

Energy

Teacher's Guide Grades 5-9

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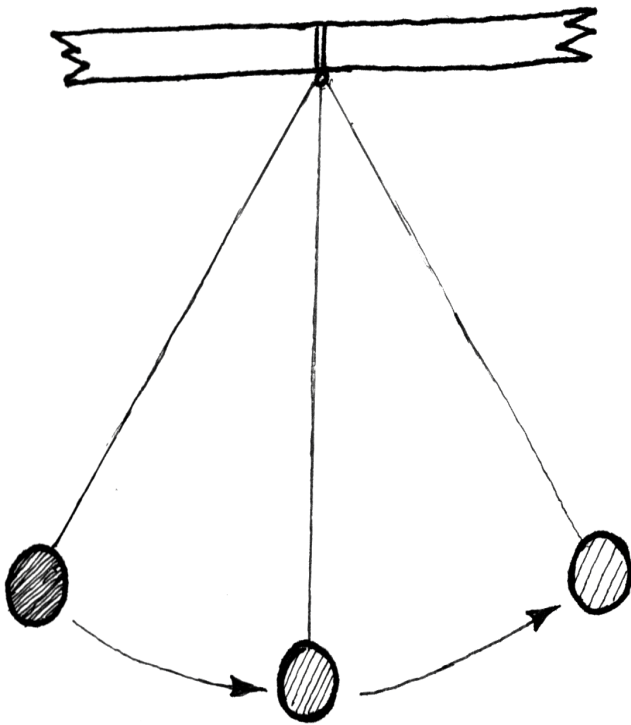
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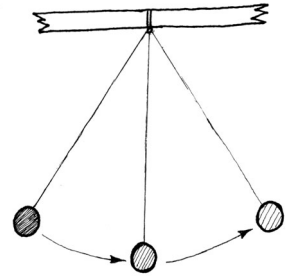


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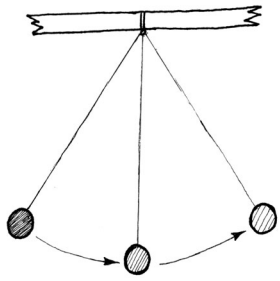
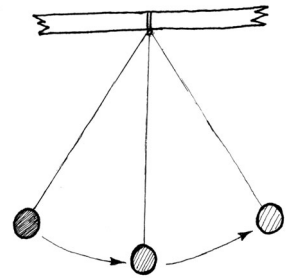


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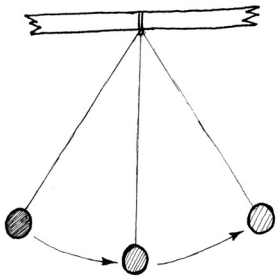
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A Message from our Company . . .

Dear Educator,

Thank you for your interest in the educational videos produced by the *Visual Learning Company*. We are a Vermont-based, family owned and operated business specializing in the production of quality educational science videos and materials.

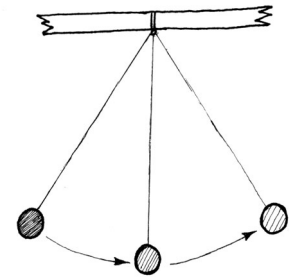
We have a long family tradition of education. Our grandmothers graduated from normal school in the 1920's to become teachers. Brian's mother was an elementary teacher and guidance counselor, and his father was a high school teacher and superintendent. This family tradition inspired Brian to become a science teacher, and to earn a Ph.D. in education, and lead Stephanie to work on science education programs at NASA.

In developing this video, accompanying teacher's guide, and student activities, our goal is to provide educators with the highest quality materials, thus enabling students to be successful. In this era of more demanding standards and assessment requirements, supplementary materials need to be curricular and standards based - this is what we do!

Our videos and accompanying materials focus on the key concepts and vocabulary required by national and state standards and goals. It is our mission to help students meet these goals and standards, while experiencing the joy and thrill of science.

Sincerely,

Brian and Stephanie Jerome



National Standards Correlations

National Science Education Standards

(Content Standards: 5-8, National Academy of Sciences, c. 1996)

Science as Inquiry - Content Standard A:

As a result of activities in grades 5-8, all students should develop:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science - Content Standard B:

As a result of their activities in grades 5-8, all students should develop an understanding of:

- Motions and Forces
- Transfer of Energy

Benchmarks for Science Literacy

(Project 2061 - AAAS, c. 1993)

The Physical Setting - Energy Transformations (4E)

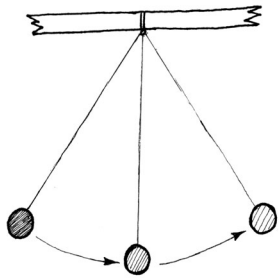
By the end of the eighth grade, students should know that:

- Energy cannot be created or destroyed, but only changed from one form into another.
- Energy appears in different forms. Heat energy is the disorderly motion of molecules in radiation; chemical energy is in the arrangement of atoms; mechanical energy is in moving bodies; and electrical energy is in the attraction or repulsion between charges.

The Physical Setting - Structure of Matter (4D)

By the end of eighth grade, students should know that:

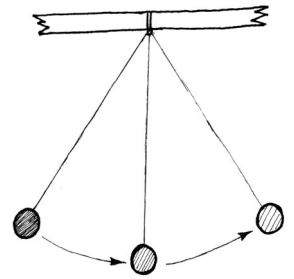
- All matter is made up of atoms, which are far too small to see directly through a microscope.



