States and Forms of Energy

Strand Force, Motion, and Energy

Topic Investigating states and forms of energy

Primary SOL PS.6 The student will investigate and understand forms of energy and how energy is transferred and transformed. Key concepts include
- a) potential and kinetic energy; and
- b) mechanical, chemical, electrical, thermal, radiant, and nuclear energy.

Related SOL PS.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
- b) length, mass, volume, density, temperature, weight, and force are accurately measured;
- d) triple beam and electronic balances, thermometers, metric rulers, graduated cylinders, probeware, and spring scales are used to gather data;
- f) independent and dependent variables, constants, controls, and repeated trials are identified;
- g) data tables showing the independent and dependent variables, derived quantities, and the number of trials are constructed and interpreted;
- i) frequency distributions, scatterplots, line plots, and histograms are constructed and interpreted.

Background Information

Energy is the ability to do work or cause change. Energy exists in one of two states—kinetic or potential. Kinetic energy is the energy of motion and is dependent on the mass and velocity of an object. Potential energy is stored energy and is dependent on the position of an object.

Energy also exists in different forms: radiant, thermal, chemical, electrical, mechanical, and nuclear. Radiant energy is the energy of electromagnetic waves, including visible light. Thermal energy originates from the motion of particles in a substance. Chemical energy is the energy stored in the bonds of chemical compounds. Electrical energy is the energy of moving electric charges that produce electricity. Mechanical energy is the energy associated with motion and position of an object. Nuclear energy is the energy stored in the nucleus of an atom and released during nuclear reactions in the form of light and heat. The Law of Conservation of Energy states that energy cannot be created or destroyed. Instead, energy changes forms (e.g., a toaster converts electrical energy into thermal energy).

Materials

- Toy cars
- Textbooks
- Meter sticks
- Wooden boards
- Stopwatches

- Electronic scales or triple beam balances
- Computers with printer or paper/pencil

Vocabulary

chemical, electrical, energy, kinetic, mass, mechanical, nuclear, potential, radiant, thermal

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Part 1: States of Energy

In this lesson, students will conduct an experiment in which they will calculate the kinetic energy and potential energy in a system.

1. Have students create ramps by stacking books and placing one end of a wooden board on the stack of books and the other end on the floor. Have them vary the number of books to create different slopes on the ramps. A book can be used at the end of the ramp to stop the motion of the toy car.
2. Have each student perform the following experiment:
   - Find the mass of a toy car.
   - Create a ramp with a height of one textbook.
   - Place the toy car at the top of the ramp, and then measure the height of the ramp at the point where the toy car sits. Record the height in a table like that at right.

Number of Textbooks	Height (m)	Potential Energy (J)	Distance (m)	Time (s)	Velocity (m/s)	Kinetic Energy (J)
1						
2						
3						
4						
5						

   - Calculate the potential energy of the toy car, and record it in the table.
     PE = mass × gravity × height (gravity = 9.8 m/s^2)
   - Measure the distance from the top of the ramp to the bottom of the ramp. Record the distance in the table.
   - Using a stopwatch, measure the time it takes for the car to roll down the ramp, and record it in the table.
   - Calculate the velocity of the car and then the kinetic energy. Record it in the table.
     velocity = distance/time
     KE = ½ × mass × $velocity^2$
   - Repeat the previous steps, adding a one textbook at a time and creating a ramp with a steeper slope until you have a stack of 5 textbooks.
   - On a separate sheet of graph paper, construct a graph showing your results. Use a RED color pencil to show Potential Energy, and a BLUE color pencil to show Kinetic Energy. Label the independent and dependent variables on each axis. Include a scientific title.
3. Have the class design and test a roller coaster with peaks and valleys using the materials used in steps 1 and 2. Additional materials may need to be included to create a roller coaster.

Part 2: Forms of Energy

1. Have students either print or draw pictures to create two sets of images:

2. Set 1: Forms of Energy—Students should print or draw pictures that represent each form of energy, including radiant, thermal, chemical, electrical, mechanical, and nuclear energy.
3. Set 2: Law of Conservation of Energy—Students should print or draw pictures that represent energy conversions. For example, a flashlight converts chemical energy from the battery to radiant (light) energy.
4. Have students use their pictures to create posters, portfolios, or brochures. Make sure they label their pictures with either the form of energy or the forms of energy present in the energy conversion. Also, have them pass their pictures around the class and fill out a table like the following by placing a check mark in the box of all energy states and forms present in the picture.

Picture	Radiant	Thermal	Chemical	Electrical	Mechanical	Nuclear

Assessment

- **Questions**
  - What state of energy is associated with motion?
  - In the experiment, as the velocity of the car increased, what happened to the kinetic energy?
  - In the experiment, as the height of the ramp increased, what happened to the potential energy of the car? What happened to the kinetic energy of the car?
  - How are kinetic energy and potential energy related?
  - What is the Law of Conservation of Energy?
  - Identify the energy conversions in the following, using the given example:

	From	To
Light bulb	electrical_____	radiant, thermal
Toaster	_____	_____
Food	_____	_____
Fan	_____	_____
Flashlight	_____	_____
Sun	_____	_____

Extensions and Connections (for all students)

5. Choose any daily activity and have students analyze the energy transformations involved.
6. Have students create a way to diagram the energy conversions of common household appliances such as a microwave oven, lamp, and hair dryer.

Strategies for Differentiation

7. Allow students to write the formula with the variables filled in as an acceptable answer rather than requiring the calculations to be completed (e.g., for [velocity = distance / time] acceptable responses would include both [v = 14 m/10 sec] or the answer [1.4 m/sec]). As an alternative, calculations could be completed as a group.

8. In part 1, have students identify variables, other than ramp height, that could be changed to alter the rates of velocity.
9. In part 2, the product created can be accepted as a form of assessment.
10. In part 2, have students turn the images they created into flash cards or use them in a game to review vocabulary.