Exploring Energy

Teacher's Guide

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Table of Contents

National Standards Correlations

Benchmarks for Science Literacy
(Project 2061 - AAAS) Grades 3-5

The Physical Setting
By the end of the 8th grade, students should know that:

Energy Transformation (4E)
- Energy cannot be created or destroyed, but only changed from one form into another.
- Energy appears in different forms. Heat energy is in the disorderly motion of molecules and in radiation; chemical energy is in the arrangement of atoms; mechanical energy is in moving bodies or in elastically distorted shapes; and electrical energy is in the attraction or repulsion between charges.

National Science Education Standards
(Content Standards: K-4 and 5-8, National Academy of Sciences)

Physical Science - Content Standard B
As a result of their activities in grades K-4, all students should develop an understanding of:

Position and Motion of Objects
- Sound is produced by vibrating objects. The pitch of the sound can be varied by changing the rate of vibration.

Physical Science - Content Standard B
As a result of their activities in grades 5-8, all students should develop an understanding of:

Transfer of Energy
- Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.

Student Learning Objectives

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

- Define energy as the ability to do work.
- Cite everyday examples of how energy is used to do work.
- Understand that kinetic energy is sometimes referred to as the energy of motion.
- List some examples of kinetic energy in action.
- Define potential energy as the energy an object has due to its position or shape.
- Explain why potential energy is sometimes described as stored energy, or energy ready to be used.
- Provide an example of an object that has potential energy.
- Define mechanical energy and cite common examples.
- Describe how thermal energy (also called heat energy) increases and decreases in relation to the movement of particles in an object.
- Explain how wood, paper, gasoline, and food are examples of chemical energy.
- List several types of electromagnetic energy, such as light, x-rays, and radio waves.
- Understand that sound energy is the result of the vibration of particles in a solid, liquid, or gas.
- Explain that nuclear energy occurs when the nuclei of atoms are fused together or broken apart.
- Describe how energy conversion involves the change of energy from one form to another.
- Provide an example of energy conversion.

Assessment

Preliminary Test (p. 14-15):

The Preliminary Test is an assessment tool designed to gain an understanding of students' preexisting knowledge. It can also be used as a benchmark upon which to assess student progress based on the objectives stated on the previous pages.

Post-Test (p. 16-17):

The Post-Test can be utilized as an assessment tool following student completion of the program and student activities. The results of the Post-Test can be compared against the results of the Preliminary Test to assess student progress.

Video Review (p. 18):

The Video Review can be used as an assessment tool or as a student activity. There are two sections. The first part contains questions displayed during the program. The second part consists of a five-question video quiz to be answered at the end of the video.

Introducing the Program

Before showing the program, introduce the concepts of kinetic and potential energy. Write the terms on the board and provide a definition of each. Next, drop a book. Ask students to describe what they observed. Then balance the book on the edge of a table. Again, ask students what they observed. Now ask students to use their knowledge of potential and kinetic energy to identify which type of energy existed in each scenario with the book. Have students provide other examples of kinetic and potential energy.

Next, hold the following objects in front of class: a piece of food, a match, a light bulb, and a picture of a bike or skateboard. Ask students what needs to happen to these things for them to be useful. These objects need to be converted to another form of energy to be useful. Explain the process of energy conversion. Then ask students to describe the energy conversions that must take place in order for the objects you held up to become useful. Tell students to pay close attention to the video to learn more about the different types of energy and energy conversions.

Program Viewing Suggestions

The student master “Video Review” (p. 18) is provided for distribution to students. You may choose to have your students complete this master while viewing the program or do so upon its conclusion.

The program is approximately 14 minutes in length and includes a five-question video quiz. Answers are not provided to the Video Quiz in the video, but are included in this guide on page 12. 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.