Student Learning Objectives

Upon viewing the video and completing the enclosed student activities, students should be able to do the following:

- Define energy;
- Identify the five main forms of energy: mechanical, nuclear, heat, chemical, and electromagnetic;
- Discuss the source and function of each of the five forms of energy;
- Understand that all forms of energy can be converted into other forms;
- Identify the two states of energy: kinetic energy and potential energy;
- Define kinetic energy and understand how it is calculated;
- Define potential energy;
- Define gravitational potential energy and understand how it is calculated; and
- Explain the law of conservation of energy, which states that energy cannot be created or destroyed, only changed in form.



Assessment

Preliminary Test:

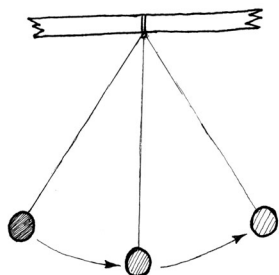
The Preliminary Test, provided in the Student Master section, is an assessment tool designed to gain an understanding of student preexisting knowledge. It can also be used as a benchmark upon which to assess student progress on the objectives stated on the previous pages.

Video Review:

The Video Review, provided in the Student Masters section, can be used as an assessment tool or as a student activity. There are two main parts. The first part contains questions titled “You Decide” that can be answered during the video. The second series of ten questions consists of video review questions to be answered at the conclusion of the video.

Post-Test:

The Post-Test, provided in the Student Masters section, can be utilized as an assessment tool following student completion of the video and student activities. The results of the Post-Test can be compared against the results of the Preliminary Test to assess student progress.



Introducing the Video

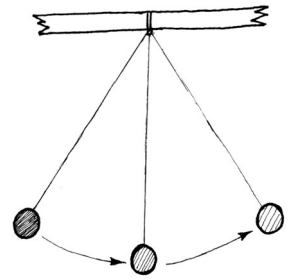
Begin by discussing the question “What is energy?” and defining energy as a class. Next, divide the class into small groups. Provide each group with a copy of a newspaper that covers both national and international news. Ask each group to formulate a list of ways in which energy is involved in the current events discussed in the paper. Examples may include nuclear issues, oil disputes, and environmental issues, such as the benefits of solar power. Allow each group 10-15 minutes to read through the paper and compile their list. Next, ask one representative from each group to write their list on the board. Compare and discuss the examples as a class. Attempt to relate some of the examples found in the newspaper to issues in your local community. Allow the lists to remain on the board during the video. After completing the program, ask students to add to the list any additional examples of energy discussed in the video.

Video Viewing Suggestions

The Student Master “Video Review” is provided for distribution to students. You may choose to have your students complete this Master while viewing the program or to do so upon its conclusion.

The program is approximately 20-minutes in length and includes a ten-question video quiz. Answers are not provided to the Video Quiz on the video but are included in this teacher’s guide. You may choose to grade student quizzes as an assessment tool or to review the answers in class.

The video is content-rich with numerous vocabulary words. For this reason, you may want to periodically stop the video to review and discuss new terminology and concepts.



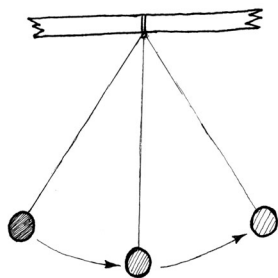
Student Assessments and Activities

Assessment Masters:

- Preliminary Test
- Video Review
- Post-Test

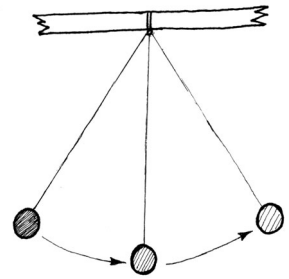
Student Activity Masters:

- Calculating Kinetic Energy
- Reaching Your Potential
- A Perfect World
- Observing the Greenhouse Effect
- Pendulum Potential
- Energy Inventors
- Vocabulary of *Energy*



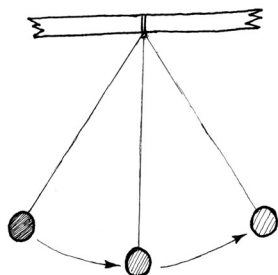
Video Script: Energy

1. Chances are you've seen the sun shine brightly in the sky,...
2. or watched a bolt of lightning strike the earth during a thunderstorm,...
3. or raised and lowered a window shade.
4. Do you know what these things all have in common?
5. That's right, they all involve energy.
6. Energy is all around us and is involved in almost everything we do.
7. We use energy when we eat,...
8. ...or when we run,...
9. ...and even when we breathe.
10. During the next few minutes we are going to study the different forms of energy and the role energy plays in our lives.
11. Energy is defined as the ability to do work. Every time we do work, we use energy.
12. When playing sports, we use a lot of energy and are often tired when we are finished.
13. We are working all the time. When we pick up a heavy object, we exert a force over a distance to move the object. We are doing work.
14. An object may gain energy as well. When we hit a tennis ball with a racquet, we are giving the ball energy to travel to the other side of the court.
15. Energy comes in many different forms but there are five main forms which are commonly used in everyday life. Let's first take a look at one type of energy with which you are very familiar - mechanical energy.
16. **Graphic Transition - Mechanical Energy**
17. **You Decide!**
18. What do the following things have in common - these race cars,...
19. ...this skateboarder,...
20. . . . and this stream?
21. That's right, they are all in motion.
22. When an object is in motion, it has energy. Energy associated with motion is called mechanical energy.
23. The wings of this bird exhibit mechanical energy or energy of motion, enabling it to fly.
24. Moving waves in the ocean also exhibit mechanical energy.
25. Most machines use mechanical energy to get certain jobs done.
26. The mechanical energy of objects that are in motion is also referred to as kinetic energy.
27. Kinetic energy is the energy of motion. We'll discuss kinetic energy in more detail in a few minutes.
28. **Graphic Transition - Nuclear Energy**
29. **You Decide!**
30. Where does nuclear energy exist in space?
31. The star from which we get light, our sun, produces nuclear energy. Nuclear energy is energy trapped in an atom.
32. This is a model of an atom. The nucleus is the center of an atom. This is where nuclear energy is stored.
33. The type of nuclear energy that occurs in the sun is called fusion, which is the result of the joining of nuclei of two hydrogen atoms.
34. Nuclear energy may also be released when the nucleus of an atom splits apart. Fission is the process of splitting the nucleus of an atom into smaller nuclei.
35. When the nucleus splits apart, a great deal of heat energy is released.
36. In nuclear power plants, such as this one, the heat from the splitting of uranium atoms is used to heat water to create steam.
37. The steam is used to spin large turbines like this one to generate electricity
38. The energy released from the nucleus is the most concentrated form of energy existing today.
39. **Graphic Transition - Heat Energy**
40. Have you ever rubbed your hands together on a cold winter day?



