Grade 8 Science, Quarter 3, Unit 3.1

Energy

Overview

Number of instructional days: 20 (1 day = 45 minutes)

Content to be learned

- Understand the properties of kinetic energy.
- Differentiate between potential and kinetic energy.
- Understand the transfer of potential energy to kinetic energy.
- Understand that energy can be transformed from one form to another.
- Understand that total energy is conserved.
- Understand voltage in terms of potential energy.
- Understand the effect of changing voltage in an electrical circuit.

Processes to be used

- Cite examples of potential and kinetic energy.
- Explain the transfer of potential to kinetic energy.
- Apply the transfer of potential to kinetic energy to real-world situations.
- Construct a model to explain the transformation of energy.
- Explain how energy is conserved.
- Explain how energy is stored, transferred, or transformed.
- Describe the effect of changing voltage in an electrical circuit.

Essential questions

- What is the relationship between potential and kinetic energy?
- How can the transfer of potential energy to kinetic energy be explained using a real-world example?
- What is the effect of changing voltage in an electrical circuit?
- How can the transformation of energy be explained using a real-world example?
- What happens to the total amount of energy when it is stored, transferred, or transformed?

Written Curriculum

Grade Span Expectations

PS 2 - Energy is necessary for change to occur in matter. Energy can be stored, transferred, and transformed, but cannot be destroyed.

PS2 (5-8)-SAE+ POC- 6

Given a real-world example, show that within a system, energy transforms from one form to another (i.e., chemical, heat, electrical, gravitational, light, sound, mechanical).

PS2 (7-8)- 6 Students demonstrate an understanding of energy by…

6a using a real world example to explain the transfer of potential energy to kinetic energy.

6b constructing a model to explain the transformation of energy from one form to another. (e.g. an electrical circuit changing electrical energy to light energy in a light bulb).

6c explaining that while energy may be stored, transferred, or transformed, the total amount of energy is conserved.

6d describing the effect of changing voltage in an electrical circuit.

Clarifying the Standards

Prior Learning

In grades 7 and below students had experiences with investigating and collecting data to classify pitches and/or volumes from different objects. They distinguished sound transferred through solids, liquids, and gases. Students showed evidence of the different variations of heat production. They identified conductors and insulators through the use of various materials and they constructed an electrical circuit. Students explained potential energy and the different ways energy is stored; they also understood the properties of the different forms of energy and how it is stored. Students were introduced to the concept of potential energy.

Current Learning

In grade 8, students are introduced to the concept of kinetic energy. They explain how energy can be transferred from potential energy to kinetic energy. Students construct a model illustrating the transformation of energy from one form to another. In addition they describe the effects of changing voltage in an electrical circuit. Using all of this knowledge, students explain the Law of Conservation of Energy.

Future Learning

In high school, students will further their knowledge of energy by describing and diagramming changes in energy transformation that occur in different systems. Students will also explain the Law of Conservation of Energy as it relates to the efficiency of a system and how efficiency is reduced due to heat loss.

Additional Research Findings

According to *Benchmarks for Science Literacy*, "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 several different forms of energy along the way: heat, light, motion of objects, chemical, and elastically distorted materials. To change something's speed, to bend or stretch things, to heat or cool them, to push things together or tear them apart all require transfers (and some transformations) of energy" (p. 24).

The book also states, "At this early stage, there may be some confusion in students' minds between energy and energy sources. Focusing on energy transformations may get around this somewhat. Food, gasoline, and batteries obviously get used up. But the energy they contain does not disappear; it is changed into other forms of energy" (p. 24).

"The most primitive idea is that the energy needed for an event must come from somewhere. That should trigger children's interest in asking, for any situation, where the energy comes from and (later) asking where it goes. Where it comes from is usually much more evident than where it goes, because some usually diffuses away as radiation and random molecular motion" (p. 24).

The energy-cannot-be-created-or-destroyed way of stating conservation fully may be more intuitive than the abstraction of a constant energy total within an isolated system. The quantitative (equal amounts) idea should probably wait until high school (p. 84).

