Conservation: Energy and Matter

STARFINDER

PROGRAM 27

Instructional Objectives

Upon completion of the previewing and postviewing activities and the viewing of instructional video, the student should be able to:

1. recognize the difference between a chemical and a physical change,
2. cite examples where the conversion from matter to energy and energy to matter occurs every day, and
3. explain the fundamental natural connection between energy and matter.

Synopsis

The program opens with Dr. Eric Chaisson and an update from the "HST Datastream." The "Science Links" section addresses the conservation of energy and matter.

"Science Links" begins with an explanation of physical reactions. The changes that are common for water are used as an example. An explanation of chemical reactions follows.

The path of energy from the sun's evaporation of water, precipitation, spinning turbines, and the generation of electricity is shown. The point of this description is to show the changes in the form of energy.

An analogy explains potential and kinetic energy. A bouncing ball describes the change in form of energy and the resultant decrease in usable energy after each change in form.

Photosynthesis provides an example of energy converting to matter. The role of chlorophyll in trapping solar energy and storing it as chemical energy in the form of carbohydrates is explained.

Interconversion, or the mutual exchange of energy and matter, is discussed in relation to nuclear reactions, such as fission and fusion.

The program closes with a career profile of Lisa Hooker, Science Writer/Public Relations Specialist at Johns Hopkins University.

Vocabulary

Astrometry - Positional astronomy. The branch of astronomy that deals with determining the exact positions of objects upon the celestial sphere.

Carbohydrate - Energy-rich compound composed of carbon, hydrogen, and oxygen.

Chemical Bond - Force that holds atoms or ions together in chemical compounds.

Chemical Reaction - Change in matter in which one or more chemical compounds are changed into new or different chemical compounds.

Chlorophyll - The green pigment found in organisms that are able to photosynthesize.

Interconversion - The change of matter into energy or energy into matter. Matter and energy are interchangeable. If matter sheds its mass and travels with the speed of light, it is radiation or energy. Also, if energy congeals and takes on a different form, we call it matter.

Kinetic Engery - Energy associated with the motion of an object.

Nuclear Fission - Splitting of one atom into two smaller atoms.

Nuclear Fusion - Combining of two atomic nuclei to form a single more massive nucleus. The sun's energy is released through nuclear fusion.

Photosynthesis - The process by which green plants convert light to chemical energy and synthesize organic compounds from inorganic compounds.

Potential Energy - The energy that results from position rather than from motion.

Pickles - The arcs of the Hubble Space Telescope's fine guidance sensors, used to lock the telescope on to a target or to study the exact position of a particular star.

Previewing

Have the students observe a rubber ball that is dropped from a few feet. Repeat the action a few times. Ask the students to describe the motion of the ball. Ask them to graph the highest point the ball reaches after every bounce.

Ask the students to describe the process of photosynthesis. Have them look up the formula for photosynthesis and record it on the board.

Go over the definitions that may be unfamiliar to your students.

Postviewing

Discuss the latest information from the Hubble Space Telescope.

Ask students if they would enjoy Lisa Hooker's career. What aspects do they like or not like?

Review the conservation of matter and the conservation of energy. Ask students to explain in their own words the conservation of matter and energy. Ask them to give examples of the conservation of matter and energy.

Ask students to draw an energy path of your local town or city. Where does the energy come from and how does it travel? Have students contact the local utility company for photographs or drawings to include in their energy path. Have students make a list of the forms that energy takes along the path.

Active Involvement

Have students go to the library and research the articles that have been written about the discoveries made based on the Hubble Space Telescope. Students may wish to write an essay which describes those discoveries.

NASA wrote a teacher's guide for the Astro-1 Mission. The Maryland State Department of Education has edited the children's educational portion of the mission down to one hour. If you send a blank tape, the Department will send you a copy of the tape and a copy of the teacher's guide produced by NASA. The address is: Astro, Maryland INTEC, 11767 Owings Mills Boulevard, Owings Mills, MD 21117. Students should research the purpose of the Astro-1 mission (December, 1990).

Have students research how the separate natural laws of the conservation of energy and the conservation of matter were eventually reconceived as the conservation of energy and matter. Familiar names will appear to them.

Bibliography

For high school readers:

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Taube, M. *Evolution of Matter and Energy.* New York: Springer Verlag, 1985.

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Carrying Energy (Exploring Energy Series). New York: Silver Burdett Publishers, 1989.

DeBruin, Jerry. *Young Scientist Explore! An Encyclopedia of Energy Activities.* New York: Good Apple, 1985

Fleisher, Paul. *Secrets of the Universe.* New York: Atheneum, 1987.

Kramer, Alan. *How to Make a Chemical Volcano and Other Mysterious Experiments.* New York: Franklin Watts, 1989.