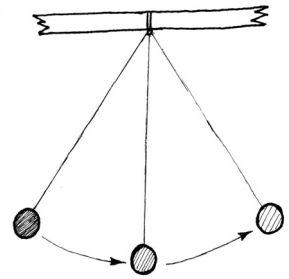
Script

41. If so, chances are you have felt your hands warm up.
42. When you rub your hands together, the friction between your hands causes mechanical energy to convert to a third form of energy - heat energy
43. All matter is composed of atoms, tiny particles that remain in constant motion.
44. Heat energy is associated with the motion of these particles.
45. When the motion of these particles increases, the amount of heat energy they produce also increases.
46. Cooler objects such as this brick contain particles that move relatively slowly.
47. But warmer substances, such as steam rising from this cup, contain particles that move faster.
48. Heat energy is responsible for changes both in temperature and in phases of matter.
49. As you probably already know, it is possible to measure temperature of objects with a thermometer.
50. Ice has less heat energy and therefore has a relatively low temperature of zero degrees Centigrade or less.
51. Whereas this cup of hot water has more heat energy and has a temperature between 60 and 70 degrees Centigrade.
52. Heat energy is also responsible for phase changes.
53. A phase change involves matter changing from one phase to another. For example, water can exist in the form of solid ice seen on this lake.
54. But when ice is heated, it changes to a liquid.
55. And if liquid water is heated even further, it changes to a gas, as seen in this steam coming off the surface of the hot water.
56. Chances are you have watched an ice cream cone melt on a hot day.
57. The high temperature causes the atoms to move more quickly, producing more heat energy which results in the ice cream melting.
58. **Graphic Transition - Chemical Energy**
59. As we have already learned, matter is composed of tiny particles called atoms.
60. Bonds like these between atoms make it possible for substances to form and hold their structure.
61. Within each of these bonds is a certain amount of energy.
62. The energy within the bonds that holds atoms together is called chemical energy.
63. When wood is burned, chemical energy is released and converted into heat energy.
64. Fuels such as gasoline and diesel fuel also contain chemical energy that when combusted propel large machinery.
65. And when certain chemicals are mixed and then ignited, the chemical energy is converted to...
66. ...heat and mechanical energy that has the ability to move huge slabs of rock. (explosion at end of sentence!)
67. We gain and use large amounts of chemical energy every day.
68. Our bodies gain chemical energy every time we eat.
69. When we digest food, the bonds between atoms are broken, releasing chemical energy.
70. When we kayak down a roaring river...
71. ...or snowboard, we use the stored chemical energy we have gained from food.
72. **Graphic Transition - Electromagnetic Energy**
73. **You Decide!**
74. What causes this bulb to give off light?
75. The bulb is lit by electricity flowing through the thin piece of metal in the bulb.
76. The energy associated with moving electrical charges, such as in the light bulb, is called electromagnetic energy.
77. All matter is composed of atoms.
78. But did you know that atoms are composed of many smaller types of particles, one of which is called an electron?
The red dots orbiting the nucleus are electrons.
79. Electrons carry an electric charge.
80. When these particles move through materials that conduct electricity, such as the metal in the light bulb, it is converted to light and heat.
81. Electromagnetic energy is all around us and we use it everyday. It is carried through power lines in the form of electricity.
82. It is used every time we turn on a computer...



Script

83. . . . and it's even in lightning!
84. **Graphic Transition - Kinetic Energy**
85. What do this hammer,...
86. . . . this spatula,...
87. . . . and this baseball bat all have in common?
88. These three objects are all doing work on a second object.
89. The hammer is forcing the nail into the wood.
90. The spatula is flipping over the egg.
91. And the bat is hitting the ball.
92. Since these objects can do work, they have energy.
93. And since the objects are in motion, this energy is called kinetic energy.
94. Kinetic energy is defined as the energy of motion.
95. **You Decide!**
96. Which has more kinetic energy - this tennis ball or this truck?
97. That's right! The truck has the most kinetic energy.
98. The amount of kinetic energy an object has is directly related to both its mass and its velocity.
99. The equation for kinetic energy is as follows-
100. Kinetic Energy equals mass times velocity squared, all divided by two.
101. Would you rather be hit by a tennis ball tossed towards you lightly....
102. ...or a tennis ball hurled toward you with great speed?
103. Hopefully, most of you would rather be hit by the ball which was lightly tossed.
104. This is because it has less kinetic energy.
105. **Graphic Transition - Potential Energy**
106. Have you ever sat at the top of a slide...
107. ...or prepared to skateboard down a ramp?
108. If so, you have experienced potential energy, the second state of energy.
109. Potential energy is stored energy. It is also referred to as the energy of position.
110. When you are at the top of a slide, your body has stored energy waiting to be released when you go down the slide.
111. This stretched rubber band has potential energy - and when released is flung outward.
112. Potential energy also exists in foods.
113. Food contains stored chemical energy which is released upon digestion.
114. **You Decide!**
115. What type of potential energy is dependent on the height of an object above the Earth's surface?
116. Any object above the Earth's surface has gravitational potential energy.
117. This bridge has gravitational potential energy,...
118. ...as does this airplane.
119. The equation for gravitational potential energy is as follows-
120. Gravitational Potential Energy equals weight times height.
121. As the weight of an object and its height above the surface increases, so does its gravitational potential energy.
122. Perhaps you have heard the expression - "The bigger they are, the harder they fall." This is true of gravitational potential energy.
123. This large tree has more gravitational potential energy than this small tree.
124. Let's see what happens when we cut down this small tree. As you can see, it came down with a small force.
125. But when we cut down this large tree, it comes down with a large force.
126. **Graphic Transition - Energy Conversions**
127. We have already learned that there are five main forms of energy.
128. But did you know that these forms of energy are interchangeable?
129. Energy is able to be converted into many different forms.
130. When you rub your hands together, mechanical energy is converted into heat energy.