Video Script

1. What do you use every day to help cook food,...
2. ...to heat or cool your home,...
3. ...to help transport you from one place to another,...
4. ...and to keep your body running?
5. That's right - energy!
6. But what exactly is energy?
7. What forms does it take?
8. And what are some of the different types of energy?
9. During the next few minutes, we are going to answer these questions and others...
10. ...as we explore the fascinating topic of energy.
11. **Graphic Transition- Energy Basics**
12. We can't really see energy in the same way that we see objects around us.
13. But it is possible to see what energy can do.
14. Energy is the ability to do work.
15. Work occurs when an object is moved or changed..
16. **Describe It!**

    Describe how work occurs on this bag of groceries.
17. The bag is lifted from the floor to the counter. In other words, the bag is moved.
18. Energy was needed to do that work.
19. So as you can see, energy and work are closely related.
20. There are hundreds of examples of energy at work around us everyday.
21. **Graphic Transition-Investigating Kinetic Energy**
22. There are two main kinds of energy: kinetic energy and potential energy.
23. Energy is considered kinetic or potential depending on whether or not an object is moving.
24. We see moving objects all the time, such as cars,...
25. ...balls,...
26. ...and even people.
27. These are examples of kinetic energy.
28. Kinetic energy is sometimes referred to as energy of motion.

Video Script

29. Objects with kinetic energy can do work.
30. This moving hammer, for example, performs work when it drives a nail into wood.
31. Every time we move, eat, talk, and write, kinetic energy is at work.
32. **Graphic Transition- Exploring Potential Energy**
33. **You Decide!**

    Does this container have kinetic energy?
34. No, it is not moving and therefore it has no kinetic energy.
35. But it does have the potential to move if dropped.
36. Potential energy is the energy an object has due to its position or its shape.
37. Sometimes potential energy is described as stored energy, or energy ready to be used.
38. This roller coaster is nearly motionless, but it has lots of potential energy because it is positioned at the top of the track and will soon lunge downward.
39. Similarly, this stretched rubber band has potential energy,...
40. ...as does this compressed spring.
41. Let's now take a look at some of the different forms of energy.
42. **Graphic Transition- Different Forms of Energy**
43. Kinetic and potential energy have a variety of different forms.
44. You are familiar with many of these different forms of energy and you use some of them everyday.
45. For example, when you skateboard...
46. ...or ride in a car, you are experiencing a form of energy called mechanical energy.
47. Mechanical energy is associated with motion, or movement.
48. Thermal energy, sometimes called heat, is another form of energy. Thermal energy is the total energy of particles in a material or substance.
49. You probably know that matter is made up of small particles that are all in motion.
50. Thermal energy increases when the particles in an object move faster.
51. For instance, ice cream melts when its thermal energy increases.
52. Chemical energy is another form of energy.
53. **You Predict!**

    What will happen when a flame comes in contact with paper?
54. That's right, the paper burns and it gives off heat energy. This occurs when energy stored in chemical bonds are released within the paper.

Video Script

55. Explosives, such as those used to blast rock,...

56. ...wood....

57. ...and even food, are examples of chemical energy. Our bodies need chemical energy on a regular basis.

58. When an engine burns gasoline, it's using chemical energy. The engine then produces both mechanical and heat energy.

59. Take a second to look at the lights around the room.

60. The lights are emitting another form of energy called electromagnetic energy.

61. Light energy, a type of electromagnetic energy, is essential to the survival of most living things.

62. X-rays, radio waves, and microwaves are a few other types of electromagnetic energy.

63. Every time you talk with someone or listen to music, you are experiencing sound energy.

64. Sound is the result of the vibrations of particles in a solid, a liquid, or a gas.

65. People and animals hear sound energy with their ears.

66. The last type of energy we will discuss is nuclear energy.

67. Nuclear energy is created when the nuclei of atoms are fused or joined together, or are broken apart.

68. Nuclear energy is the source of energy in the sun burning...

69. ...and it's even used here on Earth to help generate electricity in nuclear power plants.

70. Graphic Transition- Energy Conversions

71. You eat food to provide your body with energy...

72. ...so it can carry out its functions...

73. ...and do the things you enjoy.

74. Plants use light energy from the sun, along with water and carbon dioxide gas, to create the food they need.

75. Both of these examples involve energy conversions.

76. Energy conversion involves the change of energy from one form to another.

77. You Decide!

What energy conversion is occurring in this toaster?

