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Welcome

The Xcel Energy School Education program is available to schools through your local utility. You and your students are energy champions through your participation. The goal of the program is to help families learn about energy. Using energy wisely saves energy and money while helping to conserve natural resources.

This *Teacher Guide* contains supplementary energy education. At your own discretion, use the activities you choose to meet the needs of your students.

The lessons in this guide are multidisciplinary and are correlated to Minnesota Academic Standards and STEM. Each lesson contains an objective, curriculum focus, materials needed, key vocabulary and detailed state learning standard correlations, in addition to the full procedures for teaching the lesson. Some lessons contain student sheets; others are to be done as class discussions or demonstrations.

STEM Connections

STEM Connections	Science				Technology				Engineering					Math			
Activity	Science as Inquiry	Energy Sources, Forms and Transformations	Science and Technology	Personal and Social Perspectives	Productivity Tools	Communication Tools	Research Tools	Problem-solving and Decision-making Tools	Historical Perspective	Design and Modeling	Invention and Innovation	Test Design and Troubleshooting	Use and Maintain	Numbers and Operations	Measurement	Data Analysis and Probability	Connection to the Real World
Pass the Sack		•		•													
Get a Clue!		•		•			•				•						
Get Your Motor Running	•	•	•	•	•	•	•	•	•	•	•	•	•				
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Go Against the Flow	•	•	•	•	•	•	•	•						•	•	•	•
How Do You Rate?	•	•	•	•										•		•	

Pass the Sack

Objective

Students will demonstrate the difference between renewable and nonrenewable resources and the need for conservation of resources.

Curriculum Focus

Science
Social Studies

Materials

- 2 different kinds of candy or other objects that students find desirable
- Sack to hold candy, such as a gallon size plastic bag

Key Vocabulary

Nonrenewable resource
Renewable resource

Science Correlations

5-ETS1 – 2
5-ETS1 – 1
5-ESS3 – 1
MS-ESS3 – 4
MS-ESS3.A

Introduction

World consumption of natural resources is increasing. Continued population growth ensures that demand for renewable and nonrenewable energy resources necessary to maintain our way of life will continue to increase. This creates problems for future availability of nonrenewable resources. Nonrenewable resources are just that, resources that cannot be renewed. For example, a resource used at our present rate might last about 100 years. Factor in population growth and that resource may last only 79 years.

In this activity, two different types of candy (or other objects students would like) will represent resources. One type of candy will represent renewable resources and the other will represent nonrenewable resources.

Procedure

1. Before class, count out enough candy so that there is one piece per student (some of each type of candy, with less of one so it will run out faster). Put it in the sack or bag. Save the remaining candy. If you have a very polite class, count enough candy for half of the class. **You want the contents to run out before everyone gets candy!**

2. Tell students you will be demonstrating how resources get used over time by playing "Pass the Sack." Show students the sack and explain that when they get the sack, they should take some energy and pass the sack to the person next to them.

3. Before passing the sack to the first student, review renewable and nonrenewable resources. Have students give examples of each as you hand the sack to a student.

4. While this discussion is taking place, allow students to pass around the bag of candy without any rules about how many pieces students may take. Occasionally add four or five pieces of **one** type of candy you are using. This will be your renewable resource. The sack will be empty before it reaches all the students.

5. Ask students who did not get any candy how they might obtain energy from other students. What if each student represented a country? How do countries obtain resources? Do they trade, barter (trade for goods), buy (trade for currency), invade and take or go to war? What effect did the availability of candy have on relationships between students? What effect might the availability of natural resources have on the relationship among nations, provinces, states, people, standards of living and quality of life?

6. Explain how our resources are like the candy. Which type was the nonrenewable? How could you tell? (No more was added to the bag once it was being passed around.) Which type was renewable? How could you tell? (It was added periodically to renew it.)

7. Point out that resources have limits just like the candy. Emphasize that many resources, such as fossil fuels, are nonrenewable and are being consumed faster than they are being replaced by nature. Discuss the fact that it would be more difficult for students to eat the candy if they had to search the room to find it instead of just taking it from the sack. Energy companies must seek resource deposits and obtain rights to drill or mine for them; they do not just magically appear.

8. Point out that renewable resources can also have limitations. They may not generate electricity as reliably as nonrenewable sources and the amount of energy produced may vary with weather and location.

9. Plan how to pass out the remaining candy.

Discussion

- Should rules be established to determine how the candy is distributed?
- Do oil, coal and natural gas companies have rules/regulations that must be followed to find resources?
- Should there be rules and regulations on how much oil, coal and natural gas people use?
- How do the class' social decisions influence the availability of candy?

To Know and Do More

Go to **eia.gov/kids** to access games, tips and facts for kids to learn about renewable energy and energy efficiency.

Discuss whether or not it is possible to run out of a renewable resource. Wood and fresh water are examples of renewable resources that can be used faster than nature can replace them.

Get a Clue!

Objective

Students will identify and use vocabulary words related to the topic of energy sources in a game situation.

Curriculum Focus

Science
Social Studies
Language Arts

Materials

- Index cards for energy source word clues
- Markers

Key Vocabulary

biomass, coal, energy, fossil fuels, garbage, geothermal, hydroelectric, methane, natural gas, nonrenewable energy, nuclear energy, ocean tides, ocean waves, oil, oil shale, petroleum, plants, renewable energy, solar (sun), steam, uranium, water, wind, wood

Science Correlations

5-ESS3 – 1
5-ESS3.C
MS-PS1 – 2
MS-ESS3.A

Introduction

Energy is essential in our daily lives. We depend on energy for our heat, air-conditioning, lights, clothing, food, transportation, and communication. Where does this seemingly endless supply of energy come from?