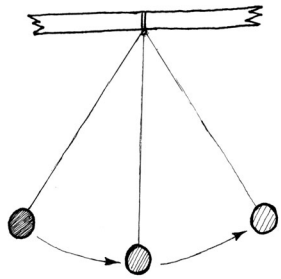


Script

131. And when you light a match an energy conversion occurs.
132. When the match head is rubbed against the box, mechanical energy changes to heat energy.
133. The heat energy causes the chemicals in the match head to ignite.
134. Chemical energy is then converted to heat energy that we can feel and light energy that we can see.
135. During photosynthesis in plants, electromagnetic energy from the sun is converted into chemical energy to be stored in the plant.
136. Energy can also be converted from potential energy to kinetic energy and vice versa.
137. **Graphic Transition - The Law of Conservation of Energy.**
138. Almost everything in this world can be created or destroyed. Can you think of one thing that can not?
139. That's right! - energy
140. The law of conservation of energy states that energy can not be created or destroyed, only changed in form.
141. Take a light bulb for example. Have you ever noticed that a light bulb gets very hot when you turn it on?
142. This heat energy is formed from excess electromagnetic energy which was not converted into light energy. No energy was lost - it simply changed form.
143. **Graphic Transition - Summing Up**
144. During the past few minutes we have discussed energy.
145. We identified the five different forms of energy, including mechanical, nuclear, heat, chemical, and electromagnetic energy.
146. We investigated kinetic energy and the factors it depends on : mass and velocity.
147. We studied potential energy as well as gravitational potential energy.
148. We also took a quick look at energy conversions....
149. ...and explained the law of conservation of energy.
150. So the next time you flip on a light,...
151. ...eat a piece of food,...
152. ...or go for a run, take a minute to think about how energy is involved in your life. You might just think of energy a little bit differently.

Video Quiz

1. Energy is the ability to do _____.
2. _____ energy is energy associated with motion.
3. _____ energy exists in the bonds that hold atoms together.
4. Electricity is an example of _____ energy.
5. Energy associated with the motion of atoms in matter is called _____ energy.
6. _____ energy is released from the nuclei of atoms.
7. The two states of energy are _____ energy and potential energy.
8. _____ energy is stored energy.
9. _____ potential energy is dependent upon an object's height above a surface.
10. The _____ states that energy may not be created or destroyed, only changed in form.



Answers to Student Assessments

Preliminary Test

1. energy
2. mechanical
3. electromagnetic
4. nuclear
5. potential
6. gravitational
7. conversion
8. electron
9. mass
10. heat
11. False
12. True
13. False
14. False
15. True
16. True
17. False
18. True
19. True
20. True

Video Review

You Decide:

- A. They are all in motion.
- B. the sun
- C. A bulb is lit by electricity flowing through the thin piece of metal in the bulb.
- D. the truck
- E. gravitational potential energy

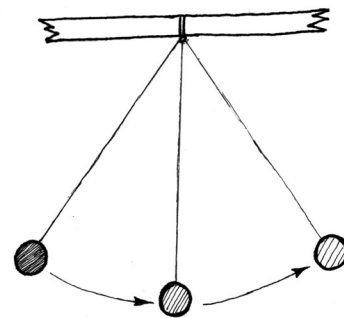
Video Quiz:

1. work
2. mechanical
3. chemical
4. electromagnetic
5. heat
6. nuclear
7. kinetic
8. potential
9. gravitational
10. law of conservation of energy

Post Test

1. True
2. True
3. True
4. True
5. True
6. False
7. True
8. False
9. False
10. False
11. electron
12. mechanical
13. gravitational
14. heat
15. mass
16. electromagnetic
17. conversion
18. energy
19. potential
20. nuclear

Answers to Student Activities



Calculating Kinetic Energy

1. 12,500 J
2. 140 J
3. the baseball
4. 2,835,000 J
5. 0 - He is not moving and therefore has no kinetic energy.

Reaching Your Potential

1. 14000 J
 2. 50000 J
 3. 3500 m
- A. 2 and 4
B. 3
C. 3
D. 2 and 4
E. 3

A Perfect World

Essays will vary.

Observing the Greenhouse Effect

Conclusions: The jar covered with the plastic bag illustrates the greenhouse effect. The plastic bag simulated the gasses which form from burning fuels. The temperature of the water in the covered jar should be higher than that of the uncovered jar. This experiment illustrates how the build up of gasses in our atmosphere has caused the world to heat up and undergo global warming.

Pendulum Potential

Conclusions: The golf ball has the greatest potential energy at the two highest points of its swing. It has the least potential energy at the bottom of its swing. This is where the ball has the most kinetic energy. The ball should swing almost all the way back to the release point. This supports the law of conservation of energy, which states that energy cannot be created or destroyed, only changed in form.