78. The toaster is converting electrical energy into heat energy,...

79. ...and heat energy toasts the bread.

80. The rushing water tumbling over Niagara Falls is an example of mechanical energy.

Video Script

81. This building contains devices called generators, which convert the mechanical energy of moving water into electrical energy.
82. Most electricity that we use is produced by electrical generators.
83. All over the world, huge amounts of oil and coal are burned everyday to convert chemical energy into heat energy.
84. This energy is used to warm houses, power engines, and to generate electricity.
85. However, one of the problems with burning fuels, such as oil and coal, is that harmful pollutants are given off in the process. Those pollutants can damage the environment.
86. One of the challenges that scientists face is to develop energy sources and energy conversion processes that are environmentally friendly.
87. **Graphic Transition- Summing Up**
88. During the past few minutes, we have explored the fascinating topic of energy.
89. We discussed the relationship between energy and work.
90. We compared kinetic energy, the energy of motion, with potential energy.
91. We briefly explored the various forms of energy, including mechanical energy, thermal energy, chemical energy, electromagnetic energy, sound energy, and nuclear energy.
92. Last, we discussed how energy can be converted from one form to another form.
93. So, the next time you play a sport,...
94. ...flip on a light switch,...
95. ...or eat,...
96. ...think about some of the things we discussed during the past few minutes.
97. You just might look at energy a little differently.
98. **Graphic Transition-Video Assessment**

Fill in the correct word to complete the sentence. Good luck and let's get started.

1. _____ is the ability to do work.
2. The energy of motion is called _____ energy.
3. The stretched rubber band has _____ energy.
4. An engine burning gasoline is using _____ energy.
5. Energy _____ involves the change of energy from one form to another.

Answer Key to Student Assessments

Pre-Test (p. 14-15)

1. c - work
2. a - moved
3. a - kinetic energy
4. a - unlit match
5. a - nuclear energy
6. d - increases
7. a - chemical energy
8. b - sound energy
9. d - energy conversion
10. b - electrical energy
11. true
12. false
13. true
14. true
15. false
16. Example: A person uses energy to lift a heavy box.
17. Example: A soccer ball rolling into a goal.
18. The rock has potential energy.
19. Energy conversion is the process by which energy changes from one form to another.
20. Electrical energy is converted to heat energy, which toasts the bread.

Post-Test (p. 16-17)

1. a - kinetic energy
2. d - increases
3. a - chemical energy
4. d - energy conversion
5. a - moved
6. b - electrical energy
7. c - work
8. b - sound energy
9. a - unlit match
10. a - nuclear energy
11. true
12. false
13. true
14. false
15. true
16. Energy conversion is the process by which energy changes from one form to another.
17. The rock has potential energy.
18. Electrical energy is converted to heat energy, which toasts the bread.
19. Example: A person uses energy to lift a heavy box.
20. Example: A soccer ball rolling into a goal.

Video Review (p. 18)

1. The bag is lifted from the floor to the counter. It is moved.
2. The container does not have kinetic energy because it is not moving.
3. The paper burns and gives off heat.
4. The toaster is converting electrical energy to heat energy.

1. energy
2. kinetic
3. potential
4. chemical
5. conversion

Answer Key to Student Activities

Vocabulary (p. 19)

1. energy
2. work
3. kinetic energy
4. potential energy
5. thermal energy
6. chemical energy
7. electromagnetic energy
8. nuclear energy
9. mechanical energy
10. energy conversion

Writing Activity (p. 20)

We can't really see energy, but it is possible to see what energy can do. Energy is the ability to do **work**. There are two main kinds of energy. **Kinetic** energy is sometimes referred to as energy of motion. **Potential** energy is referred to as stored energy. There are many different forms of energy. For example, **thermal** energy, sometimes called heat energy, is the total energy of particles in a substance. The energy stored in a match is an example of **chemical** energy. Light, x-rays, and radio waves are example of **electromagnetic** energy. A moving skateboarder is an example of **mechanical** energy, also referred to as the energy of motion. When you talk to someone or listen to music, you are using **sound** energy. **Nuclear** energy is created when the nuclei of atoms are fused together or broken apart. Energy changes from one form to another through the process of energy **conversion**.

