01 Kinematics

Content Area: **Science**
Course(s): **AP Physics 1**
Time Period: **Semester 1**
Length: **4 weeks**
Status: **Published**

Standards

SCI.HS.PS2.A	Forces and Motion
SCI.HS.PS2.B	Types of Interactions
SCI.HS.ESS1.B	Earth and the Solar System
SCI.HS-ESS1-4	Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
SCI.HS-PS2-1	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.
SCI.HS-PS2-4	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
	Cause and Effect
	Scale, Proportion, and Quantity
	Analyzing and Interpreting Data
	Using Mathematics and Computational Thinking
	Patterns

Enduring Understandings

Position, Velocity, and Acceleration

1. All forces share certain common characteristics when considered by observers in inertial reference frames.

Representations of Motion

2. The acceleration of the center of mass of a system is related to the net force exerted on the system, where a = F/m

Essential Questions

1. How can the motion of objects be predicted and/or explained?

2. Can equations be used to answer questions regardless of the questions' specificity?

3. How can the idea of frames of reference allow two people to tell the truth yet have conflicting reports?

4. How can we use models to help us understand motion?

5. Why is the general rule for stopping your car “when you double your speed, you must give yourself four times as much distance to stop?”

Knowledge and Skills

Knowledge:

1. An observer in a reference frame can describe the motion of an object using such quantities as position, displacement, distance, velocity, speed, and acceleration.

a. Displacement, velocity, and acceleration are all vector quantities.

b. Displacement is change in position. Velocity is the rate of change of position with time. Acceleration is the rate of change of velocity with time. Changes in each property are expressed by subtracting initial values from final values.

c. A choice of reference frame determines the direction and the magnitude of each of these quantities.

d. There are three fundamental interactions or forces in nature: the gravitational force, the electroweak force, and the strong force. The fundamental forces determine both the structure of objects and the motion of objects

e. In inertial reference frames, forces are detected by their influence on the motion (specifically the velocity) of an object. So force, like velocity, is a vector quantity. A force vector has magnitude and direction. When multiple forces are exerted on an object, the vector sum of these forces, referred to as the net force, causes a change in the motion of the object. The acceleration of the object is proportional to the net force.

f. The kinematic equations only apply to constant acceleration situations. Circular motion and projectile motion are both included. Circular motion is further covered in Unit 3.

g. For rotational motion, there are analogous quantities such as angular position, angular velocity, and angular acceleration.

h. This also includes situations where there is both a radial and tangential acceleration for an object moving in a circular path. For uniform circular motion of radius r, v is proportional to omega, ω (for a given r), and proportional to r (for a given omega, ω).

2. The linear motion of a system can be described by the displacement, velocity, and acceleration of its center of mass.

a. The variables x, v, and a all refer to the center-of-mass quantities.

3. The acceleration is equal to the rate of change of velocity with time, and velocity is equal to the rate of

change of position with time

a. The acceleration of the center of mass of a system is directly proportional to the net force exerted on it by all objects interacting with the system and inversely proportional to the mass of the system

b. Force and acceleration are both vectors, with acceleration in the same direction as the net force.

c. The acceleration of the center of mass of a system is equal to the rate of change of the center of mass velocity with time, and the center of mass velocity is equal to the rate of change of position of the center of mass with time.

d. The variables x, v, and a all refer to the center-of-mass quantities

Skills :

1. Express the motion of an object using narrative, mathematical, and graphical representations.

2. Design an experimental investigation of the motion of an object.

3. Analyze experimental data describing the motion of an object and be able to express the results of the analysis using narrative, mathematical, and graphical representations.

4. Use representations of the center of mass of an isolated two-object system to analyze the motion of the system qualitatively and semi-quantitatively.

5. Make predictions about the motion of a system based on the fact that acceleration is equal to the change in velocity per unit time, and velocity is equal to the change in position per unit time.

6. Create mathematical models and analyze graphical relationships for acceleration, velocity, and position of the center of mass of a system and use them to calculate properties of the motion of the center of mass of a 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