Solar Education for NY
SchoolPower...Naturally

Energy Misconceptions

SPN LESSON #1

TEACHER INFORMATION

LEARNING OUTCOME

After taking a true-false quiz and completing a series of activities focusing on energy concepts, students identify their own previously held misconceptions about energy.

LESSON OVERVIEW

In this lesson, students take a true-false quiz. They read ten different statements and decide whether the energy concept expressed in each is correctly stated. After completing the quiz, class answers are tabulated but no confirmation is made of what is right or wrong. The quiz papers are handed in.

Then students complete a series of energy activities and retake the quiz. The earlier quiz is returned and students review their original answers. They reevaluate each of their responses and make necessary changes. Next, pairs of students compare answers and determine where they agree and disagree. Where there is disagreement, they must reach consensus and decide on one answer. They may use class notes and other references to reach a decision. Both names should appear at the top of the paper. A new tabulation of answers is made and responses are discussed. At this time the energy concepts are reviewed, along with the reason why each statement is either true or false.

GRADE-LEVEL APPROPRIATENESS

This lesson is intended for use with students in grades 7-8 but may be used at higher grade levels.

MATERIALS

A copy of the student handout "Energy Misconceptions True-False Quiz"

SAFETY

There are no specific safety concerns associated with this activity.

TEACHING THE LESSON

Before class:

Copy the student handout "Energy Misconceptions True-False Quiz."

During class, part A:

- Introduce the lesson by explaining to students that they will be studying energy and that you want to find out what they already know about the topic. Also explain that it is important for you to be aware of any misconceptions they have about certain energy-related topics. Explain that misconceptions are mistaken ideas or misunderstandings about

something. An example of a misconception is that breathing swamp air causes malaria. Since people living near swampy areas are more likely to become ill with malaria than people living in the mountains, the air was thought to be the reason. Through scientific study and improved technology, we now know that this is not true. It's the mosquitoes that live in the swamps that are the real culprits.

- Administer the quiz. Before collecting the student papers, read through each statement and ask all students who think the statement is true to raise their hands. Record the number. Then ask who thinks the statement is false, and record that number as well. It is important to record class responses on a transparency, for future use as a reference. Do not tell students what the correct answers are or the reasons why.

During class, part B:

- After working through a series of energy activities, readminister the quiz. Provide each student with his/her original quiz sheet. Ask students to examine their answers and change any they no longer feel are correct.
- Pair students with a partner and tell them to compare answers. If they agree, they should put both names on both papers and be ready to defend their thinking. If they disagree, they may use class notes and other references to reach consensus. Once all answers on both papers are the same, they should put both names on both papers and be ready to defend their thinking.
- Again, before collecting the student papers, read through each statement and ask all students who think the statement is true to raise their hands. Record the number. Then ask who thinks the statement is false, and record that number as well. This time provide students with information about what the correct response for each should be and briefly explain why. Compare how students did the first time they took the quiz to this time. Ask students to describe what helped them to dispel some of their misconceptions.
- It is appropriate to use this quiz even though not all of the concepts are a part of the current energy unit. Explain that energy is important to both the living and nonliving environments and that the same laws are at work.

SOURCE OF THIS ADAPTED ACTIVITY

The basic idea for this activity came from *"Electricity" Misconceptions in K - 6 Textbooks*, by William J. Beaty, at http://www.amasci.com/miscon/eleca.html#current

ACCEPTABLE RESPONSES FOR DEVELOP YOUR UNDERSTANDING SECTION and BACKGROUND INFORMATION

Activity Analysis

1. Energy is found only in living things.

FALSE: This statement is not correct because everything has energy. In physics, *energy* is defined as the ability or capacity to do work or to produce change. Forms of energy include heat, light, sound, electricity, and chemical energy. The composition of an object or its position determines what kind of energy it has (e.g., chemical, potential, thermal). Living things are unique because they have the ability to convert energy in the food they consume to another form.

For more information, go to *The Columbia Encyclopedia*, Sixth edition, 2001, at http://webdoc.sub.gwdg.de/ebook/p/2005/bartleby/www.bartleby.com/65/default.htm

2. ***Electric current is a flow of energy.***

FALSE: Electric current is actually the very slow flow of charged particles. On the other hand, electric energy is different in that it moves *very* rapidly. Electric energy moves at a different speed than electric current; so there must be two different things flowing in wires at the same time.

In an electric circuit, the path of the charges is circular. The path of the energy is not. A battery can send electric energy to a light bulb, and the bulb changes electrical energy into light. The energy does not flow back to the battery again. At the same time, the electric current is a circular flow, and the charges flow through the light bulb filament and return to the battery.

Electric energy can even flow in a direction opposite to that of the electric current. In a single wire, electric energy can move continuously forward while the direction of the electric current is alternating back and forth at high frequency.