According to the *Atlas for Science Literacy*, "Students rarely think energy is measurable and quantifiable. Students' alternative conceptualizations of energy influence their interpretations of textbook representations (and definitions) of energy. While students may have difficulty conceptualizing what energy is, they should be able to recognize different forms, especially those with perceivable effects. Middle- and high-school students tend to think that energy transformations involve only one form of energy at a time. The transformation of motion to heat seems to be difficult for students to accept, especially in cases with no temperature increase. Finally, it may not be clear to students that some forms of energy, such as light, sound, and chemical energy, can be used to make things happen. The idea of energy conservation seems counterintuitive to middle- and high-school students who hold on to the everyday use of the term energy. Teach heat dissipation ideas at the same time as energy conservation. It would be beneficial in teaching conservation of energy to use an appropriate model (such as a flashlight) In addition, middle- and high-school students tend to use their conceptualizations of energy to interpret energy conservation ideas. Some students interpret the idea that "energy is not created or destroyed" to mean that energy is stored up in the system and can even be released again in its original form or they may believe that no energy remains at the end of a process, but may say that "energy is not lost" because an effect was caused during the process (for example, a weight was lifted)" (p. 24).

The book also states, "Students of all ages have difficulty reasoning that all parts of a circuit are interrelated and influence each other. Many students believe that in circuit energy is being 'used up' as opposed to dissipated" (p. 26).

Notes About Resources and Materials

Suggested materials

Prentice Hall textbook: Motion, Forces and Energy

- 6a Potential and Kinetic Energy (pp. 140–145)
- 6b Energy Conversion and Conservation (pp. 148–153)
- 6c Energy Conversions and Fossil Fuels (pp. 154–157)
- Lab (p. 146) Soaring Straws (gravitational potential energy depends on elastic potential energy)

Suggested websites

- Middle School Portal—Discover resources
  <http://msteacher.org/return_list_science.aspx?id=1536>
- Flying Turtle Exploring
  <http://www.ftexploring.com/energy/energy-1.htm>
- MiddleSchoolScience.com
  <www.middleschoolscience.com>
- National Teacher Enhancement Project
  <http://ed.fnal.gov/ntep/f98/projects/nrel_energy_2/energy.html>
- Campbell, C. Jefferson County Schools science units: Energy
  <http://classroom.jc-schools.net/sci-units/energy.htm>
- Science-Class.net (click on physics, energy)
  <http://science-class.net>

Grade 8 Science, Quarter 3, Unit 3.2

Force and Motion

Overview

Number of instructional days: 25 (1 day = 45 minutes)

Content to be learned

- Understand methods and units of measuring time.
- Understand methods and units of measuring distance.
- Solve the mathematical expression *S* = *D*/*T*.
- Describe acceleration as directly proportional to force on an object.
- Describe how acceleration is inversely proportional to the mass of an object.
- Explain the difference between electromagnetic and mechanical waves. (*Local assessment only*)

Processes to be used

- Measure time using appropriate tools and units.
- Measure distance using appropriate tools and units.
- Solve for any unknown in *S* = *D*/*T* given values for the other two variables.
- Describe and/or graph the proportional relationship of acceleration and force.
- Describe and/or graph the inverse relationship of acceleration and mass.
- Experiment with electromagnets.
- Observe mechanical waves.
- Describe electromagnetic and mechanical waves as forms of energy. (*Local assessment only*)

Essential questions

- What are the relationships among speed, distance, and time?
- How can the expression *S* = *D*/*T* be graphically represented?
- What is the relationship between acceleration and force?
- What is the relationship between acceleration and mass?
- What is the difference between electromagnetic and mechanical waves?

Written Curriculum

Grade Span Expectations

PS 3 - The motion of an object is affected by forces.

PS3 (5-8) INQ+ POC –8

Use data to determine or predict the overall (net effect of multiple forces (e.g., friction, gravitational, magnetic) on the position, speed, and direction of motion of objects.

PS3 (7-8) – 8
Students demonstrate an understanding of motion by…

8a measuring distance and time for a moving object and using those values as well as the relationship s=d/t to calculate speed and graphically represent the data.

8b solving for any unknown in the expression s=d/t given values for the other two variables.

8e describing or graphically representing that the acceleration of an object is proportional to the force on the object and inversely proportional to the object's mass.

8f differentiating between mass and weight.

PS3 (5-8) SAE+INQ – Local Assessment Only

Experiment, observe, or predict how energy might be transferred by means of waves.

