

PHYSICS

Introduction

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Science Benchmark

The motion of an object can be described by measurements of its position different times. Velocity is a measure of the rate of change of position of an object in a given time. Acceleration is a measure of the rate of change of velocity of an object in a given time. This change in velocity may be a change in speed and/or direction. Motion is defined relative to the frame of reference from which it is observed. An object's state of motion will remain constant unless the object is acted upon by an unbalanced force. This is Newton's first law of motion,

Standard I: Students will understand how to measure, calculate, and describe the motion of an object in terms of position, time, velocity and acceleration.

Objective 1: Describe the motion of an object in terms of position, time, and velocity.

- a. Measure the position at two or more times of a moving object to calculate its average velocity.
- b. Distinguish between speed and velocity.
- c. Determine the average velocity of an object from data showing position at given times.
- d. Collect data and create an appropriate graph of position vs. time.
- e. Interpret a graph of position versus time in order to describe the motion of an object.

Objective 2: Analyze the motion of an object in terms of velocity, time, and acceleration.

- a. Determine the average acceleration of an object from data showing velocity at given times.
- b. Describe the velocity when acceleration is zero.
- c. Create a graph of velocity vs. time from collected data.
- d. Interpret a graph of velocity vs. time for an object in order to describe the motion of the object.
- e. Describe the acceleration of an object moving in a circular path at constant speed (i.e., constant speed, but changing direction).

Objective 3: Relate the motion of objects to the frame of reference.

- a. Compare motion of an object from two frames of reference.
- b. Predict the motion of an object from a different frame of reference (e.g., an object dropped from a moving vehicle observed from the vehicle and from a person standing on the sidewalkcall Tim 430-4551).
- c. Describe how selecting a specific frame of reference can simplify the description of the motion of an object.

Objective 4: Use Newton's first law to explain the motion of an object.

- a. Describe the motion of a moving object on which balanced forces are acting.
- b. Describe the motion of a stationary object on which balanced forces are acting.
- c. Explain, in terms of velocity, what would happen to an object on which forces are unbalanced.
- d. Describe the forces on an automobile moving at constant velocity.

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Objects in the universe interact with one another by way of forces. Changes in the motion of an object are proportional to the sum of the forces, and inversely proportional to the mass. Whenever a force is applied to an object there is an equal and opposite reaction force.

Science has identified four fundamental forces in the universe as gravitational, electromagnetic, nuclear strong and nuclear weak forces. Any two objects in the universe with mass exert equal and opposite gravitational forces on one another. Any two objects in the universe with a net electric charge exert equal and opposite electromagnetic forces on one another. While gravitational forces are always attractive, electromagnetic forces can be either attractive or repulsive. Gravitational and electromagnetic forces work at directly observable levels while nuclear forces exist within the atom and are not easily observed.

Frictions, tension, compression, spring, gravitational and normal forces are all common observable forces. The net force on an object is the vector sum of all the forces acting upon the object. A system is made up of objects and the forces that act upon the objects.

Standard II:

Students will understand the relation between force, mass and acceleration.

Objective 1: Analyze forces applied to an object.

- Identify common forces (e.g., friction, gravity, normal, tension).
- Use diagrams to identify the forces acting on an object
- Measure the forces on an object and represent them in a vector diagram.
- Relate the identified in the laboratory to forces observed in everyday life.
- Calculate the net force on an object.

Objective 2: Using Newton's 2nd law, relate the force, mass and acceleration of an object.

- Determine the relationship between the net force on an object and the object's acceleration.
- Relate the effect of an object's mass to its acceleration when an unbalanced force is applied.
- Determine the mathematical relationship between force, mass, and acceleration from experimental data and compare the results to Newton's 2nd Law.

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- Predict the combined effect of multiple forces (such as friction, gravity, and normal forces) on an object's motion.

Objective 3: Explain that forces act in pairs as described by Newton's 3rd law.

- Identify pairs of forces (e.g., action-reaction, equal and opposite) acting between two objects (e.g., two electric charges, a table and a book that rests on top of it, a person and a rope she pulls on).
- State the magnitude and direction of one force when the reacting force's magnitude and direction is known.
- Provide examples of practical applications of Newton's third law (e.g., forces on a retaining wall, rockets, walking).

Standard III: Students will understand the factors determining the strength of gravitational and electromagnetic forces and theories describing these forces.

Objective 1: Relate the strength of the gravitational force to the distance between two objects and the mass of the objects.

- a. Describe how mass affects the gravitational force.
- b. Calculate the effect of mass on gravitational force.
- c. Describe how distance between objects affects the gravitational force.
- d. Compare and describe the effect of the gravitational forces of the moon and sun on objects on Earth.

Objective 2: Describe the factors that affect the electromagnetic force.

- a. Describe the types of charge and their effect on electromagnetic force.
- b. Relate the distance between charged objects to the strength of the electromagnetic force.
- c. Research and report on electromagnetic forces to everyday applications in nature and technology (e.g., Call Tom Erikson)

Objective 3: Describe how gravitational, electromagnetic, and nuclear forces compare to one another in terms of source, magnitude, and distance over which they may act and describe the development of theories to describe these forces.