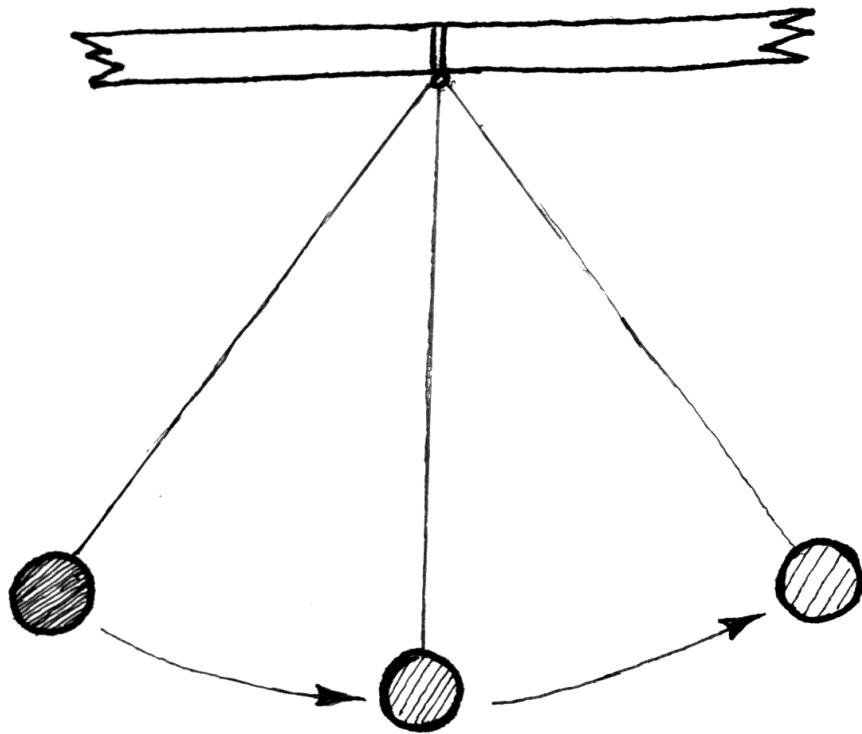
Energy Inventors

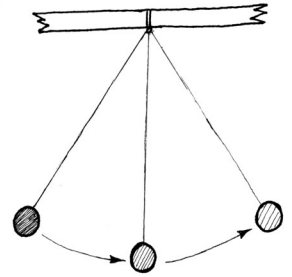
1. Count Alessandro Volta
2. Granville T. Woods
3. Albert Einstein
4. Anders Celsius
5. Lewis Howard Latimer
6. George Simon Ohm
7. Marie Curie
8. Lise Meitner
9. Nikola Tesla
10. James Prescott Joule

Vocabulary of Motion

1. law of conservation of energy, d
2. gravitational potential energy, e
3. nuclear energy, a
4. potential energy, f
5. energy, b
6. electromagnetic energy, c
7. kinetic energy, j
8. chemical energy, i
9. mechanical energy, h
10. heat energy, g

Assessment and Student Activity Masters





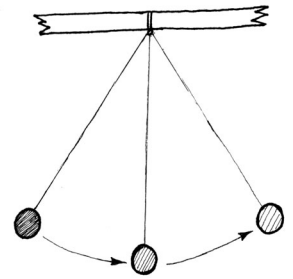
Preliminary Test

Directions: Fill in the blank with the correct word. A list of possible answers is provided at the bottom of the page.

1. The ability to do work is called _____.
2. A car travelling down a highway has a great deal of _____ energy.
3. Power lines carry _____ energy in the form of electricity.
4. _____ energy is the most concentrated form of energy.
5. _____ energy is energy of position.
6. A falling raindrop has _____ potential energy.
7. When kinetic energy changes into potential energy, it undergoes an energy _____.
8. An _____ is a particle that is even smaller than an atom.
9. _____ and velocity are used to calculate kinetic energy.
10. When you rub your hands together you convert mechanical energy into _____ energy.

heat
mechanical
electromagnetic
gravitational
electron
mass

energy
atom
nuclear
conversion
potential
light

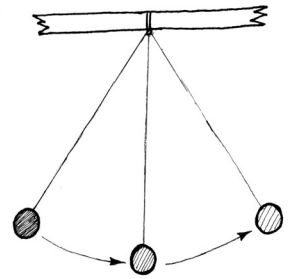


Preliminary Test

Directions: Decide whether the statement is True (T) or False (F).

- | | | |
|--|---|---|
| 11. The slower atoms move, the more heat energy they contain. | T | F |
| 12. Chemical energy holds atoms together. | T | F |
| 13. The two states of energy are kinetic and static. | T | F |
| 14. The energy of motion is called potential energy. | T | F |
| 15. Chemical energy stored in food is an example of potential energy. | T | F |
| 16. Gravitational potential energy is calculated by multiplying the weight of an object by its height above a surface. | T | F |
| 17. Only some types of energy can be converted to other forms. | T | F |
| 18. Energy cannot be created or destroyed. | T | F |
| 19. Energy conversions occur without gain or loss of energy. | T | F |
| 20. The nucleus is the center of an atom. | T | F |

Video Review



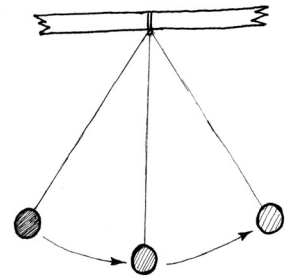
Directions: During the course of the program answer the “You Decide” questions as they are presented in the video. Answer the video quiz questions at the end of the video.