For more information, go to *"Electricity" Misconceptions in K - 6 Textbooks*, by William J. Beaty, at http://www.amasci.com/miscon/eleca.html#current

3. ***The "electricity" that flows in wires is supplied by generators.***

FALSE: The electric current in a copper wire is actually a flow of electrons. These electrons are not supplied by batteries. Generators do not "generate" them. The electrons come from the wire itself. In copper wire, atoms supply the flowing electrons. The electrons in a circuit were already there before the battery or generator such as a photovoltaic cell was connected. They were even there before the copper was mined and made into wires! Batteries and generators do not create these electrons but merely pump them. The electrons are like a preexisting fluid that is found within the wires making up a circuit. Many textbooks state that "batteries and generators create current electricity." Rephrase this to something like "batteries and generators cause electric charge to flow."

For more information, go to *"Electricity" Misconceptions in K - 6 Textbooks*, by William J. Beaty, at http://www.amasci.com/miscon/eleca.html#current

4. ***Energy is associated only with movement.***

FALSE: Nonmoving objects have potential energy. The composition of an object or its position determines what kind of energy it has (e.g., chemical, potential, thermal). A moving object has kinetic energy.

For more information, go to *The Columbia Encyclopedia*, Sixth edition, 2001, at http://webdoc.sub.gwdg.de/ebook/p/2005/bartleby/www.bartleby.com/65/default.htm

5. ***Energy is created as the result of an activity.***

FALSE: As the result of an activity or process, energy is transferred from one system to another. Examples include generating electricity and eating food. No additional energy is created during an activity. If this were the case, energy would be created from nothing—and that is impossible!

The first law of thermodynamics, often called the law of conservation of energy, states that energy can be transferred from one system to another in many forms. However, it cannot be created or destroyed. Thus, the total amount of energy available in the universe is constant. Einstein's famous equation $E = MC^2$ describes the relationship between energy and matter. Energy (E) is equal to matter (M) times the square of a constant (C). Einstein suggested (by way of his equation) that the quantity of energy and matter in the universe is fixed.

For more information, go to:

- *The Columbia Encyclopedia*, Sixth edition, 2001, at http://webdoc.sub.gwdg.de/ebook/p/2005/bartleby/www.bartleby.com/65/default.htm
- *Energy and Matter: The Laws of Thermodynamics*, created by Michael J. Pidwirny, Ph.D., Department of Geography, Okanagan University College,

6. Energy can be recycled through an ecosystem many times.

FALSE: Energy "flows" through an ecosystem in the form of carbon-carbon bonds. When respiration occurs, the carbon-carbon bonds are broken and the carbon is combined with oxygen to form carbon dioxide. This process releases the energy, which is either used by the organism (to move its muscles, digest food, think, and so on) or lost as heat. Most of the energy in an ecosystem comes from the Sun. The ultimate fate of all energy in all ecosystems is to be lost as heat. Energy does not recycle!!

The field of thermodynamics studies the behavior of energy flow in natural systems. It is the second law of thermodynamics that deals with the fact that energy cannot be cycled through an ecosystem in the same way that matter is. It deals with the fact that heat can never pass from a colder to a hotter object. Natural processes that involve energy transfer must have one direction, and all natural processes are irreversible. This law also predicts that the entropy of an isolated system increases over time. Entropy is the measure of the disorder or randomness of energy and matter in a system. Because of the second law of thermodynamics, both energy and matter in the universe are becoming less useful as time goes on.

For more information, go to:

- *Energy and Matter: The Laws of Thermodynamics*, created by Michael J. Pidwirny, Ph.D., Department of Geography, Okanagan University College
- *Energy Flow Through Ecosystems* at the Marietta College Environmental Biology – Ecosystems Page http://w3.marietta.edu/~biol/102/ecosystem.html#Energyflowthroughtheecosystem3

7. Energy is a fuel.

FALSE: Fuel is a source of energy but is not itself energy. Fuel is a resource such as coal, oil, and the food we eat. Fuels have potential energy in the chemical bonds that make up the substance.

Fuel is defined as something that is burned to provide power or heat. It could also be fissionable material used to create power in a nuclear generator.

For more information, go to *The Columbia Encyclopedia*, Sixth edition, 2001, at http://webdoc.sub.gwdg.de/ebook/p/2005/bartleby/www.bartleby.com/65/default.htm

8. Photosynthesis converts light energy into usable chemical energy.

TRUE: Photosynthesis does convert light energy into chemical energy. All the food we eat and all the fossil fuel we use are products of photosynthesis, which is actually a complex series of reactions that convert the energy in sunlight to chemical forms of energy that can be used by biological systems. Photosynthesis is the process by which plants, some bacteria, and some protozoans use the energy from light to produce sugar. The best-known form of photosynthesis is the one carried out by higher plants and algae, as well as by cyanobacteria and their relatives. Energy for photosynthesis is provided by light, which is absorbed by pigments (primarily chlorophylls and carotenoids). Chlorophylls absorb blue and red light and carotenoids absorb blue-green light. Green and yellow light are not effectively absorbed by photosynthetic pigments in plants. These colors are either reflected by leaves or passed through leaves. This is why plants are green. The yellow pigments, when present, are overshadowed by the green chlorophyll. This can be proven to students through chromatography.

