07 Oscillations

Content Area: **Science**
Course(s): **AP Physics 1**
Time Period: **Semester 2**
Length: **7 Periods**
Status: **Published**

Standards

	Patterns
	Cause and Effect
PS3.B	Conservation of Energy and Energy Transfer
PS3.A	Definitions of Energy
HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
	Stability and Change
HS-PS4-5	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.
PS3.D	Energy in Chemical Processes
PS4.A	Wave Properties
PS4.B	Electromagnetic Radiation
	Scale, Proportion, and Quantity
	Using Mathematics and Computational Thinking
	Analyzing and Interpreting Data

Enduring Understandings

Classically, the acceleration of an object interacting with other objects can be predicted by using $a=\sum F/m$

The energy of a system is conserved.

Essential Questions

1. How can oscillations be used to make our lives easier and more comfortable?
2. How can an astronaut be “weighed” in space?
3. How could you measure the length of a long string with a stopwatch?
4. What do a child on a swing, a beating heart, and a metronome have in common?

Knowledge and Skills

7.1 Defining Simple Harmonic Motion (SHM)

Knowledge

- Simple harmonic motion is a special case of periodic motion.
- SHM results when the magnitude of the restoring force exerted on an object is proportional to that object's displacement from its equilibrium position.
    - A restoring force is a force that is exerted in a direction opposite to the object's displacement from an equilibrium position.
    - An equilibrium position is a location at which the net force exerted on an object or system is zero.
    - The motion of a pendulum with a small angular displacement can be modeled as simple harmonic motion because the restoring torque is proportional to the angular displacement.

Skills

- Create qualitative sketches of graphs that represent features of a model or the behavior of a physical system.
- Calculate or estimate an unknown quantity with units from known quantities, by selecting and following a logical computational pathway.
- Apply an appropriate law, definition, theoretical relationship, or model to make a claim.
- Justify or support a claim using evidence from experimental data, physical representations, or physical principles or laws.

7.2 Frequency and Period of SHM

Knowledge

- The period of SHM is related to the frequency f of the object's motion by the following equation: $T = \frac{1}{f}$
    - The period of an object - ideal spring oscillator is given by the equation $T_s = 2\pi\sqrt{\frac{m}{k}}$
    - The period of a simple pendulum displaced by a small angle is given by the equation

$$T_p = 2\pi\sqrt{\frac{l}{g}}$$

Skills

- Create quantitative graphs with appropriate scales and units, including plotting data.
- Derive a symbolic expression from known quantities by selecting and following a logical mathematical pathway.
- Predict new values or factors of change of physical quantities using functional dependence between variables
- Create experimental procedures that are appropriate for a given scientific question.
- Justify or support a claim using evidence from experimental data, physical representations, or physical principles or laws.

7.3 Representing and Analyzing SHM

Knowledge

- For an object exhibiting SHM, the displacement of that object measured from its equilibrium position can be represented by the equations

  $x = A\cos(2\pi ft)$ or $x = A\sin(2\pi ft)$.

  - Minima, maxima, and zeros of displacement, velocity, and acceleration are features of harmonic motion.
  - Recognizing the positions or times at which the displacement, velocity, and acceleration for SHM have extrema or zeros can help in qualitatively describing the behavior of the motion.

- Changing the amplitude of a system exhibiting SHM will not change the period of that system.
- Properties of SHM can be determined and analyzed using graphical representations.

Skills

- Create qualitative sketches of graphs that represent features of a model or the behavior of a physical system.
- Derive a symbolic expression from known quantities by selecting and following a logical mathematical pathway.
- Predict new values or factors of change of physical quantities using functional dependence between variables.
- Justify or support a claim using evidence from experimental data, physical representations, or physical principles or laws.

7.4 Energy of Simple Harmonic Oscillators

Knowledge

- The total energy of a system exhibiting SHM is the sum of the system's kinetic and potential energies.

- Conservation of energy indicates that the total energy of a system exhibiting SHM is constant.
- The kinetic energy of a system exhibiting SHM is at a maximum when the system's potential energy is at a minimum.
- The potential energy of a system exhibiting SHM is at a maximum when the system's kinetic energy is at a minimum.
    - The minimum kinetic energy of a system exhibiting SHM is zero.
    - Changing the amplitude of a system exhibiting SHM will change the maximum potential energy of the system and, therefore, the total energy of the system.

Skills

- Create diagrams, tables, charts, or schematics to represent physical situations.
- Calculate or estimate an unknown quantity with units from known quantities, by selecting and following a logical computational pathway.
- Compare physical quantities between two or more scenarios or at different times and locations in a single scenario.
- Apply an appropriate law, definition, theoretical relationship, or model to make a claim.

Transfer Goals

Patterns: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

Cause and Effect: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

Scale, Proportion, and Quantity: In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

Systems and System Models: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

Energy and Matter: Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

Structure and Function: The way an object is shaped or structured determines many of its properties and functions.

Stability and Change: For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

Assessments

https://docs.google.com/document/d/1wR7bQF-8AQoRrt0g4C3hKja0yjwDjC9_BiAmONWbTcI/edit?usp=sharing

Modifications

https://docs.google.com/document/d/1ODqaPP69YkcFiyG72fIT8XsUIe3K1VSG7nxuc4CpCec/edit?usp=sharing