#3604

WORK AND ENERGY

Grade Levels: 7-12
15 minutes
CAMBRIDGE EDUCATIONAL 1998

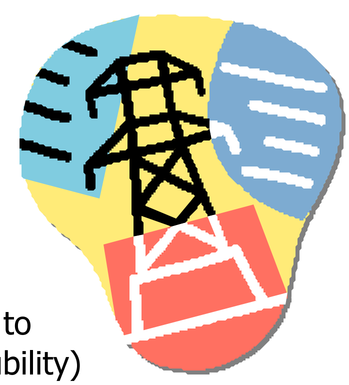
DESCRIPTION

Offers a fundamental look at the basic concepts of work and energy. Includes definitions, discussions, and some real-world examples of work, power, energy, force, and efficiency. Briefly covers the law of conservation of energy. Reviews the highlights of this animated and real-life presentation.

ACADEMIC STANDARDS

Subject Area: Science

- Standard: Understands motion and the principles that explain it
  - Benchmark: Knows the relationship between the strength of a force and its effect on an object (e.g., the greater the force, the greater the change in motion; the more massive the object, the smaller the effect of a given force)
  - Benchmark: Knows that when a force is applied to an object, the object either speeds up, slows down, or goes in a different direction
- Standard: Understands energy types, sources, and conversions, and their relationship to heat and temperature
  - Benchmark: Knows that electricity in circuits can produce light, heat, sound, and magnetic effects
  - Benchmark: Knows that heat is often produced as a byproduct when one form of energy is converted to another form (e.g., heat is produced by mechanical and electrical machines)



- Standard: Understands basic concepts about the structure and properties of matter
  - Benchmark: Knows that objects can be classified according to their properties (e.g., magnetism, conductivity, density, solubility)

AFTER SHOWING

1. The equation for work is force times ___________.
2. A newton-meter is also known as a ____________.
3. True or false, James Watt defined "horsepower"? __________

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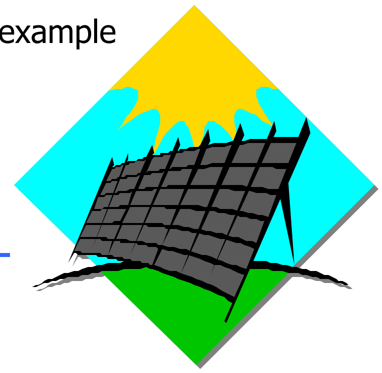
4. True or false, power equals work divided by time? __________
5. A pendulum converts potential energy into ______ energy and back into potential energy.
6. __________ is a percentage used to describe how much energy is wasted in a system.
7. The Law of __________ of Energy states that energy can change form, but the amount of energy must remain the same.
8. True or false, a person on a bike sitting at the top of a hill is an example of potential energy? _________
9. True or false, energy cannot change from one form to another? _______



SUMMARY

THE BASICS OF WORK AND ENERGY

Work is done when a force moves something in the direction of that force. Work is only done if something moves. If someone pushes against a wall and if the wall does not move, no work has been done. Here is the equation for work:

Work = Force x Distance or W= F x D

In the equation, force is a push or pull. Force is usually measured in pounds (lbs.) in the English system and Newton's (N) in the metric system. Force is often the weight of an object.

Distance in this equation is how far the object is moved. Distance is usually measured in feet or meters.

The most common units for work are foot-pounds in the English system and newton-meters, also known as joules, in the metric system.

Power is the amount of work completed over time. Here is the equation for power:

$$\text{Power} = \frac{\text{Work}}{\text{Time}} \text{ or } P = \frac{W}{T}$$

Power is usually expressed as horsepower in the English system and Watts in the metric system. One horsepower is equal to 550 foot-pounds of work per second. James Watt defined the horsepower in the 18^{th} century. One watt is equal to one joule per second. In industrial environments, power is often expressed in kilowatts, which are equal to 1000 watts.

Energy is the ability to do work. Energy can be found in several forms such as: heat, light, and sound. There are several different types of energy. Chemical energy is energy that is stored in a chemical reaction. Things burning and batteries being used are examples of chemical energy at work. Electrical energy is energy that uses electrical current (the flow of electrons). Electrical energy can be used to do work, produce heat, or generate light. Radiant energy is energy that exists as waves. Solar energy is radiant energy from the sun. Nuclear energy is a special kind of energy that occurs inside the nucleus of an atom. Nuclear energy converts mass to energy.