For more information, go to:

- FT Exploring: Science and Technology Education at http://www.ftexploring.com/index.html
- Introduction to Photosynthesis and Its Applications [level: middle school and above] – This basic introduction to photosynthesis explains areas studied by researchers and highlights much of the work done at the Photosynthesis Center.

9. Photovoltaic cells convert light energy into electrical energy.

TRUE: Photovoltaic solar cells directly convert sunlight into electricity (electrical energy). They are made of semiconducting materials. The simplest cells power watches and calculators, while more complex systems can light houses and provide power to the electric grid. For more information, go to the U.S. Department of Energy Efficiency and Renewable Energy Web site http://www.eere.energy.gov/RE/solar_photovoltaics.html

10. Photovoltaic systems cause electricity to flow through conductors.

TRUE: All conductors are full of movable charge. That's what a conductor is—a material that contains movable charge.

When the Sun is shining on a photovoltaic cell, the cell is like your heart: it moves blood, but it does not create blood. The conductors are like your veins and arteries. When the Sun goes down, or when the metal circuit is opened, all the electrons stop where they are, and the wires remain filled with electric charges. This isn't unexpected because, to begin with, the wires were full of charge.

For more information, go to *"Electricity" Misconceptions in K - 6 Textbooks*, by William J. Beaty, at http://www.amasci.com/miscon/eleca.html#exist

EXTENDED ACTIVITIES

Survey

Students could use the quiz as a survey. Ask them to select several different age groups for comparison. They might want to each ask five high school students (15 to 18 years old), five college students (19 to 22 years old), five adults in the parent age range (35 to 45 years old), and five adults in the grandparent age range. Have students compile their findings and do an analysis of the results. They might answer such questions as: Was there a difference in the number of correct responses from one age group to the next? If there is a difference, how can it be explained? If there is no difference, how can this be explained? What could the class do to help people to become better informed?

Research

Assign each question to a different student team. Ask them to research the question and to create a poster that illustrates the concept correctly. The poster should have some sort of graphic or data table along with text. The text should be limited so that a person examining the poster might read through it in a short time (five minutes or less).

Class Project

Ask students to search for examples of bad science on the Web or in books. Have them quote the claim, reference the source, and then explain what is wrong.

ADDITIONAL SUPPORT FOR TEACHERS

Addressing misconceptions is a critical part of every lesson. Previous knowledge can either help or hinder the understanding of new information. Before students can learn new concepts, they often must reconceptualize misconceptions that interfere with learning. “Teachers can help students change their original conceptions by helping students make their thinking visible so that misconceptions can be corrected and so that students can be encouraged to think beyond the specific problem or to think about variations on the problem.” (Bransford, 1999) The true-false quiz serves to reveal student misconceptions. It is then easier to design bridging activities, demonstrations, and other learning strategies to overcome these misconceptions.

REFERENCES FOR BACKGROUND INFORMATION

Bransford, John, Ann Brown, and Rodney Cocking. *How People Learn.* National Academy Press, Washington, DC, 1999.

Chiras, Daniel D. *Environmental Science: A Framework for Decision Making.* Addison-Wesley Publishing Company, Menlo Park, CA, 1989.

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Smith, Leo. *Ecology and Field Biology.* 4th edition. HarperCollins Publisher, New York, 1990.

Wright, Richard T. and Bernard J. Nebel. *Environmental Science: Toward a Sustainable Future.* Pearson Education, Inc., Upper Saddle River, NJ, 2002.

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(STUDENT HANDOUT SECTION FOLLOWS)

Name_____

Date _____

Energy Misconceptions True-False Quiz

A misconception is a mistaken idea or view resulting from a misunderstanding of something. All of us have many misconceptions about common, everyday events. If you think back to when you were very young, you can probably remember believing that something happened for a reason that you now know is not true. One common misconception that many people have is that Earth is closer to the Sun during our summer months than during the winter. Not true! Even though it seems reasonable, scientists have learned that it is during our winter that Earth is closest to the Sun.

There are many misconceptions regarding energy and the use of energy. Read the ten statements below. Each relates information about energy. Some of the statements are based on common misconceptions and some are true. After each statement, circle the *T* if you feel that the statement is in fact true and circle the *F* is you feel the statement is false.

1. Energy is found only in living things. T F

2. Electric current is a flow of energy. T F

3. The "electricity" that flows in wires is supplied by generators. T F

4. Energy is associated only with movement. T F

5. Energy is created as the result of an activity. T F

6. Energy can be recycled through an ecosystem many times. T F

7. Energy is a fuel. T F

8. Photosynthesis converts light energy into usable chemical energy. T F

9. Photovoltaic cells convert light energy into electrical energy. T F

10. Photovoltaic systems cause electricity to flow through conductors. T F