LESSON 1 What is Energy?

Overview

In this lesson students review what they know about energy in everyday life, define it, learn the different energy forms through play, and differentiate between **potential and kinetic energy**.

Student Learning Targets

- I can use my own words to show I understand "energy."
- I can describe the main forms of energy and give examples.
- I can show potential and kinetic energy with my body and I can give examples of each.
- I can give examples of how I use energy every day.

NGSS

MS-PS3-5.

Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. [Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.] [*Assessment Boundary: Assessment does not include calculations of energy.*]

Background

Energy is part of everything that happens in the world and everything we do. Energy can be in the form of heat, light, gravity, sound, motion, chemical reactions, or electricity. ***Energy is the ability to do work or make a change.***

Nine forms of energy: (see Overhead 1 "Forms of Energy")

- **Chemical**: Chemical energy is the energy stored in the bonds of atoms and molecules. Biomass, petroleum, natural gas, propane and coal are examples of stored chemical energy.
- **Nuclear**: Nuclear energy is the energy stored in the nucleus of an atom. It is the energy that holds the nucleus together. The nucleus of a uranium atom is an example of nuclear energy.
- **Stored Mechanical**: Stored mechanical energy is energy stored in objects or substances and released by the application of a force. Compressed metal springs and stretched rubber bands are examples of stored mechanical energy.
- **Gravitational**: Gravitational energy is the energy of place or position. Water held in a reservoir behind a hydropower dam is an example of

potential gravitational energy. When the water in the reservoir is released to spin the turbines, it becomes motion energy.

- **Radiant**: Radiant energy (light) is electromagnetic energy that travels in transverse waves. Radiant energy includes visible light, x-rays, gamma rays, and radio waves. Solar energy is an example of radiant energy.
- **Thermal**: Thermal energy (or heat) is the internal energy in substances. It is the vibration and movement of atoms and molecules within substances. Geothermal energy is an example of thermal energy.
- **Motion**: The movement of objects or substances from one place to another is motion. Wind is an example of motion energy.
- **Sound**: Sound is the movement of energy through objects or substances in longitudinal waves.
- **Electrical**: Electrical energy is the movement of electrons. Lightning and electricity are examples of electrical energy.

All forms of energy are either **potential** or **kinetic**. Potential energy includes: chemical energy, nuclear energy, stored mechanical energy, and gravitational energy. Kinetic forms include: radiant energy, thermal energy, motion, sound, and electrical energy.

Potential energy is the result of relative shape and/or position; it is stored energy and the energy of position (gravitational)*.* Examples are: a charged battery, a boulder poised at the edge of a cliff, a stretched rubber band, etc. These examples are things that aren't moving but have the potential to release energy. ***Kinetic energy is the energy an object has because of its movement – motion****. It is the motion of waves, electrons, atoms, molecules and substances.* Anything that's moving has kinetic energy. Examples are: a falling object, a running child, and heat.

Vocabulary

Energy, potential energy, kinetic energy, chemical energy, bonds, nuclear energy, stored mechanical energy, gravitational energy, radiant energy, transverse waves, thermal energy, geothermal energy, motion, sound, longitudinal waves, electrical energy, electrons.

Materials

For each student

1 pencil
1 science journal
Handout: "Forms of Energy"

For the class

1 White board or newsprint to record student contributions
Overhead projector and screen
Overhead 1: "Forms of Energy"
Extension cords if using table lamps instead of sun
Overheads 2 through 7

For small teams of students or stations

Team 1 - Water wheel, pan, water
Team 2 - Balloons, fabric tape measure
Team 3 - Wind mills (pin wheels), fan
Team 4 - Radiometer, sun (or lamp)
Team 5 - 2 Glow toys, sun (or lamp), black construction paper, scissors, tape
Team 6 - 15 cc Baking soda, 15 ml vinegar, 1 zip lock bag, 2 measuring cups, 1 thermometer, plastic spoon, instruction sheet to record results
Team 7 - 2 Thermometers, white & black construction paper, sun (or lamp)
Team 8 - 2 Chemical hand warmers, 2 zip lock bags, 2 thermometers, scissors, instruction sheet to record results
Written instructions as needed for Teams 1-8

For Part 2

1-10 Toy steam boats and paraffin candles
Propane lighter per teacher
1-10 Glass or tin pie plates filled with water

Preparation

Gather together supplies with an exploratory set of items in separate piles/boxes/bins for each team. Set up table lamps for teams 4, 5, and 7 if direct sunlight isn't available. Set up fan for team 3.

Part 2
Fill reservoir in toy steamboat with water. Fill pie plate with water. Teachers will light paraffin and place under reservoir in boat until steam is produced and boat moves. Can also be done in teams of students.

