- Students can participate in a "Roller Coaster Contest" to test their knowledge of kinetic and potential energy. Using cardboard or foam board, have small groups of students create a roller coaster track with two hills. Students can design this track in any manner, but the goal is to have a tennis ball start at the top of the first hill and make it over the second to complete the track. Students should discuss the design of their track before building, focusing on concepts like the height and steepness of hills. Which roller coaster design most effectively utilizes kinetic and potential energy?
- Have students spend a day examining the world around them for examples of potential and kinetic energy. Students can look to the classroom, cafeteria or neighborhood and record as many examples of potential and kinetic energy they can discover. Student observations of energy could then be recorded in a written journal, sketchbook or photo-journal and displayed throughout the classroom.
- Encourage students to watch brief clips from various sporting events (skiing, diving, swimming, football, etc.). Students can identify how potential and kinetic energy are used in each sport. Using their knowledge of these states of energy, students can also brainstorm ways that athletes could increase their potential and kinetic energy, and also the possible outcomes of maximizing their energy. See *Science Projects About the Physics of Sports* by Robert Gardner (Enslow Publishers, 2000) for more ideas about using athletics to study energy concepts.

Suggested Internet Resources

Periodically, Internet Resources are updated on our web site at www.LibraryVideo.com

- **www.miamisci.org/af/sln/mummy/raceways.html**
  "The Atoms Family" web site, sponsored by the Miami Museum of Science, presents an activity about potential and kinetic energy called the "Mummy's Tomb Raceways." In this activity, students are encouraged to build a raceway for marbles that takes into consideration their knowledge of energy and gravity.
- **www.learner.org/exhibits/parkphysics/index.html**
  This "Amusement Park Physics" page explains how roller coasters use kinetic and potential energy. On this site, students are able to use this information to design their own roller coaster.
- **ericir.syr.edu/Virtual/Lessons/Science/Physical/PHY0067.html**
  This page provides a fun, hands-on activity that reflects inquiry-based learning strategies. Students create "spool racers" to investigate the relationship between potential and kinetic energy.

TEACHER'S GUIDE

Suggested Print Resources

- Crow, Linda W. and Bill G. Aldridge. *Middle Level Energy Series.* National Science Teachers Association, Washington, D.C.; 1994.
- Doherty, Paul, Dan Rathjen and the Exploratorium Teacher Institute. *The Spinning Blackboard and Other Dynamic Experiments on Force and Motion.* Wiley, New York, NY; 1996.
- Taylor, Beverley A.P. *Exploring Energy With Toys: Complete Lessons for Grades 4–8.* Learning Triangle Press, New York, NY; 1998.

TEACHER'S GUIDE CONSULTANT

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TITLES

- **ELECTROMAGNETIC ENERGY**
- **ENERGY: POTENTIAL & KINETIC**
- **ENERGY RESOURCES: USE & CONSERVATION**
- **HEAT & CHEMICAL ENERGY**
- **MECHANICAL ENERGY**
- **NUCLEAR ENERGY**
- **THE TRANSFER OF ENERGY**

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TEACHER'S GUIDE

ENERGY IN ACTION™

Energy: Potential & Kinetic

Grades 5–8

Students in grade 5–8 classrooms possess a wide range of background knowledge. Student response to this video program is sure to be varied, so the teachers at these grades need all the help they can get! This guide has been designed to help the 5–8 science teacher by providing a brief synopsis of the program, previewing and follow-up questions, activities, vocabulary and additional resources.

Before Viewing: Extensive research tells how important it is for the teacher to discover what the students know — or think they know — about a topic, before actually starting a new unit. Therefore, after prompting discussion with the pre-viewing questions, lead your class to create an "Everything We Think We Know About…" list. You may also wish to preview key vocabulary words, and have students raise additional questions they hope will be answered.

After Viewing: Have your students share video excerpts that fascinated or surprised them, then challenge your students to prove or disprove the accuracy of the facts they put on their "Everything We Think We Know About…" list. Discuss what else they learned and use the follow-up questions and activities to inspire further discussion. Encourage students to research the topic further with the Internet and reading resources provided.

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Program Summary

Everything that moves — cars driving, kids on skateboards, waves crashing on the shore — uses mechanical energy in one of two states: kinetic or potential. Kinetic energy is active or moving energy. Potential energy is stored energy, or energy waiting to be transferred into kinetic energy. If work is done on an object without any outside force involved, the total mechanical energy — the sum of the kinetic and potential energy — remains constant. When using a bow and arrow, the more you pull back on the bow, the greater the potential energy. When the arrow is released, the distance it travels will depend upon the amount of work that was done on the bowstring; in other words, the potential energy it was given by your pull. The greater the pull on the bow, the greater the kinetic energy of the moving arrow and the distance the arrow can travel.

