01 Motion and Forces

Content Area: **Science**
Course(s): **Physics A**
Time Period: **Semester 1**
Length: **10 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

1. Newton's second law accurately predicts changes in the motion of macroscopic objects.

2. Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the orientation of the planet's axis of rotation, both occurring over tens to hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on Earth. These phenomena cause cycles of ice ages and other gradual climate changes.

3. Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects.

4. Forces at a distance are explained by fields permeating space that can transfer energy through space. Magnets or changing electric fields cause magnetic fields; electric charges or changing magnetic fields cause electric fields. Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. The strong and weak nuclear interactions are important inside atomic nuclei—for example, they determine the patterns of which nuclear isotopes are stable and what kind of decays occur for unstable ones.

5. Systems often change in predictable ways; understanding the forces that drive the transformations and cycles within a system, as well as the forces imposed on the system from the outside, helps predict its

behavior under a variety of conditions. When a system has a great number of component pieces, one may not be able to predict much about its precise future. For such systems (e.g., with very many colliding molecules), one can often predict average but not detailed properties and behaviors (e.g., average temperature, motion, and rates of chemical change but not the trajectories or other changes of particular molecules). Systems may evolve in unpredictable ways when the outcome depends sensitively on the starting condition and the starting condition cannot be specified precisely enough to distinguish between different possible outcomes.

Essential Questions

1. How can one predict an object's continued motion, changes in motion, or stability?
2. How can one explain and predict interactions between objects and within systems of objects?
3. What underlying forces explain the variety of interactions observed?
4. What are the predictable patterns caused by Earth's movement in the solar system?
5. How are force and motion related?
6. Why does the Earth orbit the Sun?
7. What is a safe following distance between your car and the car in front of you?
8. How can an object be moving and not moving at the same time?

Knowledge and Skills

Knowledge:

1. Motion can be described mathematically, pictorially, graphically, and in words.
2. Different observers may view the same motion differently.
3. Objects fall toward Earth with a constant acceleration in the absence of air resistance.
4. Net force causes acceleration.
5. Newton's second law accurately predicts changes in the motion of macroscopic objects. (DCI PS2.A Forces and Motion).
6. Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (DCI ESS1.B Earth and the Solar System)

7. A force is an interaction between two objects.
8. Net force is the vector sum of the forces exerted on an object in the x-direction or in the y-direction.
9. The net force vector and the acceleration vector are ALWAYS in the same direction.
10. Forces can either act through the physical contact of 2 objects (contact force) or at a distance (field force).
11. The tendency of an object not to accelerate is called inertia. Mass is the physical quantity used to measure inertia.
12. An object is in a state of equilibrium when the net force acting on the object is zero.
13. An object in equilibrium has zero acceleration.
14. Zero acceleration can either mean: 1) the object is at rest ($v=0m/s$ and $a=0m/s/s$) OR 2) the object is moving at a constant velocity ($v\neq0m/s$ and $a=0m/s/s$)
15. An inertial reference frame is a reference frame in which the observer can observe Newton's 1st Law in action.
16. Observers in a non-inertial reference frame cannot explain why an object is accelerating using Newton's 1st Law.
17. Acceleration is directly proportional to the net force.
18. Acceleration is inversely proportional to the mass of the object.
19. Forces always exist in pairs, when object A exerts a force on object B, object B exerts a force on object A that is equal in magnitude but in the opposite direction.
20. The weight of an object is the magnitude of the gravitational force on the object and is equal to the object's mass times the acceleration due to gravity.
21. A normal force is a force that one surface exerts on another that is perpendicular to where the two surfaces meet.
22. Friction is a resistive force that acts in a direction opposite to the direction of motion.
23. The force of friction is parallel to where the 2 surfaces meet.

Skills :

1. Develop and use models to describe motion.
2. Analyze and construct mathematical and graphical representations of motion.
3. Analyze data to support the claim that Newton's second law of motions describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

5. Design a plan for collecting data to answer a particular scientific question.

Modifications

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

Assessments

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