Time

Part 1: 55 minutes
Part 2: 5-15 minutes (depending on whether done as teacher demonstration or student teams)

Procedure

1. Tell students that during this lesson they will have a chance to share what they have learned and know about energy and discover some new knowledge through experimentation. Tell them that they are going to begin with a brainstorming activity in which each student will take turns sharing what they have previously learned or already know about energy. THINK-PAIR SHARE: Direct students to draw a web in their journal with energy at the center and at least three things they know about energy. After a minute, have students turn to a partner and share what they have recorded with each other. Ask students to raise their hands to share their ideas and record them in a class web.

   Alternative to THINK-PAIR SHARE
   POPCORN: Another way of doing this is telling them to POPCORN… just 'shout' out answers but they must get their answers recorded. Ask students: "What do you already know about energy?" Record their responses on the white board or newsprint. When a duplicate response is mentioned, put a check next to the item to indicate that another student responded the same, rather than writing it down again.

2. After about 5 minutes, bring the brainstorming to a close. THINK-PAIR SHARE: Direct students to write in their journal a list of ways that they use energy every day to get ready for school, to play, and to live. After a minute, have students turn to a partner and share what they have recorded with each other. Call on each group and record responses.

3. Have groups of 4 students collaborate on "a definition of energy" in their own words. Have them write it on the board when finished. Give them 2-3 minutes. Encourage creative thinking and tell them not to worry about right or wrong answers as even scientists do a lot of educated guessing to learn. After all the groups have written a definition on the board, discuss them as a class and come to a consensus on one strong definition. Write the following definition on the board, discuss how it compares/contrasts with the class definition and have students copy in their science journals*:* ***Energy is the ability to do work or change things.***

4. Use the Overheads 2 through 7 "Energy" to share with students that:
   - Energy makes change
   - Energy makes light
   - Energy makes heat
   - Energy makes motion
   - Energy makes sound

- Energy makes growth

Refer back to original web and highlight or "star" ideas that match these explanations of energy.

5. Ask students: "Have humans ever not used some form or energy? Where did cavemen get energy?" Explain that the sun was the first energy source. It provided heat and light for the first humans; and then humans discovered fire started from lightning. Early explorers captured wind energy to sail their ships, and grind their grain with windmills. Later people started using energy from water motion in water wheels to grind grain. Early Egyptians burned oil and animal fat (chemical energy) for heat and light.

6. Ask students, "How would humans survive today without energy?" Answer: We couldn't.

7. Ask students to "list the different **forms or kinds of energy**." Have them look around the classroom and using all their senses see if they can detect different forms/kinds of energy. Write "*Forms/Kinds of Energy"* on the board and record their answers. If students start naming sources of energy, create a second heading called "*Sources of Energy."* Explain to students the difference and continue to facilitate the answers toward forms rather than sources. Let students know that you will keep the sources list and talk about sources at a later date.

8. Divide the class into small teams, and tell them to explore the items in their box to determine if they can make the object work. Have them detect which form or forms of energy are causing the items to work or causing change. Distribute items to each team. Allow students in teams 4, 5, and 7 to go outdoors if the sun is shining or instruct them to use lamps if not. *Alternative method: you can set up supplies as stations and have all students rotate through each station.*

   Note that Investigations 4 and 5 can be combined or completed as a mini, two-group rotation during the time given as they take less time than the others.

   Do not give out instructions 1 through 8 immediately. Let teams figure out what to do on their own. If some teams finish early or have trouble figuring out what to do, give them the direction sheets to follow or another set of objects to work with.

9. After 10-15 minutes ask teams to take their seats. Have each group take turns explaining their items, how the items worked, and which forms of energy caused them to work and how. ***NOTE:*** *Some students will notice that one form of energy changed into another form in the process.* ***Explain that energy from one form doesn't disappear but is transformed (converted) into other forms.***

10. Add to the "Forms of Energy" list the additional forms the students identified through their items.

11. Distribute handout "Forms of Energy" to students, or show as an overhead and have them copy into their journals. (You can also make flashcards with Forms of Energy & definition on one side and Examples on the other side.) Explain that "all energy forms fall into one of two major groups: **Potential or Kinetic.**" Explain that "potential energy is stored energy and gravitational energy, while kinetic energy is energy in motion." Have the students stand and tell them to act as potential energy by staying perfectly still and silent; then tell them they will act like kinetic energy by being noisy and moving a lot. Have students continue to demonstrate each when you call out potential and kinetic.

