07 Oscillations

Content Area: **Science**
Course(s):
Time Period: **Semester 2**
Length: **5 weeks**
Status: **Published**

Standards

SCI.HS.PS3.A	Definitions of Energy
SCI.HS.PS3.B	Conservation of Energy and Energy Transfer
SCI.HS.PS3.D	Energy in Chemical Processes
SCI.HS.PS4.A	Wave Properties
SCI.HS.PS4.B	Electromagnetic Radiation
SCI.HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
SCI.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.
	Analyzing and Interpreting Data
	Patterns
	Using Mathematics and Computational Thinking
	Scale, Proportion, and Quantity
	Stability and Change
	Cause and Effect

Enduring Understandings

Period of Simple Harmonic Oscillators

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

Energy of a Simple Harmonic Oscillator

The energy of a system is conserved.

Essential Questions

1. How does a restoring force differ from a “regular” force?

2. How does the presence of restoring forces predict and lead to harmonic motion?
3. How does a spring cause an object to oscillate?
4. How can oscillations be used to make our lives easier?
5. How does the law of conservation of energy govern the interactions between objects and systems?
6. How can energy stored in a spring be used to create motion?

Knowledge and Skills

Knowledge:

1. When a linear restoring force is exerted on an object displaced from an equilibrium position, the object will undergo a special type of motion called simple harmonic motion. Examples include gravitational force exerted by Earth on a simple pendulum and mass-spring oscillator.

    a. For a spring that exerts a linear restoring force, the period of a mass-spring oscillator increases with mass and decreases with spring stiffness.

    b. For a simple pendulum, the period increases with the length of the pendulum and decreases with the magnitude of the gravitational field.

    c. Minima, maxima, and zeros of position, velocity, and acceleration are features of harmonic motion. Students should be able to calculate force and acceleration for any given displacement for an object oscillating on a spring.

2. A system with internal structure can have internal energy, and changes in a system's internal structure can result in changes in internal energy

3. A system with internal structure can have potential energy. Potential energy exists within a system if the objects within that system interact with conservative forces.

    a. The work done by a conservative force is independent of the path taken. The work description is used for forces external to the system. Potential energy is used when the forces are internal interactions between parts of the system.

    b. Changes in the internal structure can result in changes in potential energy. Examples include mass-spring oscillators and objects falling in a gravitational field.

    c. The change in electric potential in a circuit is the change in potential energy per unit charge

4. The internal energy of a system includes the kinetic energy of the objects that make up the system and the potential energy of the configuration of the objects that make up the system.

    a. Since energy is constant in a closed system, changes in a system's potential energy can result in changes to the system's kinetic energy.

    b. The changes in potential and kinetic energies in a system may be further constrained by the construction of the system.

Skills :

1. Predict which properties determine the motion of a simple harmonic oscillator and what the dependence of the motion is on those properties.
2. 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.
3. Analyze data to identify qualitative and 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 and use those data to determine the value of an unknown
4. Construct a qualitative and/ or quantitative explanation of oscillatory behavior given evidence of a restoring force.
5. 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.
6. Describe and make qualitative and/or quantitative predictions about everyday examples of systems with internal potential energy.
7. Make quantitative calculations of the internal potential energy of a system from a description or diagram of that system
8. Apply mathematical reasoning to create a description of the internal potential energy of a system from a description or diagram of the objects and interactions in that system.
9. Describe and make predictions about the internal energy of systems.
10. Calculate changes in kinetic energy and potential energy of a system using information from representations of that system

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