You Decide:

- A. What do the following things have in common- these race cars, this skateboarder, and this stream? Answer: _____
- B. Where does nuclear energy exist in space? Answer: _____
- C. What causes this light bulb to give off light? Answer: _____
- D. Which has more kinetic energy- this tennis ball, or this truck? Answer: _____
- E. What type of potential energy is dependant on the height of an object above Earth’s surface? Answer: _____

Video Quiz:

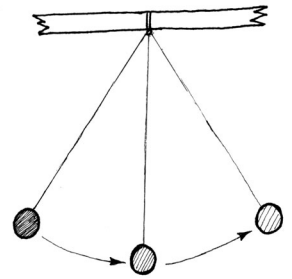
- Energy is the ability to do _____.
- _____ energy is energy associated with motion.
- _____ energy exists in the bonds that hold atoms together.
- Electricity is an example of _____ energy.
- Energy associated with the motion of atoms in matter is called _____ energy.
- _____ energy is released from the nuclei of atoms.
- The two states of energy are _____ energy and potential energy.
- _____ energy is stored energy.
- _____ potential energy is dependant on an object’s height above a surface.
- The _____ states that energy may not be created or destroyed, only changed in form.



Post Test

Directions: Decide whether the statement is True (T) or False (F).

- | | | |
|---|---|---|
| 1. Energy conversions occur without gain or loss of energy. | T | F |
| 2. Chemical energy holds atoms together. | T | F |
| 3. Gravitational potential energy is calculated by multiplying the weight of an object by its height above a surface. | T | F |
| 4. Energy cannot be created or destroyed. | T | F |
| 5. Chemical energy stored in food is an example of potential energy. | T | F |
| 6. The two states of energy are kinetic and static. | T | F |
| 7. The nucleus of an atom is the source of nuclear energy. | T | F |
| 8. The energy of motion is called potential energy. | T | F |
| 9. The slower atoms move, the more heat energy they contain. | T | F |
| 10. Only some types of energy can be converted to other forms. | T | F |



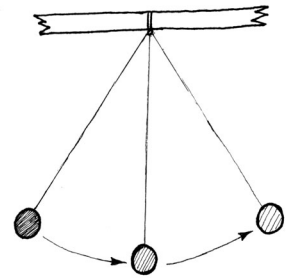
Post Test

Directions: Fill in the blank with the correct word. A list of possible answers is provided at the bottom of the page.

11. An _____ is a particle that is even smaller than an atom.
12. A car travelling down a highway has a great deal of _____ energy.
13. A falling raindrop has _____ potential energy.
14. When you rub your hands together you convert mechanical energy into _____ energy.
15. _____ and velocity are used to calculate kinetic energy.
16. Power lines carry _____ energy in the form of electricity.
17. When kinetic energy changes into potential energy, it undergoes an energy _____.
18. The ability to do work is called _____.
19. _____ energy is energy of position.
20. _____ energy is the most concentrated form of energy.

heat
mechanical
electromagnetic
gravitational
electron
atom

mass
energy
nuclear
light
conversion
potential



Calculating Kinetic Energy

Objective: In this lab you will learn to calculate kinetic energy.

Directions: Use the information provided below to answer the following questions. Use the back of this page to do your calculations.

Background:

Chances are you have seen a baseball bat hit a baseball, or a hammer drive a nail into a piece of wood. If so, you have witnessed **kinetic energy**, or energy of motion. The hammer and the bat do work on the nail and ball by colliding with them and moving them through a certain distance. Because these objects are able to do work, they have energy. This energy is kinetic energy because it is associated with motion.

So how do we calculate the amount of kinetic energy an object possesses? In order to find the kinetic energy of an object, we must first know its mass and the velocity at which it travels. The equation used to calculate kinetic energy is as follows:

$$\text{Kinetic Energy}^{**} = \frac{\text{Mass} \times \text{Velocity}^2}{2}$$

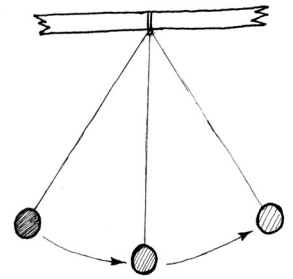
** Kinetic energy is measured in units called Joules (J).

***We can predict that any increase in either the mass or velocity of an object will result in an increase in its kinetic energy.

Questions:

1. A moving car has a mass of 1000 kilograms and is travelling at 5 meters per second (m/s). What is the kinetic energy of the car?
2. A boy has a mass of 70 kg and is running at a velocity of 2 m/s. What is his kinetic energy?
3. A baseball with a mass of .5 kg is thrown at a speed of 15 m/s. A softball with a mass of 1 kg is thrown at a speed of 10 m/s. Which ball has more kinetic energy?
4. A small plane with a mass of 700 kg is flying through the air at 90 m/s. What is its kinetic energy?
5. A skier with a mass of 90 kg is standing at the top of a ski slope. What is his kinetic energy?

Reaching Your Potential



Objective: In this lab you will learn to calculate gravitational energy.

Background: What do a skier at the top of a ski slope, a stretched rubber band, and a jack-in-the-box all have in common? That's right! They all have **potential energy**, or stored energy. You might be wondering how these objects have energy because they do not seem to be working, but they are! These objects are doing work by storing energy that was previously gained. Take the rubberband for example. The rubberband gains energy when it is stretched. It then does work to store that energy so that it may be released when the rubberband is shot across the room. So once the rubber band and the other objects have stored energy, they have potential energy. The skier has the potential to ski down the mountain. The rubberband has the potential to shoot across a room. And finally, the jack-in-the-box has the potential to pop up out of its box.