    OR, Jigsaw – Each team member (or "expert") is responsible for learning a specific part of the assigned topic (energy). Members go and talk with "experts" of other groups with the same topic. After meeting with members of other groups, the "experts" return to their own groups and present their findings. Team members are then quizzed on all topics. Form teams of 4 students. Half the teams will become Potential Energy Experts and half will become Kinetic Energy Experts. Have 'experts' explore/look around classroom and "list their energy **forms and/or kinds of energy**." Write "*Forms/Kinds of Energy"* on the board and have teams record their answers*.* If students start naming sources of energy, create a second heading called "*Sources of Energy."* Explain to students the difference and continue to facilitate the answers toward forms rather than sources. Let students know that you will keep the sources list and talk about sources at a later date.

12. Review with students through class participation which forms are potential energy, which are kinetic, and why.

    Or you could try **<u>Team Word-Webbing:</u>** Four or five students write simultaneously on a large piece of paper or on the board, providing

main concepts, supporting elements, and bridges representing the relationship between ideas in a concept. Students draw lines and explain to each other why those lines work.

Procedure

PART 2

Demonstrate the toy steamboat operating in the tub of water. Ask students to trace the energy flow back to the original source through class discussion. You may have to explain to students that wax is a product of plants (paraffin) and/or animals (bee's wax). Both are chemical energy that can be traced back (directly and indirectly) to plants and the process of photosynthesis, which relies on radiant energy from the sun.

Tell students Einstein's quote: **"Energy cannot be created or destroyed, it can only change form."** This quote by Einstein is known as the Law of Conservation of Energy. Through class discussion, ask students to tell you what form(s) of energy were present in this experiment.

Note: you can also teach Part 2 by having teams of students conduct their own investigation on transformation of energy with the toy boats. However, you will need a set of supplies for each team. For safety, have an adult light the candles for the teams.

Assessment

The brainstorming session will provide you with some information about each student's current knowledge of energy and provide a baseline against which to evaluate their progress as they complete the following lessons. (You could also try the Team Word-Webbing to practice the use of cooperative learning techniques.)

RESOURCES:

Short Videos that demonstrate energy

Bill Nye The Science Guy on Energy 2.01minutes

Shows Kinetic, Potential and then an example of transforming one source into another

http://www.youtube.com/watch?v=0ASLLiuejAo

Potential Energy: Wile E Coyote & Roadrunner 1.22 minutes

Energy being converted from Potential to Kinetic

http://www.youtube.com/watch?v=Jnj8mc04r9E

Story of Kinetic and Potential Energy 3.55minutes

Explanatory cartoon about transforming Potential to Kinetic. More technical with vocabulary words.

http://www.teachertube.com/video/story-of-kinetic-and-potentia l-energy-127812

INTERACTIVE

You can download this **Energy in a Roller Coaster Ride** from PBS Learning Media

If you have iPads or you can demo for class. This interactive roller coaster ride produced for Teachers' Domain illustrates the relationship between potential and kinetic energy. As the coaster cars go up and down the hills and around the loop of the track, a pie chart shows how energy is transformed back and forth between gravitational potential energy and kinetic energy.

http://www.pbslearningmedia.org/resource/hew06.sci.phys.maf.rollercoaster/energy-in-a-roller-coaster-ride/

Energy flow….connecting the methods to make the potential energy into kinetic

http://www.sciencemuseum.org.uk/onlinestuff/games/energy_flows.aspx

Energy, Light, and Sound: 10 Study Jams! Interactive Science Activities

Students will have fun learning about such topics as fossil fuels, renewable resources, electricity, magnetism, and heat in these 10 interactive science activities Grades: **3–5, 6–8**

http://www.scholastic.com/teachers/activity/energy-light-and-sound-10-studyjams-interactive-science-activities

EXTENSION ACTIVITIES

POPSICLE STICK CHAIN REACTION

Weave popsicle sticks together to build potential energy before releasing them in a flurry of kinetic energy, with video.

http://www.stevespanglerscience.com/lab/experiments/popsicle-stick-chain-reaction

Other activities on this page might be worth exploring:

http://www.stevespanglerscience.com/lab/experiments/category/energy

COOPERATIVE LEARNING STRATEGIES

Cooperative Learning in the Science Classroom

Article was written in 6/2/2006 – by Emily Lin for the National Science Teachers Association

Even though this article addresses secondary science teachers, the article shares sound research why Cooperative Learning is important and lists some of the strategies you can use. Take a moment to scan the article for some ideas.

