Grade 8 Science, Quarter 3, Unit 3.1

Energy

Overview

Number of instructional days: 20 (1 day = 50 minutes)

Content to be learned

- Show that within a system, energy transforms from one form to another.
- Show the transfer of potential energy to kinetic energy using a real-world example.
- Construct a model to explain that energy can be transformed from one form to another.
- Explain that while energy can be stored, transferred, or transformed, the total amount of energy is conserved.
- Describe the effect of changing voltage in an electrical circuit.

Science processes to be integrated

- Use real-world examples.
- Explain the transfer of energy.
- Construct a model.
- Describe cause-and-effect relationships.
- Examine patterns of change.
- Examine energy transfers within systems.
- Describe how energy is transformed within a system.

Essential questions

- What are some real-world examples of the transfer of potential energy to kinetic energy?
- What kinds of models can be used to explain the transformation of energy from one form to another?
- How does changing the voltage in an electrical circuit affect the system?
- How is energy conserved when energy transformations occur?

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 K–2, students experimented and described how objects sound. They described how objects make sound. Students described the various effects of light (including the sun). They know the sun is the source of heat energy and described how it warms the land and water. Students described the change in temperature of an object by adding or subtracting heat.

In grades 3 and 4, students continued to experiment with sound and added data to explain the causes of pitch and volume changes. They continued to investigate light, predicting and describing how light rays are reflected, refracted, and absorbed. Students knew that heat moves from warm objects to cooler objects and eventually becomes the same temperature. Students had the experience of drawing, diagramming, building, and explaining a complete electrical circuit. In addition, they classified materials as either conductors or insulators.

In grades 5 and 6, students identified real-world examples of heat energy transfer. They differentiated among the properties of various forms of energy and energy transfers. For example, when presented with real-world examples of different forms of energy, students were able to classify whether they were mechanical, light, heat, gravitational, etc. Students explained how energy may be stored in various ways. They described sound as the transfer of energy through various materials (e.g., solids, liquids, gases).

In grade 7, students designed a diagram, model, or analogy to explain the motion of molecules in warmer and cooler states. They explained the differences and diagrammed how energy travels through different materials by conduction, convection, and radiation.

Current Learning

It is important to connect this content to quarter 1 of grades 5 and 7. In grade 8, students are introduced to the concept of kinetic energy. This content is developmental; however, students have already learned about examples of potential energy, so this part is reinforcement. 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. Simple examples include an elastic band stretched and not stretched, a spring compressed and uncompressed, or a Slinky. More advanced examples include having students identify points of greatest or least potential and kinetic energy, such as a roller coaster diagram. Videos or interactive web sites that demonstrate these are of high interest to middle school students.

In addition, students describe the effects of changing voltage in an electrical circuit. They may build a simple electrical circuit, change the number of batteries, and observe the effects on the brightness of a bulb. Students can also describe how the energy is transferred and transformed in terms of the Law of Conservation of Energy.

Students explain the transfer and transformation of energy when they construct various models and apply real-world examples to demonstrate their understanding. Students describe the cause-and-effect relationships of the transfer and transformation of energy when they build a simple circuit and change the voltage. They look for patterns in various forms of energy transfer and transformation by comparing their models and diagrams to real-world examples such as the simple circuit or roller coaster.

Students use a variety of investigations and demonstrations to show and explain the transfer and transformation of energy. Some examples are a pendulum to demonstrate the transfer of potential to kinetic energy and building a simple electrical circuit to demonstrate the transformation of chemical energy to mechanical energy to light and heat energy. A model roller coaster can be fashioned from foam pipe insulation and marbles.

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 the efficiency is reduced due to heat loss. They will classify chemical reactions as either endothermic or exothermic based on the energy data provided. Students will explain or model nuclear decay. In addition, they will differentiate between nuclear fusion and fission. Students will explain or diagram electrostatic interactions (or like changes repel). They will model or explain the factors that affect the electrostatic force present. Students will explain or model the interaction between electric charges and magnetic fields.

Additional 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)

> "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)

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 (e.g., light, sound, 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 (e.g., 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 say that "energy is not lost" because an effect was caused during the process (e.g., a weight was lifted). (*NSDL Science Literacy Maps*, p. 24)

Students of all ages have difficulty reasoning that all parts of a circuit are interrelated and influence each other. (*NSDL Science Literacy Maps,* p. 26)

Notes About Resources and Materials

- Prentice Hall textbook, *Motion Forces and Energy*
  - 6a—Potential and Kinetic Energy
  - 6b—Energy Conversion and Conservation
  - 6c—Energy Conversions and Fossil Fuels
  - Lab Soaring Straws (gravitational potential energy depends on elastic potential energy)
- Potential and Kinetic Energy
  http://msteacher.org/return_list_science.aspx?id=1536