- a. Identify situations that would produce a gravitational or electromagnetic force, and identify which of these forces is most pervasive in a given situation.
- b. Describe how the holding together of many similarly charged protons in an atom's nucleus requires the presence of another force besides gravity or electromagnetism.
- c. Describe the nature of science by explaining how evidence and inference are used to describe fundamental forces in nature.
- d. Relate the use of evidence to development of theories and theory in the development.
- e. Relate the development of descriptions of the fundamental forces to the nature of the development of theories in science.

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The total energy of the universe is constant; however, the total amount of energy available for useful transformation is almost always decreasing. Energy can be converted from one form to another and move from one system to another. Transformation of energy usually produces heat that spreads to cooler places by radiation, convection or conduction. The total amount of energy remains constant but is less concentrated to do useful work. Energy can be classified as potential or kinetic energy. Potential energy is stored energy and includes chemical, gravitational, electrostatic, elastic, and nuclear. Kinetic energy is the energy of motion.

Moving electric charges produce magnetic forces and moving magnets produce electric forces. The interplay of electric and magnetic forces is the basis for electric motors, generators, and many other modern technologies, including the production of electromagnetic waves. Modern electric generators produce electricity by converting mechanical energy into electrical energy.

Sound and light transfer energy from one location to another as waves. Characteristics of waves include wavelength, amplitude, and frequency. Waves can combine with one another, bend around corners, reflect off surfaces, and be absorbed by materials they enter, and change direction when entering a new

material. All these effects vary with wavelength. The energy of waves can be changed into other forms of energy.

Observable waves include mechanical and electromagnetic. Mechanical waves transport energy through a medium. Sound waves, waves in a liquid, wave on a string, and waves in a solid are all examples of mechanical waves.

Accelerating electric charges produce electromagnetic waves. Electromagnetic radiation is differentiated by wavelength and includes radio waves, microwaves, radiant heat, visible light, ultraviolet radiation, x rays, and gamma rays. These wavelengths vary from radio waves, the longest, to gamma rays the shortest. In empty space all electromagnetic waves move at the same speed, - the “speed of light”.

Standard IV Students will understand forms of energy and its conservation and transformation.

Objective 1: Compare kinetic and potential energy.

- a. Identify various types of potential energy (i.e., gravitational, elastic, chemical, electrostatic, nuclear).
- b. Compare the kinetic energy of various objects in motion.
- c. Calculate the kinetic energy of an object given the velocity and mass of the object.
- d. Describe the types of energy contributing to the total energy of a given system.
- e. Gather data and calculate the gravitational potential energy and the kinetic energy of an object (e.g., pendulum, water flowing downhill, ball dropped from a height) and relate this to the conservation of energy of a system.

Objective 2: Demonstrate an understanding of energy transformation and transfer.

- a. Describe a closed system in terms of its total energy.
- b. Describe the loss of useful energy in energy transformation.
- c. Relate the transformation of kinetic and potential energy in a system (e.g., moving magnet induces electricity in a coil, roller coaster, internal combustion engine).
- d. Report on the transformation of energy in an electrical generation plant (e.g., chemical to heat to electricity, nuclear to heat to mechanical to electrical, gravitational to kinetic to mechanical to electrical).
- e. Evaluate social, economic and environmental issues related to the production and transmission of electrical energy.
- f. Investigate the transfer of heat energy by conduction, convection and radiation.

Standard V Students will understand the properties and application of wave properties in technology.

Objective 1: Demonstrate an understanding of the properties of waves.

- a. Differentiate between period, frequency, wavelength, and amplitude of waves.
- b. Distinguish between different parts of the electromagnetic spectrum (e.g. radio waves and x-rays or visible light and microwaves).
- c. Relate the relationship of energy to wavelength or frequency for electromagnetic radiation.
- d. Investigate and compare reflection, refraction and diffraction of waves and provide examples of wave commonly observed in nature and/or used in technological applications.
- e. Provide examples of the use of electromagnetic radiation in every day life, (e.g. communications, lasers, microwaves, cellular phones, satellite dishes).

Objective 2: Describe the nature of electromagnetic radiation and visible light.

- a. Identify visible light as a small part of the electromagnetic spectrum
- b. Recognize that electromagnetic radiation travels through a vacuum at the speed of light.
- c. Relate the color of visible light to the wavelength of the light and demonstrate that white light is the combination of light of various colors.
- d. Investigate the properties of visible light (e.g., refraction, reflection, diffraction).
- e. Report on technological applications that use visible light (e.g. DVD players, lasers, lenses, mirrors).

Objective 3: Describe the transfer of energy by sound waves.

- a. Explain why sound, a mechanical wave, requires a medium to transfer energy.
- b. Compare the speed of sound to the speed of light.
- c. Explain the observed change in pitch (frequency) of a sound coming from a moving object as it approaches and then moves away (Doppler shift).
- d. Design and construct devices that use sound to perform a task.