Cooperative learning definition

Cooperative learning is an instructional method in which students work in small groups to accomplish a common learning goal under the guidance of a teacher. The method is characterized by the following features, which are distinct from other forms of group work:

. Learners positively depend on each other in a team to achieve a mutual learning goal.
. Learners engage in face-to-face interactions.
. Learners are assessed individually and held accountable for equally sharing and contributing to the mastery of learning goals.
. Learners use and develop appropriate collaborative and interpersonal skills to teach and encourage each other to learn.
. Learners reflect and assess the effectiveness of group functioning for future learning (Johnson and Johnson 1999; Kagan 1994).

http://www.nsta.org/publications/news/story.aspx?id=52116

Two examples from the above article:

Three-minute review tactic with alternating think-pair-share The review tactic structure involves a three-step process in which students are first asked to think and summarize the key concepts on a list for one minute. After the minute, pairs of students alternate and share only one key point at a time with each other for two minutes. Alternatively, the two minutes can be divided into one-minute segments. During the first minute, one student talks while the other actively listens, making only supporting comments but not offering his or her own ideas. During the second minute, these roles are reversed. Students add any missing points to their own list. This structure may be used during hypothesis-seeking activities, or when reviewing concepts during lectures or discussions, generating experimental/calculation procedures, or exchanging ideas on controversial issues.

Head count and formal roles The head count structure promotes both individual and group thinking and reflection on issues, questions, or problem-solving. Each member in a team of four is numbered off as 1, 2, 3, or 4. Each member is assigned a role in the group: Number 1 is the leader/manager (manages the group and ensures that members fulfill their roles and work cooperatively in a timely manner); Number 2 is the recorder (records the group's answers and discussion outcomes); Number 3 is the materials manager/technician (collects materials for the group and performs technical analysis for the group including using calculators, etc.); and Number 4 is the skeptic/reflector (ensures that all possibilities have been explored by posing questions such as "What's another idea?" or "How can we look at this problem in another way?" Also observes the group dynamics).

Other roles could be:
Reflector: Observes and notes the group dynamics for better future group functioning.
Encourager/coach: Ensures that all members are participating.
Reader: Reads the instruction or any information orally to the group.
Checker: Checks group members to ensure that each member can explicitly explain how the conclusion/solutions were derived.

Other examples found on the internet:
Round Table or Rally Table are simple cooperative learning structures that cover much content, builds team spirit, and incorporates writing. The roundtable has three steps to it. In the first step, the teacher poses a question that has multiple answers. Step two, the first student in each group writes one response on a paper and passes the paper counterclockwise to the next student. Finally, in step three, teams with the greatest number of correct responses gain some type of recognition. This type of cooperative learning can easily be used in the science classroom. For example, the students may be asked to write as many types of renewal energy as they can. At the end the group with the most types written down is rewarded.
- (Example: A teacher displays a picture and asks what the various energy sources found within the picture are. One student writes an energy source on a piece of paper then passes the paper to other members of the team for them to write an energy source that they see in the picture. Students continue to pass around the paper until the teacher stops the activity or until a group runs out of answers.)

Jigsaw II is used with narrative material in grades 3-12. Each team member is responsible for learning a specific part of a topic. After meeting with members of other groups, who are the "expert" in the same part, the "experts" return to their own groups and present their findings. Team members then are quizzed or assessed on all topics.
- (Example: Discussion of circuits and how they work.)

A Gallery Walk (sometimes called Carousel Walk) is a way to assess students in groups. The teacher puts large pieces of newsprint around the room. On the top of each is a question for which there are several answers. Student groups are given different colored markers and asked to write one correct answer to each question. Answers cannot be repeated on a page. The teacher can informally assess student learning by listening to them as they “think out loud” in their groups (Slavin calls this oral elaboration). Or teachers can more formally assess the answers by noting the flow of answers used by each colored group.

Instructional Strategies Online by Saskatoon Public Schools
Here is a website with forms for self-evaluation, group evaluation, and many types of cooperative learning strategies listed alphabetically. Give this a look. Many of the activities focus on reading and how to get the most out of reading for comprehension.
http://olc.spsd.sk.ca/DE/PD/instr/index.html
http://olc.spsd.sk.ca/DE/PD/instr/alpha.html

20 Collaborative Learning Tips And Strategies For Teachers from Te@chThought

Wonderful article with online ways of sharing those cooperative learning activities and information. ***Technology makes collaborative learning easier.*** *Collaboration had the same results via technology as in person, increased learning opportunities. Try incorporating free savvy tools for online collaboration such as Stixy, an online shared whiteboard space, Google groups, or Mikogo for online meetings. Be aware that some research suggests that more exchanges related to planning rather than challenging viewpoints occurred more frequently through online interactions. This may be because the research used students that did not know one another. If this is your scenario, you may want to start by having students get to know each other's backgrounds and ideas beforehand on a blog or chat-board.*

http://www.teachthought.com/learning/20-collaborative-learning-tips-and-strategies/

The Basic Collaborative Learning Techniques

(Supplemental Instruction Iowa State University)

Sixteen different Cooperative Learning configurations with diagrams on how to set each strategy up. You may want to download it for ideas.

http://www.dso.iastate.edu/asc/supplemental/SIShowcaseCollaborative.pdf