Energy Types (p. 21–22)

1. chemical energy
2. electromagnetic energy
3. nuclear energy
4. mechanical energy
5. thermal energy

Kinetic or Potential? (p. 23)

1. potential
2. kinetic
3. kinetic
4. potential
5. kinetic
6. potential
7. potential
8. kinetic
9. examples will vary
10. examples will vary

Energy Conversions (p. 24)

1. electrical; thermal
2. mechanical; electrical
3. nuclear; heat; electrical
4. examples will vary

Energy from Coal (p. 25)

1. Coal was formed from the remains of plants and animals, which were solidified in swampy areas.
2. Coal is abundant, easily transported, and cheaper than other energy sources.
3. Burning coal emits carbon dioxide, a leading cause of global warming, and pollutes air, soil, and water.
4. Examples include reducing energy consumption and using more environmentally-friendly types of energy, such as solar and wind energy.

In Your Own Words (p. 20)

1. Nuclear energy is produced when the nuclei of atoms are fused together or broken apart.
2. Kinetic energy is the energy of motion. Potential energy is stored energy, or energy ready to be used.
3. Mechanical energy, such as wind or moving water, is converted to electrical energy by a generator.

Pre-Test

Name _____

Circle the best answer for each of the following questions.

1. Energy is the ability to do:

a. kinetic ***b. conversion*** ***c. work*** ***d. thermal***

2. Work is done when an object has changed or:

a. moved ***b. burned*** ***c. evaporated*** ***d. synthesized***

3. Energy of motion refers to:

a. kinetic energy ***b. nuclear energy*** ***c. thermal energy*** ***d. potential energy***

4. This is an example of potential energy:

a. unlit match ***b. moving ball*** ***c. speeding car*** ***d. swinging bat***

5. This type of energy is created when the nuclei of atoms are fused together or broken apart:

a. nuclear energy ***b. thermal energy*** ***c. mechanical energy*** ***d. heat energy***

6. Ice cream melts when its thermal energy:

a. decreases ***b. stays constant*** ***c. decelerates*** ***d. increases***

7. The energy we obtain from eating food is an example of:

a. chemical energy ***b. nuclear energy*** ***c. mechanical energy*** ***d. kinetic energy***

8. When you talk to someone or listen to music, you are using this type of energy:

a. light energy ***b. sound energy*** ***c. heat energy*** ***d. electromagnetic energy***

9. Plants using the sun's light energy to make food is an example of:

a. thermal energy ***b. light energy*** ***c. sound energy*** ***d. energy conversion***

10. A generator converts mechanical energy into:

a. light energy ***b. electrical energy*** ***c. thermal energy*** ***d. sound energy***

Pre-Test

Name _____

Write true or false next to each statement.

11. _____ Objects with kinetic energy can do work.

12. _____ A stretched rubber band does not have potential energy.

13. _____ Thermal energy increases when particles move faster.

14. _____ When an engine burns gasoline, it is using chemical energy.

15. _____ Energy conversion does not occur when you cook food.

Write a short answer for each of the following.

16. Provide an example of how energy is used to do work.

_____

_____

17. Cite an example of kinetic energy related to a sport.

_____

_____

18. Does a rock resting on the edge of a cliff have potential or kinetic energy?

_____

_____

19. What is energy conversion?

_____

_____

20. Describe the type of energy conversion involved in toasting bread.

_____

_____

Post-Test

Name _____

Circle the best answer for each of the following questions.