PS3 (7-8) – LA Students demonstrate an understanding of the visible spectrum of light by…

LAc differentiating between electromagnetic and mechanical waves.

Clarifying the Standards

Prior Learning

Prior to grade 8, students have learned that force is a push-and-pull action. They have learned how electric currents and magnets exert force on each other. Students learned about the relationship between force and gravity. They conducted experiments demonstrating changes to the direction and speed of an object under the influence of different amounts force. They learned to describe graphically the speed of different objects. They also learned how to differentiate between force, motion, speed, and acceleration.

Current Learning

In grade 8, students calculate the speed of a moving object using the formula $S = D/T$, as well as graphically represent the data. Additionally, given any two of the variables in the formula $S = D/T$, students calculate the value of the third variable. They also examine the direct relationship between force and acceleration, and the indirect relationship between mass and acceleration. Furthermore, students will learn how energy can be transferred by waves and differentiate between electromagnetic waves and mechanical waves.

Future Learning

Students in high school will deepen their knowledge of motion. Using the relationships among force, mass, velocity, momentum, and acceleration, they will explain the motion of objects by predicting and/or graphing the path of objects in different reference planes. They will use a variety of means to explain how distance and velocity change over time for a free-falling object.

Additional Research Findings

According to *Benchmarks for Science Literacy*, "The benchmarks for understanding the motion of objects and repeating patterns of motion do not require equations. For purposes of science literacy, a qualitative understanding is sufficient. Equations may clarify relationships for the most mathematically apt students, but for many students they are difficult and may obscure the ideas rather than clarify them. For example, almost all students can grasp that the effect of a force on an object's motion will be greater if the force is greater and will be less if the object has more mass—but learning and applying the formula $a = F/m$ (which to many teachers seems like the same thing) is apparently much harder" (p. 87).

Newton's laws of motion are simple to state, and sometimes teachers mistake the ability of students to recite the three laws correctly as evidence that they understand them. 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. A basic problem is the perception that sustained motion requires sustained force. The notion that it takes force to change an object's motion, that something in motion will move in a straight line forever without slowing down unless a force acts on it, runs counter to what we can see happening with our eyes. Limitations in describing motion may keep students from learning about the effect of forces. Students of all ages tend to think in terms of motion or no motion. So the first task may be to help students divide motion into steady motion, speeding up, and slowing down. For example, falling objects should be described as falling faster and faster rather than just falling down. Students should have lots of experiences to shape their ideas about motion and forces long before encountering laws. Especially helpful are experimentation and discussion of what happens as surfaces become more or less free of friction.

The book also states, "Students have no trouble believing that an object at rest stays that way unless acted on by a force; they see it every day. The difficult notion is that an object in motion will continue to move unabated unless acted on by a force. Telling students to disregard their eyes will not do the trick—the things around them do appear to slow down of their own accord unless constantly pushed or pulled. The more experiences the students can have in seeing the effect of reducing friction, the easier it may be to get them to imagine the friction-equals-zero case" (p. 87).

According to the *Atlas of Science Literacy,* students tend to think of force as a property of an object ('an object has force,' or 'force is within an object') rather than as a relation between objects. Students believe constant speed needs some cause to sustain it. In addition, students believe that the amount of motion is proportional to the amount of force; that if an object is not moving, there is no force acting on it; and that if an object is moving there is a force acting on it in the direction of the motion."

"Research has shown less success in changing middle-school students' ideas about force and motion. Nevertheless, some research indicates that middle-school students can start understanding the effect of constant forces to speed up, slow down, or change the direction of motion of an object. This research also suggests it is possible to change middle-school students' belief that a force always acts in the direction of motion" (p. 62).

Notes About Resources and Materials

Suggested materials

Prentice Hall textbook: Motion, Forces and Energy

- 8a (pp. 16–25)
- 8e (pp. 34–38, 52–54)

Suggested websites

- Learner.org—Designing a roller coaster
  <www.learner.org>
- Science-class.net—Interactive lesson plans
  <www.science-class.net>
- The Science Desk—Lab activities
  <www.thesciencedesk.com>
- Science Spot—Acceleration lab
  <www.sciencespot.net>
- MiddleSchoolScience.com—Physics lesson plans, scientific method, metric system, motion, etc.
  <www.middleschoolscience.com/class3.htm>