The higher and heavier an object is, the greater its potential energy. This is called gravitational potential energy, calculated by multiplying an object's weight by its height of position. If two objects of different weights are about to be dropped from the same height, the heavier one has greater potential energy. Accordingly, when they are dropped, the heavier one has greater kinetic energy. If two marbles are rolled down a ramp from the same height toward a container, the heavier marble will move the container farther than the lighter one. However, raise the lighter marble higher on the ramp, and it will move the container just as far.

Kinetic energy is measured in units called joules and can be calculated by multiplying an object's mass by the square of its velocity, then dividing that number by two. Once you examine this formula, you will realize than in order to go twice as fast, you need four times the kinetic energy! Since potential energy is transformed into kinetic energy, an increase in mass or height of position will translate to greater kinetic energy. Understanding the relationship between potential and kinetic energy helps us to gather information about the world around us.

Vocabulary

The following words are included for teacher reference or for use with students. They are listed in the order in which they appear in the video.

matter — Any substance that takes up space. Matter is made of small particles called atoms and can be in the form of a solid, liquid, gas or plasma.

energy — The ability to make things happen or to do work.

work — The energy it takes to move or change something.

potential energy — Energy that is stored or waiting to be used.

kinetic energy — Energy that is active or moving. The formula to calculate the kinetic energy of an object is $(\text{mass})(\text{velocity})^2$.

energy transfer — The change of energy from one form to another. Energy can change from kinetic to potential energy, but the total amount of energy remains the same. ***(Continued)***

gravity — The force of attraction that pulls down on everything on Earth.

weight — A measurement of the force of gravity pulling down on an object. Weight is determined as (mass)(gravity).

gravitational potential energy — The energy of an object due to its position. The higher an object is, the more potential energy it has. A heavier object has more potential energy than a lighter one at the same position. The formula to calculate the gravitational potential energy of an object is (weight)(height).

joules — Units that measure the amount of work or energy produced. One joule is equivalent to 1 kilogram $(\text{meter/second})^2$.

mass — The amount of matter that is contained in an object. The more mass an object has, the greater its weight.

velocity — How quickly an object changes its position. The speed of an object in a certain direction is its velocity.

Pre-viewing Discussion

Before students generate their list of "Everything We Think We Know About…" for this topic, stimulate and focus their thinking by raising these questions so that their list will better reflect the key ideas in this show:

- Which has more energy, a tennis ball or a bowling ball?
- Does a small object with high speed have more energy than a large object with low speed? Explain.

After the class has completed their "Everything We Think We Know About…" list, ask them what other questions they have that they hope will be answered during this program. Have students listen closely to learn if everything on their class list is accurate and to hear if any of their own questions are answered.

Focus Questions

1. What is matter?
2. How are energy and work related?
3. What is kinetic energy? Give some examples.
4. What is potential energy? How is it different from kinetic energy?
5. How can the kinetic energy of an object change if the total mechanical energy of the system remains constant?
6. Would you rather have a water balloon dropped on you from 1 meter above you or from 3 meters above you? Explain the role of potential and kinetic energy in dropping water balloons.
7. What is an energy transfer?
8. How is potential energy transformed into kinetic energy?
9. Why can a yo-yo be called an "energy transfer machine"?
10. Why is it true that as an object's kinetic energy increases, its potential energy decreases? Give an example. ***(Continued)***

11. How can you increase gravitational potential energy?
12. What is the formula for computing the gravitational potential energy of an object?
13. What factors are involved in determining the kinetic energy of a moving object?
14. What are joules?
15. What is the formula for computing the kinetic energy of an object?
16. If you roll two marbles down ramps, will they always travel at the same speed? Why or why not?

Follow-up Discussion

Research indicates that students will retain their previous misconceptions about a topic, in preference to new information, until they actively recognize and correct their own errors. Therefore, it is important to have your students re-examine the facts/beliefs they put on their "Everything We Think We Know About…" list. It might also be helpful to review the list by marking each entry with a "+" or "-" to show which facts were correct and which were incorrect.

Thought-provoking discussions provide a good way to assess the overall depth of student understanding. The following are some suggested discussion topics.

- Explain how energy can be stored in a spring or a rubber band, and how this energy can change form.
- Give some examples of useful tools or other items that possess gravitational potential energy.
- Explain that energy can be converted from one form to another; energy is changed, but it is neither created nor destroyed.
- Follow the changes in kinetic and potential energy of a baseball at rest, through the addition of energy to the ball by a pitcher, until it is hit by a batter and caught by an outfielder.

Follow-up Activities

- Using different sized marbles and ramps of varying heights, have students investigate the relationship between kinetic and potential energy. (See ericir.syr.edu/Virtual/Lessons/Science/Physical/PHY0036.html for guidelines for this activity.)
- Students can experiment with a pendulum to learn more about potential and kinetic energy. Encourage students to design studies that test the effects of certain variables on the performance of the pendulum. Students can investigate the influence of the pendulum's weight or height on the number of swings.

(Continued)