1. Energy of motion refers to:

   a. kinetic energy ***b. nuclear energy*** ***c. thermal energy*** ***d. potential energy***

2. Ice cream melts when its thermal energy:

   a. decreases ***b. stays constant*** ***c. decelerates*** ***d. increases***

3. The energy we obtain from eating food is an example of:

   a. chemical energy ***b. nuclear energy*** ***c. mechanical energy*** ***d. kinetic energy***

4. Plants using the sun's light energy to make food is an example of:

   a. thermal energy ***b. light energy*** ***c. sound energy*** ***d. energy conversion***

5. Work is done when an object has changed or:

   a. moved ***b. burned*** ***c. evaporated*** ***d. synthesized***

6. A generator converts mechanical energy into:

   a. light energy ***b. electrical energy*** ***c. thermal energy*** ***d. sound energy***

7. Energy is the ability to do:

   a. kinetic ***b. conversion*** ***c. work*** ***d. thermal***

8. When you talk to someone or listen to music, you are using this type of energy:

   a. light energy ***b. sound energy*** ***c. heat energy*** ***d. electromagnetic energy***

9. This is an example of potential energy:

   a. unlit match ***b. moving ball*** ***c. speeding car*** ***d. swinging bat***

10. This type of energy is created when the nuclei of atoms are fused together or broken apart:

    a. nuclear energy ***b. thermal energy*** ***c. mechanical energy*** ***d. heat energy***

Post-Test

Name _____

Write true or false next to each statement.

11. _____ Thermal energy increases when particles move faster.

12. _____ Energy conversion does not occur when you cook food.

13. _____ When an engine burns gasoline, it is using chemical energy.

14. _____ A stretched rubber band does not have potential energy.

15. _____ Objects with kinetic energy can do work.

Write a short answer for each of the following.

16. What is energy conversion?

_____

_____

17. Does a rock resting on the edge of a cliff have potential or kinetic energy?

_____

_____

18. Describe the type of energy conversion involved in toasting bread.

_____

_____

19. Provide an example of how energy is used to do work.

_____

_____

20. Cite an example of kinetic energy related to a sport.

_____

_____

Video Review

Name _____

While you watch the video, answer these questions:

1. **Describe it!** Describe how work occurs on this bag of groceries.

_____

_____

_____

2. **You Decide!** Does this container have kinetic energy?

_____

_____

_____

3. **You Predict!** What will happen when a flame comes in contact with paper?

_____

_____

_____

4. **You Decide!** What energy conversion is occurring in this toaster?

_____

_____

_____

After you watch the video, test your knowledge with these questions.

1. _____ is the ability to do work.

2. The energy of motion is called _____ energy.

3. The stretched rubber band has _____ energy.

4. An engine burning gasoline is using _____ energy.

5. Energy _____ involves the change of energy from one form to another.

Vocabulary

Name _____

Use these words to fill in the blanks next to the sentences below.

Words

mechanical energy thermal energy kinetic energy
nuclear energy work chemical energy energy conversion
electromagnetic energy energy potential energy

1. _____ The ability to do work.

2. _____ Occurs when an object is moved or changed.

3. _____ Referred to as the energy of motion.

4. _____ Described as stored energy or energy to be used.

5. _____ The total energy of particles in a material or substance.

6. _____ A form of energy stored in chemical bonds.

7. _____ Examples of this type of energy include light, x-rays, and microwaves.

8. _____ Created when the nuclei of atoms are fused together or broken apart.

9. _____ A form of energy associated with movement.

10. _____ The change of energy from one form to another.

Writing Activity

Name _____

nuclear	work	thermal	conversion	mechanical	
sound	electromagnetic	potential	kinetic	chemical	

Use the correct word from above to complete the sentences in the following paragraph.

We can't really see energy, but it is possible to see what energy can do. Energy is the ability to do _____. There are two main kinds of energy. _____ energy is sometimes referred to as energy of motion. _____energy is referred to as stored energy. There are many different forms of energy. For example, _____ energy, sometimes called heat energy, is the total energy of particles in a substance. The energy stored in a match is an example of _____ energy. Light, x-rays, and radio waves are example of _____ energy. A moving skateboard is an example of mechanical energy, also referred to as the energy of motion. When you talk to someone or listen to music, you are using _____energy. _____ energy is created when the nuclei of atoms are fused together or broken apart. Energy changes from one form to another through the process of energy _____.