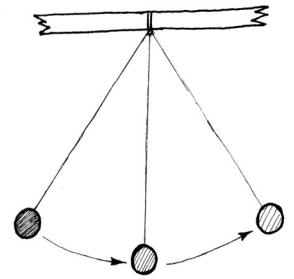
Remember the skier at the top of the ski slope? He has a special kind of potential energy - gravitational potential energy. **Gravitational potential energy** is potential energy that depends upon an object's weight as well as its height above a surface. In other words, objects with the potential to fall to the surface of the Earth have gravitational potential energy. Other examples of objects with gravitational potential energy include a woman standing on a bridge before bungee jumping or in a plane before sky diving. The equation used to calculate the gravitational potential energy of an object is as follows:

$$\text{Gravitational Potential Energy} = \text{Weight} \times \text{Height (above a surface)}$$

From this equation we can predict that the higher an object is above a surface, or the more it weighs, the greater its potential energy.

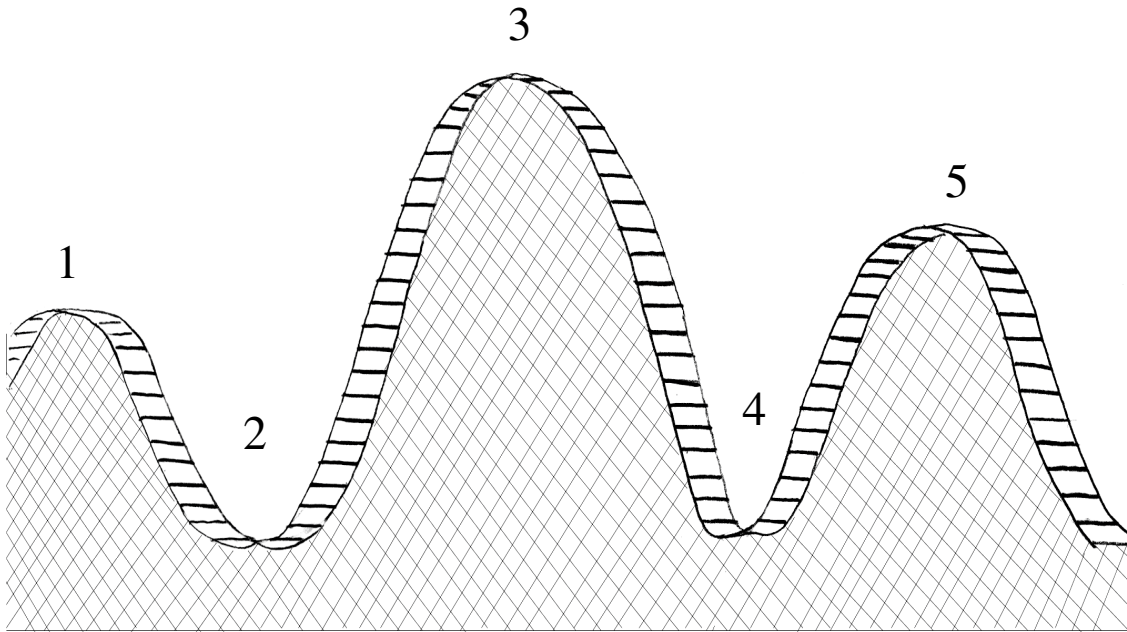
Directions: Use the information provided above to complete the following calculations. You may use the back of this page to do the calculations.

1. A woman weighing 70 kilograms prepares to bungee jump off a bridge. If the bridge is 200 meters high, how much potential energy (J) does she have?
2. A boulder weighing 500 kg teeters on the edge of a 100 meter high cliff. What is its potential energy (J)?
3. A man weighing 100 kg prepares to sky dive from a plane. If he has a potential energy of 350,000 J, how high above ground is the plane?

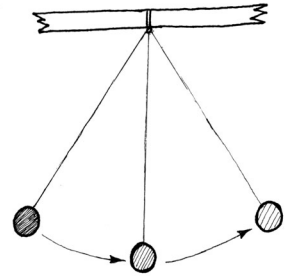


Reaching Your Potential

Directions: Examine the picture of the roller coaster below. Use the information on the previous page to answer the following questions



- A. At what point(s) does the roller coaster car have the least potential energy?
- B. At what point(s) does the roller coaster car have the most potential energy?
- C. Does the car have more potential energy at point 3 or 5?
- D. At what point(s) does the roller coaster car have the most kinetic energy?
- E. At what point(s) does the roller coaster car have the least kinetic energy?

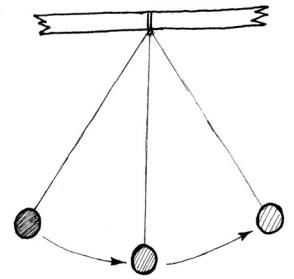


A Perfect World

Background: The environment is a popular topic in our society today. Chances are you have heard environmentalists talk about conserving energy and maintaining our environment. The human race, along with plants and animals all around us, continuously feel the effects of creating energy. Power plants have contributed to massive air pollution as well as the emergence of acid rain. Automobiles, fueled by gasoline, emit chemicals into our air everyday, resulting in smog which can make the air unhealthy to breathe. Fortunately, this pollution has not gone unnoticed. People in many parts of the world have formed organizations in an attempt to clean up our air and our environment. Now it is time for you to get involved!

Directions: Use your imagination to create your own environmentally safe world. In a one page essay, describe the world you would create. Include answers to the following questions. You may use the bottom portion and backside of this page to complete your essay. After writing your essay, share it with your classmates and discuss each other's ideas. As a class, try to develop an energy-efficient world.

1. What type of energy would be most commonly used?
2. How would this type of energy be safer for the environment?
3. How would you make automobiles and other forms of transportation more environmentally friendly?
4. How would you regulate industries and factories that cause air pollution?
5. How would you educate the people of your perfect world about the need to keep the environment clean?



