle
- driving
- restoring force
- phase
- equilibrium
- frequency
- damping

Skills

- Learning Objective (2.B.1.1): The student is able to apply **F** =m**g** to calculate the gravitational force on an object with mass m in a gravitational field of strength g in the context of the effects of a net force on objects and systems.
- Learning Objective (3.A.2.1): The student is able to represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation.
- Learning Objective (3.B.3.1): The student is able to predict which properties determine the motion of a simple harmonic oscillator and what the dependence of the motion is on those properties.
- Learning Objective (3.B.3.2): The student is able to design a plan and collect data in order to ascertain the characteristics of the motion of a system undergoing oscillatory motion caused by a restoring force.
- Learning Objective (3.B.3.3): The student can analyze data to identify qualitative or quantitative relationships between given values and variables (i.e., force, displacement, acceleration, velocity, period of motion, frequency, spring constant, string length, mass) associated with objects in oscillatory motion to use that data to determine the value of an unknown.
- Learning Objective (3.B.3.4): The student is able to construct a qualitative and/or a quantitative explanation of oscillatory behavior given evidence of a restoring force.
- Learning Objective (3.C.4.1): The student is able to make claims about various contact forces between objects based on the microscopic cause of those forces.
- Learning Objective (3.C.4.2): The student is able to explain contact forces (tension, friction, normal, buoyant, spring) as arising from interatomic electric forces and that they therefore have certain directions.
- Learning Objective (5.B.2.1): The student is able to calculate the expected behavior of a system using the object model (i.e., by ignoring changes in internal structure) to analyze a situation. Then, when the model fails, the student can justify the use of conservation of energy principles to calculate the change in internal energy due to changes in internal structure because the object is actually a system.

Resources

Standards

AP: Physics 1 (2014 -15)
AP: AP
Big Idea 3: The interactions of an object with other objects can be described by forces
Enduring Understanding 3.A: All forces share certain common characteristics when considered by observers in inertial reference frames.
Learning Objective (3.A.2.1): The student is able to represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation. [See Science Practice 1.1]

Enduring Understanding 3.B: Classically, the acceleration of an object interacting with other objects can be predicted by using $a = \Sigma F/m$
Learning Objective (3.B.1.1): The student is able to predict the motion of an object subject to forces exerted by several objects using an application of Newton's second law in a variety of physical situations with acceleration in one dimension. [See Science Practices 6.4 and 7.2]

Learning Objective (3.B.3.2): The student is able to design a plan and collect data in order to ascertain the characteristics of the motion of a system undergoing oscillatory motion caused by a restoring force. [See Science Practice 4.2]

Learning Objective (3.B.3.3): The student can analyze data to identify qualitative or quantitative relationships between given values and variables (i.e., force, displacement, acceleration, velocity, period of motion, frequency, spring constant, string length, mass) associated with objects in oscillatory motion to use that data to determine the value of an unknown. [See Science Practices 2.2 and 5.1]

Learning Objective (3.B.3.4): The student is able to construct a qualitative and/or a quantitative explanation of oscillatory behavior given evidence of a restoring force. [See Science Practices 2.2 and 6.2]

Enduring Understanding 3.C: At the macroscopic level, forces can be categorized as either long-range (action-at-a-distance) forces or contact forces.
Learning Objective (3.C.4.1): The student is able to make claims about various contact forces between objects based on the microscopic cause of those forces . [See Science Practice 6.1]

Learning Objective (3.C.4.2): The student is able to explain contact forces (tension, friction, normal, buoyant, spring) as arising from interatomic electric forces and that they therefore have certain directions. [See Science Practice 6.2]

Big Idea 5: Changes that occur as a result of interactions are constrained by conservation laws
Enduring Understanding 5.B: The energy of a system is conserved.
Learning Objective (5.B.2.1): The student is able to calculate the expected behavior of a system using the object model (i.e., by ignoring changes in internal structure) to analyze a situation. Then, when the model fails, the student can justify the use of conservation of energy principles to calculate the change in internal energy due to changes in internal structure because the object is actually a system. [See Science Practices 1.4 and 2.1]