In Your Own Words

1. What is nuclear energy?

_____

_____

_____

2. Explain the difference between potential and kinetic energy.

_____

_____

_____

3. Give an example of an energy conversion.

_____

_____

_____

Energy Types

Name _____

Background: Energy is the ability to do work. There are many forms of energy, which are at work all around us.

Activity: Read the definitions of five important types of energy. On the next page, there are several pictures of energy at work. Label the type of energy depicted in each image. In the last box, draw and label an image of a type of energy at work.

Mechanical energy - associated with motion. Mechanical energy is the energy of an object that is moving or can move.

Thermal energy - the total energy of particles in a material or substance. Thermal energy is produced through the movement of these particles; also referred to as heat energy.

Chemical energy - produced when matter is chemically changed into a different form. An example is food being converted into energy that the body can use to move muscles.

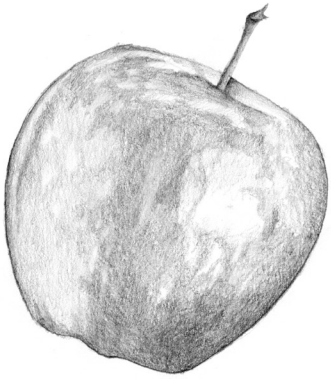
Electromagnetic energy - made up of small electric charges that move in waves. Light and radio waves are examples of electromagnetic energy.

Nuclear energy - created when atoms are joined together and then broken apart. Nuclear energy is the source of energy in the sun. Scientists have created nuclear power plants to generate electricity.

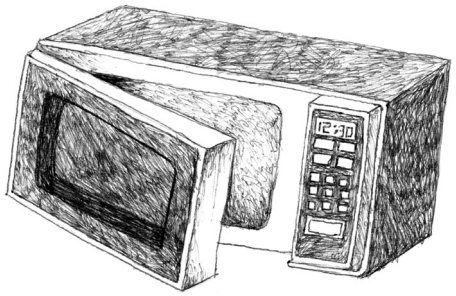
Energy Types

Name _____

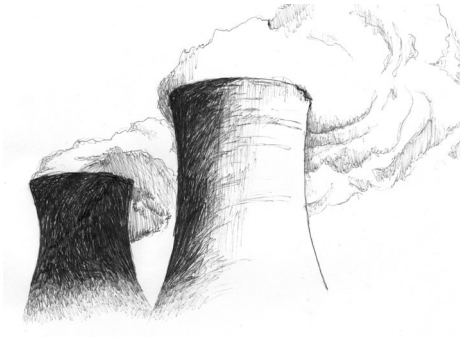
mechanical energy nuclear energy thermal energy
electromagnetic energy chemical energy



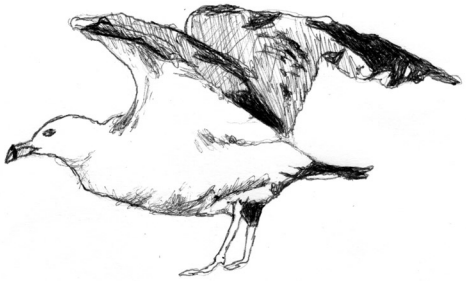
1. _____



2. _____



3. _____



4. _____

5. _____

Your example

Kinetic or Potential?

Name _____

Background: There are two main kinds of energy: kinetic and potential. Kinetic energy is referred to as energy of motion. Objects with kinetic energy can do work. Anything that is moving has kinetic energy. Potential energy is the energy an object has due to its position or shape. Potential energy is sometimes referred to as stored energy, or energy ready to be used.

Activity: Read the descriptions below. Label each description as either kinetic energy or potential energy. In the last two rows, write an example of each kind of energy.