- teacher resource
  http://www.ftexploring.com/energy/energy-1.htm
- demonstration of potential and kinetic energy (*physics*, scroll to end, *roller coaster*)
  www.middleschoolscience.com
- student resource
  http://ed.fnal.gov/ntep/f98/projects/nrel_energy_2/energy.html
- interactive/lessons
  http://classroom.jc-schools.net/sci-units/energy.htm
- http://science-class.net
  (click on *physics* and then *energy*)
- PhET Simulations
- Molecular Workbench

Grade 8 Science, Quarter 3, Unit 3.2
Force and Motion

Overview

Number of instructional days: 25 (1 day = 50 minutes)

Content to be learned

- Measure time and distance for a moving object.
- Solve the mathematical expression $s = d/t$ using student-collected data.
- Solve for any unknown in the expression $s = d/t$ given values for the other two variables.
- Describe and graphically represent that the acceleration of an object is proportional to the force on the object.
- Describe and graphically represent that the acceleration of an object is inversely proportional to mass of an object.

Science processes to be integrated

- Use appropriate scientific tools and units.
- Solve for any unknown given values for the other two variables in an equation.
- Graph, interpret, analyze, and report data.
- Perform experiments, make observations, and make predictions.
- Examine patterns of change.
- Using data and observations, make predictions and provide explanation.

Essential questions

- What are the relationships among force, mass, and acceleration of an object?
- What are the relationships among speed, distance, and time?
- How would a graph that shows the acceleration of an object change as the mass of the object increases or decreases?
- How would a graph that shows the acceleration of an object change as the force applied to the object increases or decreases?

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.

Clarifying the Standards

Prior Learning

In grades K–2, students observed and sorted objects that are or are not attracted to magnets. They showed how pushing and pulling an object affects its motion and predicted the direction the object will move. Students showed that objects fall to Earth unless something is holding them up.

In grades 3 and 4, students used prior knowledge to investigate and predict if an object is attracted to a magnet. They described what happens when magnets of opposite poles are placed near each other. Students explored the relative strength of magnets. Students continued to predict the direction and described the motion of various objects and their relative change of position. They investigated and conducted experiments to demonstrate that applied forces (including gravity) change the speed and direction of an object.

In grades 5 and 6, students showed that electric currents and magnets can exert a force on each other. They learned that a force is a push or pull and explained that a change in the speed of an object is caused by forces. Students continued using data and graphs to compare the relative speed of objects.

In grade 7, students made and tested predictions of how unbalanced forces can change speed and/or direction. They measured distance and time for a moving object and calculated speed. Students know the difference among speed, velocity, and acceleration.

Current Learning

It is important to connect this content to grade 5 quarter 2 and grade 7 quarter 1. The appropriate level of instruction for the content in this unit is the reinforcement level. Students have been introduced to this content in previous grade levels; therefore, they should be able to use that content as a basis for this new content. Students deepen their knowledge of speed, force, mass, and acceleration through the introduction of graphical representations of these relationships. Using the $s = d/t$ formula, given any two of the three variables in the formula, they can solve for the third. This skill should reinforce the understanding of the direct relationship between force and acceleration. For the first time, students describe and graphically represent that the acceleration of an object is proportional to the force on the object and inversely proportional to mass. Instruction at this point is developmental.

Students use appropriate scientific tools and units to measure speed, distance, and acceleration. To meet the requirements of the standard, inquiry and patterns of change must be embedded in the instruction. If students are graphing speed, they must not only be able to graph the data, but also identify patterns. When students are investigating the relationships among force, mass, and acceleration, they should be experimenting through inquiry. Students should be able to predict what happens to the acceleration of an object if there is a change in the force applied on the mass of the object. They should be able to predict what happens to the acceleration of an object if there is a change in the mass of the object.

Students are actively engaged in measuring time and distance and using those values to calculate speed. For example, students can alter the slope of a ramp and allow a vehicle to roll down. They can then measure the time differences with a stopwatch or motion sensor. Students can measure distance differences using meter sticks with appropriate units from the metric system. They then calculate the speed and graph the results either by hand or with a graphing program. Students look for patterns within the graphs and interpret these patterns to make predictions. Given the data, they graphically represent and interpret the acceleration of an object and its proportionality to the force exerted on the object. Also with data, students graphically represent and interpret the acceleration of an object inversely proportional to the object's mass.

Future Learning

Students in high school will deepen their knowledge of motion by using the relationships among force, mass, velocity, momentum, and acceleration to predict and 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 Findings

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Notes About Resources and Materials

- Prentice Hall textbook, *Motion, Forces, and Energy*
  - 8a 16–25
  - 8e 34–38, 52–54
- Designing a roller coaster
  www.learner.org
- interactive lesson plans
  www.science-class.net
- Lab activities
  www.thesciencedesk.com [URL doesn't work]
- acceleration lab
  www.sciencespot.net
- Physics lesson plans, scientific method, metric system, motion, etc.
  www.middleschoolscience.com/class3.htm
- PhET Simulations