Sixth Grade Earth Physical Science Unit

Force, Motion, Energy

Teacher Background Information

Motion is as much a part of the physical world as matter and energy are. Everything moves—atoms and molecules; the stars, planets, and moons; the earth and its surface and everything on its surface; all living things, and every part of living things. Nothing in the universe is at rest.

The change in motion of an object is proportional to the applied force and inversely proportional to the mass. Whenever one thing exerts a force on another, an equal amount of force is exerted back on it. All motion is relative to the frame of reference chosen-there is no motionless frame from which to judge all motion. Accelerating electric particles produce waves. These electromagnetic waves have varying wavelengths and these affect how they interact with matter. Some pass through the human body with little effect and others are harmful. In empty space all electromagnetic waves travel at the speed of light.
Science Matters, p. 45-47 for information on light
Science for All Americans, p. 52-58 information on motion and forces
Benchmarks for Science Literacy, p. 89-92, Motion
NSES, p. 155, Transfer of Energy

Instructional Implications

The idea of gravity should be generalized to all matter everywhere in the universe. Some demonstration of the gravitational force between objects may be essential to break through the intuitive notion that things just naturally fall. Gravity becomes appreciable only when very large accumulations of matter figure, such as that of a student and the entire earth.
Students need concrete experiences with forces and motion. By using simple objects, such as rolling balls and mechanical toys, students can begin to describe the forces acting on the objects using measurement and simple math. Through experiences in which friction is reduced, students can begin to see that a moving object with no friction would continue to move indefinitely. Understanding the motion of objects and repeating patterns of motion does not demand the use of equations at this stage. Newton's laws of motion are simple to state, and but students need to demonstrate understanding of them rather than reciting them. Students can learn some of the properties of waves by using water tables, ropes, and springs. Wave length should be the property receiving the most attention but only minimal calculation.
At this level, students should be introduced to energy primarily through energy transformations. Students should trace where energy comes from (and goes next) in examples that involve motion of objects, heat, and friction through experiments and demonstrations. To change something's speed, to push things together or tear them apart all require transfers (and some transformations) of energy.

Big Idea

Forces, motion and energy interrelate and can be quantified.

Essential Question

How do forces interact to influence the motion and position of objects?

How do waves move?

AAAS Benchmarks and National Standards

Forces that Shape the Earth
Everything on or anywhere near the earth is pulled toward the earth's center by gravitational force. 4B/M3

Motion: Laws of Motion
*The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph. (NSES)
*An object that is not being subjected to a force will continue to move at a constant speed and in a straight line. (NSES)
An unbalanced force acting on an object changes its speed or direction of motion, or both. 4F/M3a

Motion: Waves
*Vibrations in materials set up wavelike disturbances that spread away from the source. Sound and earthquake waves are examples. These and other waves move at different speeds in different materials. 4F/M4
*Wave behavior can be described in terms of how fast the disturbance spreads, and in terms of the distance between successive peaks of the disturbance (the wavelength). (SFAA, p. 54)
*Light acts like a wave in many ways. And waves can explain how light behaves. 4F/M6
*Something can be "seen" when light waves emitted or reflected by it enter the eye—just as something can be "heard" when sound waves from it enter the ear. 4F/M2

Energy Transformations
*Energy can be transferred from one system to another (or from a system to its environment) in different ways: …2) mechanically, when two objects push or pull on each other over a distance….4E/M2
Energy appears in different forms and can be transformed within a system. Motion energy is associated with the speed of an object. … Gravitational energy is associated with the height of an object above a reference point…4E/M4

Whenever energy appears in one place, it must have disappeared from another. Whenever energy is lost from somewhere, it must have gone somewhere else. Sometimes when energy appears to be lost, it actually has been transferred to a system that is so large that the effect of the transferred energy is imperceptible. 4E/M1* ***RECOMMENDED FOR Extension Concept*

Student Misconceptions and Difficulties

Most students believe that the force is still acting if the object is moving or that it is "used up" if the motion stops. Students also think that friction, not inertia, is the principle reason objects remain at rest or require a force to move. Much research in recent years has documented that students typically have trouble relating formal ideas of motion and force to their personal view of how the world works.
Students in grades 5-8 associate force with motion and have difficulty understanding balanced forces in equilibrium, especially if the force is associated with static, inanimate objects, such as a book resting on the desk.
Some middle-school students do not have a notion of light as something that travels from one place to another and reject the idea that ordinary objects reflect light.

Materials/Resources

KNEX Roller Coasters
Science Explorer: Forces and Motion

Materials World Module: Sports Materials kit
Science Olympiad activities:
http://soinc.org/

UAS physical scientists
www.science-class.net/Physics/force_motion.htm
Amusement park physics:
http://www.learner.org/interactives/parkphysics/

Local Connections

Avalanches
Skiing and snowboarding
Cars, bicycles, skateboards
Waves and tides

ASSESSMENTS

Science Notebooks

Science Probes Volume 1:*#4 Making Sound*

Alaska GLE's

The student demonstrates an understanding of motions, forces, their characteristic's, relationships, and effects by:

[6] SB4.2 stating that every object exerts gravitational force on every other object.

{add-ons} *compare the rate of fall of two objects of different mass.*

[6] SB4.3 making waves move through a variety of media (L)

[7] SB4.1 illustrating that unbalanced forces will cause an object to accelerate.

[7] SB4.3 describing the characteristics of a wave (i.e., amplitude, wavelength, and frequency)

The student demonstrates an understanding of how energy can be transformed, transferred, and conserved by:

[6] SB2.1 **recognizing** that energy can exist in many forms (i.e., *heat*, *light*, ……, *mechanical*).

[7] SB2.1 explaining that energy (i.e., *heat*, *light*, …. *mechanical*) can change form

Connections to other subjects

Energy : transformations and transfers of energy, forms of energy, electromagnetic waves
Astronomy : universal gravity
Forces that Shape the
Earth: destructive force of gravity
Human Body: movement