Example	Kinetic or potential?
1. Snowboarder standing at the top of a half pipe, waiting her turn	
2. Boy skating down the street on his skateboard	
3. Dog chasing a ball	
4. Rock sitting on the edge of a steep cliff	
5. Hammer hitting a nail	
6. Book resting on a desk, half of it hanging over the edge	
7. Stretched rubber band	
8. Space shuttle traveling into space	
9.	Kinetic
10.	Potential

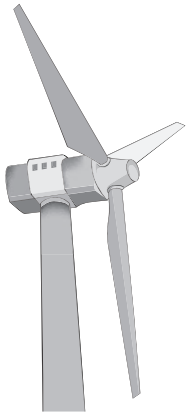
Energy Conversions

Name _____

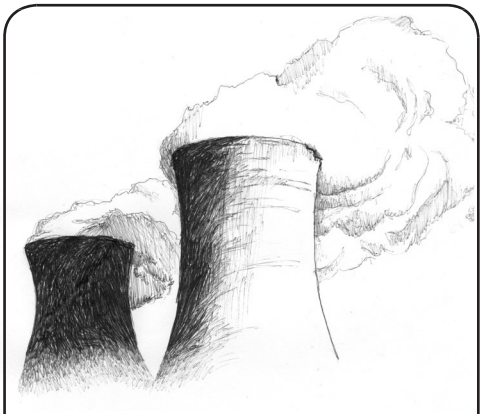
Background: There are many different forms of energy, including electromagnetic, electrical, mechanical, thermal (also referred to as heat), chemical, sound, and nuclear. These different forms of energy can be changed from one form to another. This happens via a process called energy conversion. Boiling a pot of water on a stove is an example of energy conversion. In this example, electrical energy is being converted into heat energy. Generators convert mechanical energy into electrical energy, which we use in our homes. Mechanical energy can come from a variety of sources, such as wind and rushing water.

Activity: In the pictures below, identify the types of energy involved in the conversion.

1. _____ energy is being converted to _____ energy.



2. _____ energy is being converted to _____ energy.



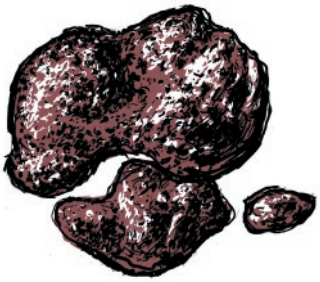
3. _____ energy is being converted to _____ energy and then _____ energy .

Draw your example here

4. _____ energy is being converted to _____ energy.

Energy from Coal

Name _____



Activity: Read the information below and answer the questions that follow.

Millions of years ago, much of Earth's land was covered by swamps. When plants and animals living in these swamps died, their bodies were buried in mud and water. Over time, the remains of once-living organisms solidified to become a sedimentary rock called coal. For this reason, coal is referred to as a "fossil fuel." Coal deposits can be found throughout the world. About 25% of the world's coal reserves are within the United States. Coal can be mined two ways. For coal deposits near the surface, a technique often called strip mining is used, in which layers of soil and rock are removed. Deposits that exist deeper in the Earth must be obtained through underground mining methods.

Coal contains carbon, which means that it can be burned to produce electricity. Because it is abundant, easily transported, and cheaper than other energy sources, it is widely used. In fact, it is used to generate 40% of the world's electricity. Coal is the most abundant fossil fuel. It is estimated that the world's supply of coal will last for 150 - 500 years, depending on the rate at which it is consumed.

Although coal has some advantages, there are also significant drawbacks. The primary problem is that it emits many pollutants into our environment. In fact, it is the largest source of carbon dioxide, a major greenhouse gas that is believed to be the primary cause of global warming. The burning of coal also emits methane, another gas linked to global warming. It is estimated that hundreds of thousands of people die each year from lung cancer, caused by these pollutants. Sulfur dioxide, a major contributor to acid rain, is also released when coal is burned. Acid rain is harmful to soils, plants, animals, and buildings. In addition, when coal surfaces are exposed during strip mining, water running through the mines becomes contaminated with pollutants, which kill fish, plants, and aquatic animals. As you can see, it is important that we find a cleaner, more environmentally-friendly source of energy or develop ways to cleanly mine and burn coal.

Questions:

1. Why is coal referred to as a fossil fuel?

2. Why is coal widely used?

3. List two drawbacks to using coal.

4. How do you think we can reduce the amount of carbon dioxide that is emitted when using coal?