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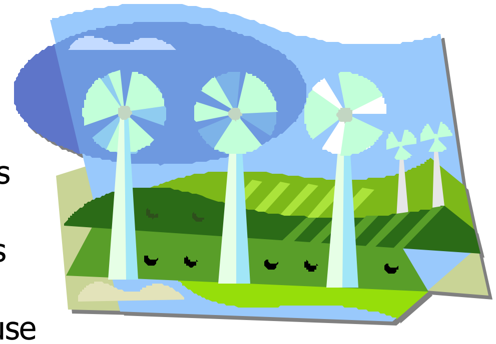

All energy exists in either potential or kinetic form. Potential energy is energy something has because of its position or state. An example of potential energy is a rock on a cliff. If the rock falls from the cliff, it has moved a distance and done work. So while the rock sits on the cliff it has the ability to do work. It has energy. Kinetic energy is the energy something has because it is moving. An example of kinetic energy is a bowling ball rolling down an alley. If the ball hits the pins, it will cause them to move. Because the rolling ball could be used to do work (moving the pins a distance), it has energy.

Energy can change from one form to another. A battery uses a chemical reaction (chemical energy) to create the flow of electrons (electrical energy). Electrical energy applied to a light bulb will create heat and light, which are forms of radiant energy.

The Law of Conservation of Energy states that while energy can change form, the amount of energy must remain the same. This means that in order for something to gain energy, it must take energy away from something else. Nuclear energy is an exception to this rule since it transforms mass into energy.

A pendulum is a good example of energy transforming from one type to another. When the weight is at its highest point, it contains potential energy. When the weight is moving fastest, in the low part of its swing, the pendulum has transferred the potential energy to kinetic energy.

As the pendulum swings back and forth, it continues to transfer energy from potential to kinetic and back to potential states. There will never be more energy in the system than the initial potential energy provided by raising the weight. The system will, however, lose energy, which is demonstrated as the pendulum eventually slows to a stop. This energy isn't really "lost." It is just transferred to a less desirable form. In the case of the pendulum, friction, wind resistance, and even sound account for the loss of energy.

Efficiency is the term used to describe how much energy is wasted in a system. This is the equation for efficiency:

$$\text{Efficiency} = \frac{\text{Work or Energy Output}}{\text{Energy Input}}$$

Efficiency is expressed as a percentage. For example, if a machine requires 50 joules of energy to do 40 joules of work, it would be 80% efficient.

RELATED RESOURCES

Captioned Media Program

- Energy #3459
- Force and Work: Energy in Action #3466
- Heat and the Changing States of Matter #3475
- Heat and Work #1980

World Wide Web

The following Web sites complement the contents of this guide; they were selected by professionals who have experience in teaching deaf and hard of hearing students. Every effort was made to select accurate, educationally relevant, and "kid-safe" sites. However, teachers should preview them before use. The U.S. Department of Education, the National Association of the Deaf, and the Captioned Media Program do not endorse the sites and are not responsible for their content.

- **PHYSICS OF EVERYDAY LIFE**

http://landau1.phys.virginia.edu/Education/Teaching/HowThingsWork/

An ask-and-answer format is used to deliver extensive background information for the teacher. Powerful internal search engine quickly returns all related answers to your questions. Great planning resource.

- **SIMPLE MACHINES**

http://sln.fi.edu/qa97/spotlight3/spotlight3.html

Print information from the Franklin Institute written for (strong readers) children. Covers the basics with text and simple graphics. Links to additional information.

- **A HISTORY OF WINDMILLS**

http://www.looklearnanddo.com/documents/history_windmills.html

From the LookLearn&Do site. Use of the windmill to do work. Fun building projects using simple machines concepts and everyday household objects. The Learning Circle button contains the links list.

- **SMITHSONIAN: INVENTORS AND INNOVATION**

http://www.si.edu/resource/faq/nmah/invent.htm

Offers a list of links that provide a short history of famous inventors and inventions. Among others, the telegraph, the light bulb, and the computer are featured.