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See for Yourself: Experiments/Projects

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PROGRAM 27

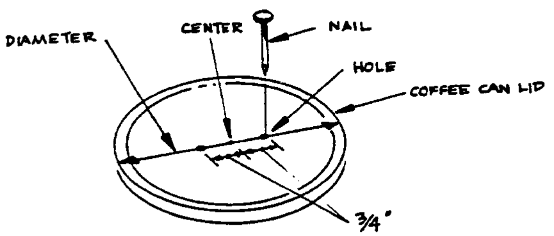
Kinetic and Potential Energy I

MATERIALS:

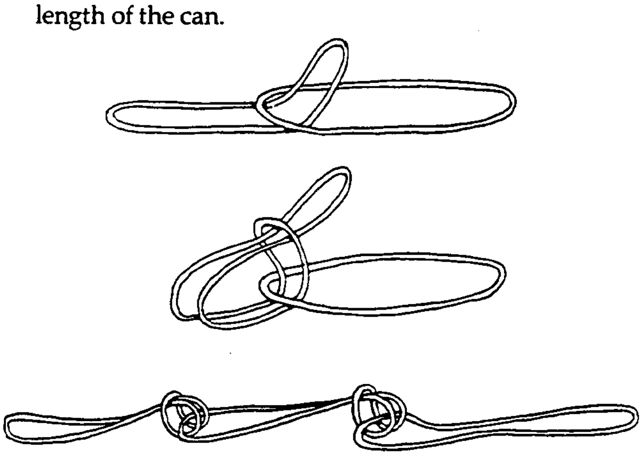
- short dowel or pencil
- large round can
- 2 snap-on plastic lids that fit the can
- heavy weights such as bolts, nuts, or fishing sinkers
- wide nail
- can opener
- sets of rubber bands of different widths
- meter stick

DIRECTIONS:

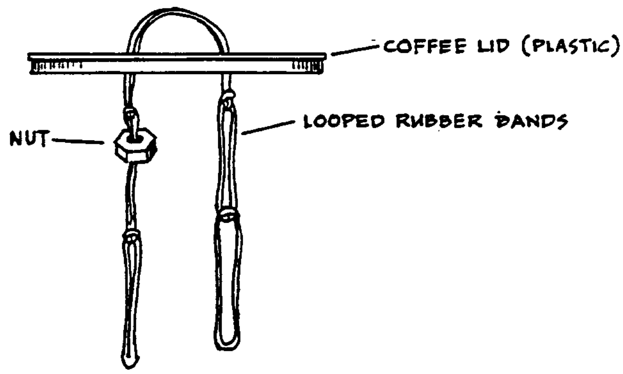
1. Remove the top and bottom of the can with the can opener. Discard (recycle) both top and bottom.
2. Mark the center and a diameter on each of the plastic lids. Using the nail, make two holes in the lid on the diameter each 3/4" from the center (see diagram).



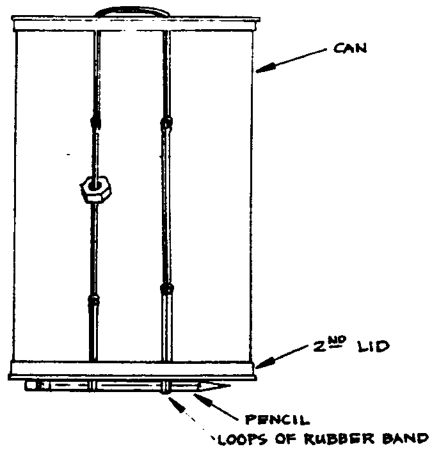
3. Knot (see diagrams) enough rubber bands of the same width together so that the unstretched length of the rubber bands is equal to approximately twice the length of the can.



4. Thread the rubber bands as shown (see diagrams). Add weight and finish threading as shown. Place lid on can. Thread rubber band through second lid (see diagram).



5. Insert dowel in rubber band loops at one end (see diagram).



6. Push the can on a smooth extended surface such as the floor. Record your observations, making note of the width of the rubber bands used.
7. Push the can again and measure the distance it travels away from you. Have everyone on your team try pushing the can and record all results.
8. Now alter the type of rubber band width used. Try pushing the can again, recording the results.
9. If a third rubber band thickness is available, try the experiment a third time.
10. Now go back to the first rubber band width. Add another weight. Repeat steps 6-9.
11. What are your conclusions? Record. What other aspects of this phenomenon intrigue you? Experiment with your ideas.

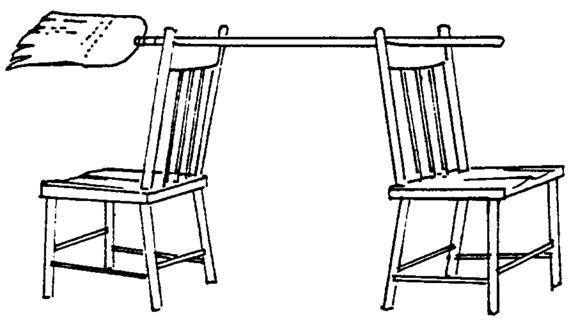
Kinetic and Potential Energy II

▶ MATERIALS:

- 2 chairs
- broom or large dowel
- string (4' or so)
- heavy washer
- dictionary (or other large book)

▶ DIRECTIONS:

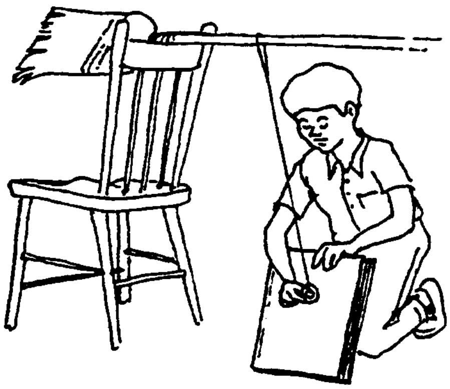
Place the chairs back to back. Separate them so that the broom rests across the back with 3-4" overhanging on each end (see diagram).