Observing the Greenhouse Effect

Objective:

In this lab activity, you will recreate the greenhouse effect and learn how this has led to global warming.

Background:

Climates are constantly changing all around us and have been doing so for centuries. Forests have found homes in milder, cooler climates over the years and at one point, sheets of ice covered much of North America. While these changes were drastic, they were natural. Today we may be facing a change in our climate caused by human beings. This change is called **global warming**.

Global warming is believed to result from the burning of fuels. These fuels include natural gas, coal, oil, and others. When these fuels are burned, gasses are formed and released into the air. Over time, these gasses have built up in the atmosphere. The gasses have formed a film in our atmosphere that acts like the glass of a greenhouse. This film allows heat energy to enter our atmosphere but prevents it from escaping. This is called the **greenhouse effect**. As you will observe in the following experiment, this film causes the Earth to heat up, leading to global warming.

Materials:

Cold water (about 6 cups)
2 Identical glass jars
1 Clear plastic bag
Thermometer
12 Ice cubes

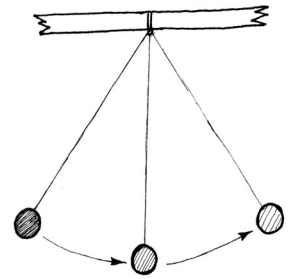
Procedure:

1. Fill each of the glass jars with 3 cups of water.
2. Place 6 ice cubes in each jar.
3. Wrap one jar with the plastic bag.
4. Allow both jars to sit in the sun for approximately 1 hour.
5. Measure the temperature of the water in both jars.

Conclusions:

Which jar was illustrating the greenhouse effect? What is the role of the plastic bag? Was the temperature of the water in the covered jar higher or lower than that of the uncovered jar? Relate this experiment to what is occurring in our atmosphere today.

Pendulum Potential

**Objective:**

In this activity, you will construct a pendulum and observe conversions between kinetic and potential energy.

Background:

We see kinetic and potential energy around us everyday. A woman running on a track has kinetic energy, while a skier at the top of a mountain has potential energy. But have you ever noticed a situation in which kinetic and potential energy were continuously converted, back and forth? There are many of these types of situations in everyday life. When you toss a basketball in the air, it initially has kinetic energy as it travels upward. It then slows down and reaches its highest point. At this point, the ball has potential energy. It then travels downward again, converting potential energy back into kinetic energy. This is just one of the many conversions happening around us all the time. If you pay attention, you may just notice a few during your own day!

Materials.

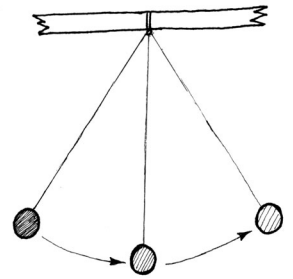
Broom handle (any pipe-like structure)
String (medium thickness)
Golf ball
Tape

Procedure:

1. Balance the broom handle on two chairs so that it is stable.
2. Cut about 1.5 ft. of string.
3. Wrap the string around the handle once and then tie a knot so that the remaining string hangs down towards the floor.
4. Tape the string to the golf ball. Make sure the ball is securely attached to the string.
5. Experiment with the pendulum you have constructed. Pull the golf ball up to one side and have someone hold their hand at the release point. Collect data on the motion of the ball.

Conclusions:

At what points does the golf ball have the most potential energy? At what point does it have the least? At what point does the ball have the most kinetic energy? Does the golf ball swing back up to the approximate point of release? What law does this finding support?



Energy Inventors

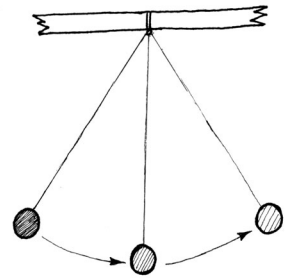
Directions: Use the list of inventors at the bottom of the page to answer the following questions. This will require some research. It may be useful to start with the California Energy Commission “Super Scientists” webpage. Information can also be found in encyclopedias and by searching on the internet.

1. Who developed a unit of electric potential and electromotive force?
2. Who was responsible for modernizing the railroad and inventing the steam boiler furnace?
3. Who discovered the mathematical equation for the nature of energy?
4. Who developed a temperature scale?
5. Whose work led to the widespread use of electric, or incandescent, lights?
6. Who discovered the mathematical law of electrical current?
7. Whose name is used as a unit of measurement of the radioactivity of an element?
8. Which scientist discovered fission?
9. Who invented fluorescent lighting and an induction motor?
10. Which scientist shared in discovering the law of conservation of energy and also developed a unit of energy?

George Simon Ohm
Lewis Howard Latimer
James Prescott Joule
Granville T. Woods
Count Alexxandro Volta

Albert Einstein
Marie Curie
Nikola Tesla
Anders Celsius
Lise Meitner

Vocabulary of Energy



Directions: Match the word with its correct definition.

- | | |
|---------------------------------------|---|
| ___ 1. wal fo nserocniovat of neregy | a. energy trapped in an atom |
| ___ 2. itavtnogriaal ottlainepegreney | b. the ability to do work |
| ___ 3. aecunlr yneerg | c. energy associated with moving charges |
| ___ 4. aitlnotpe greyne | d. energy cannot be created or destroyed |
| ___ 5. nergey | e. potential energy that is dependant upon height above a surface |
| ___ 6. elgortcmanetcie greeny | f. stored energy |
| ___ 7. tiniyec ynereg | g. energy associated with the motion of atoms |
| ___ 8. chcmeail neregy | h. energy associated with motion |
| ___ 9. nialcahcem yeerng | i. energy found in the bonds that hold atoms together |
| ___ 10. ehat geenyr | j. energy of motion that depends on the mass and velocity of an object. |