Tie a string onto the center of the broom handle. Slide the knot around until it is facing the ground. Now tie the string onto the washer so that it is hanging slightly above the floor. Remove any excess string.

Pull the washer out to touch the book so that when the book is resting on the ground the top of the washer lines up with the top of the book.

1. Release the washer and record your observations.
2. Repeat step 1, but this time notice the speed of the washer. When does it speed up and when does it slow down?
3. Repeat step 1 and count the number of swings back and forth before the washer comes to a stop.
4. Now move the book in closer so that the washer is at the midpoint of the book. Release the washer. Observe and record your observations. Repeat this twice, counting the swings.



5. Describe potential and kinetic energy in relationship to this washer. Draw the path of the washer and label the positions of the washer as potential or kinetic energy.

Science Career Profile

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LISA HOOKER
Science Writer
Office of News and Information
Johns Hopkins University, Baltimore

Education: B.A. Journalism and History

General Responsibilities

As a member of the Office of News and Information at Johns Hopkins University, Lisa Hooker's primary responsibility is to serve as a liaison, or go-between, between the researchers at the University and the media. But her ultimate audience is the general public, whom she reaches by interpreting the highly technical terms of the scientists into everyday language.

Because Lisa is responsible for presenting information in the basic sciences—biology, chemistry, mathematics, physics, earth sciences, psychology, and astronomy—she has to know a little about a lot of subjects. She begins her research by reading, and trying generally to understand the subject matter. She is then ready to interview the researcher about his or her specific work.

Her next step is to take the information and get it out to the media, the newspaper, journal, television and radio reporters. This might involve writing a press release, phoning a reporter who is particularly interested in the subject, sending a fax, or making up a complete press kit. Using different techniques allows her to interest as many reporters as possible.

These early steps often lead to a reporter's request to interview the scientist, and it is Lisa's job to get the two together. This involves much more than setting up a time for them to meet. Lisa becomes teacher to both the reporter and the scientist so that each will be better able to communicate with the other. Because many reporters may not have the general science background necessary to present their story to the public, Lisa will provide a broad picture of the research, furnish the necessary scientific and historic background, explain why a particular subject is important, and suggest ideas for effective questioning. At the same time that the reporter is preparing to understand the science behind the upcoming story, the scientist may need some coaching to communicate effectively his or her data to the media. Lisa often spends time with the researcher explaining how the media works, and may even do a mock interview in preparation for the meeting. Depending on the needs of the meeting, she may or may not be present during the actual interview.

There are times when Lisa must be the official spokesperson for a scientist. One recent example occurred when Johns Hopkins scientists were operating the Hopkins Ultraviolet Telescope (HUT). This was one of four telescopes aboard NASA's Astro mission. Although these astronomers held many press conferences and interviews, there were times when they were just too busy with the science aboard the space flight to meet with reporters. It was up to Lisa, then, to provide timely and accurate information to the media.

Typical Day

One of Lisa's favorite aspects of her job is that she is never bored. Each day is different as she learns about new and exciting areas of science.

Lisa begins each morning by reading one of several national or local newspapers. In order to communicate effectively with reporters, she must be aware of what is going on in the world. If the world is unusually occupied with a major news event, it is better for her to look for science that ties in with the news, rather than to promote unrelated stories.

Because most reporters like to set up interviews in the morning, Lisa tries to complete most of her phone calls before noon. She contacts reporters and scientists, returns phone calls, and sets up interviews. This leaves the rest of the day to do research, interview scientists, and write up news stories and press releases. However, her number one priority is to get her story out to the public, so if a reporter calls her, she must drop everything to handle the inquiry.

Lisa gets to travel frequently. In the past few months, she has made six trips to the Kennedy Space Flight Center and several to Huntsville, Alabama for NASA business. She often attends science conferences so that she can keep up with the science community and meet reporters.

Career Viewpoint

Lisa was a lucky student—she enjoyed everything. Her three favorite subjects in high school were journalism, computer science, and physics, but of the three, it was only her journalism teacher who encouraged her to pursue his subject as a career. She soon found that she had to struggle with some of her science and math classes. Although she continued to take science in high school and college, she concentrated on what came most easily, thinking that if she was going to be a journalist, why would she need science.

She later wished that someone had said to her that her struggles with science and math were just what she needed—a challenge. Fortunately, Lisa ended up in a career that gave her the opportunity to combine her talent for writing and her interest in the sciences. She advises students to trust their own instincts and believe that they can succeed in what they enjoy. As Lisa has proven, it is not always necessary to choose between two paths. Often exciting combinations are possible that make use of a variety of abilities and fields of interest.

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