There are many sources from which we get our energy. Some are endless or renewable, such as energy we get from the sun, wind, and water. Other sources are limited or nonrenewable, such as fossil fuels like coal, oil and natural gas. Some sources are only available in certain areas such as geothermal. Some sources are readily available but difficult to harness, such as ocean tides; others are expensive to extract or might present environmental concerns.

Scientists are constantly searching for sources of energy and more efficient ways to use them. Many sources of energy have been used for hundreds, even thousands of years. Sources such as coal and natural gas can be burned to produce energy. Wind can be harnessed as well as the sun's power (solar energy). In the late 1800s it was discovered that these sources could be used to generate electricity and distribute it as needed. In the middle 1900s fuel cells and photovoltaic cells were discovered. These are just a few of the sources and their uses we take advantage of each day.

Procedure

1. The success of this activity depends upon adequate student preparation. Class time should be spent learning to spell and define the following energy source words:

geothermal	coal	nuclear energy	natural gas
oil	solar	wind	wood
fossil fuels	gasoline	ocean waves	biomass
oil shale	methane	uranium	battery
steam	hydroelectric	petroleum	garbage
ocean tides	plants		

2. Divide the class into two groups of approximately equal ability. Choose one student from each team to give clues and have them sit at the front of the room. Each clue giver will be giving clues to their team.

3. You may want to use the list of suggested words included or add your own choices.

4. How the game is played:
   a. Each of the clue givers is shown an energy source word.
   b. The clue givers then give clues alternately to their teams as to the identity of the energy source word. Some teachers allow only one word clue to be given, or you may prefer to allow more clues within a certain time period, such as 15 seconds. (Have one student be the timekeeper.)
   c. After giving a clue, the clue giver chooses someone on their team to guess the energy source word. If that team member guesses the correct word, their team scores (see step f) and a new round begins using a new energy source word. Alternately, team members guess the word by order of seating rather than being chosen by the clue giver to guess the word.
   d. If the team member guesses incorrectly, the turn goes to the other team's clue giver who gives a new clue for the same energy source word to a member from their team.
   e. After the word has been guessed correctly by one team or the other, the new word goes first to the clue giver who did not start the previous round.
   f. Scoring is as follows:
      - 10 points for the team guessing the word correctly on the first clue
      - 9 points if the correct word is guessed on the second clue
      - 8 points if the team guesses the energy source word after hearing the third clue, etc.
   g. New clue givers should be chosen from each team after every three or four rounds have been played.

Discussion

Have students categorize the energy source words as either renewable or nonrenewable. A sample chart is provided below. Use the words and definitions learned to create an energy crossword puzzle. Puzzle creation software is readily available on the internet.

Renewable	**Nonrenewable**
geothermal	oil, petroleum
ocean tides, waves	nuclear energy, uranium
hydroelectric	coal
biomass, plants, wood	natural gas
solar	methane
garbage	gasoline
wind	battery

To learn more, visit thinkenergy.org/XcelEnergy.

To Know and Do More

Write the energy source words on index cards. (Duplicate the cards, if necessary, to have one for each student.) Tape one card on the back of each student; they should not know what their own card says. Allow students to ask each other yes or no questions to try to identify their energy source. Once they have identified their own energy source, they still continue answering others' questions. As students identify their energy sources, they may remove the card from their back and place it on their chest.

Have students research the energy sources used to generate electricity in your area. Sources of information include your local utility provider and government agencies such as the United States Energy Information Administration (**eia.gov**). Discuss the reasons behind the energy sources used in your area, such as costs of transporting fuels, availability of sunlight or wind, etc.

Career Awareness Activity

Using the following careers, or others you might think of, have students match them with the correct source of energy. Some careers will match with more than one energy source.

- Meteorologist (wind)
- Reactor operator (nuclear)
- Hydrologist (geothermal)
- Electrician (all sources)
- Geologist (geothermal, hydroelectric, coal, oil, natural gas)
- Physicist (nuclear, solar)
- Tank truck driver (gasoline, oil)
- Welder (all sources)
- Pipe fitter (all sources)
- Plumber (all sources)
- Accountant (all sources)
- President and CEO (all sources)
- Engineer (all sources)

Choose some energy related careers and use them as tiebreakers or bonus rounds in your energy source word game.

Get Your Motor Running

Objective
Students will experience energy transformations as they build a direct current (DC) motor.

Curriculum Focus
Science
Technology

Materials
- C or D dry cell batteries
- Ceramic magnets
- Large paper clips
- Enamel coated wire of varying thicknesses
- Sandpaper
- Tape or rubber bands (optional)
- Copies of "Student Sheet: Get Your Motor Running"

Key Vocabulary
Alternating current (AC)
Direct current (DC)
Electrical circuit
Electromagnet
Motor
Resistance

Science Correlations
5-PS1 – 3
5-ETS1 – 1-2
MS-PS1 – 6
MS-PS2 – 3, 5
MS-PS3 – 1-5

Recommendation
This is a STEM rich activity requiring substantial time, supplies and student skill in problem solving. If resources are limited, the activity may be used as a teacher demonstration or as group work rather than an individual assignment.

Introduction

In this activity, students investigate multiple energy transformations while constructing a simple DC motor. The most difficult part of this activity is building a properly shaped coil. You may wish to build the coils for students in advance, then keep them for future use.

Procedure

1. Explain to students that a motor is a device that transforms electrical energy into mechanical energy. Motors are used in many household appliances such as hair dryers, vacuum cleaners and blenders.
2. Place students in pairs or small groups and provide them with their materials. Each group will need approximately 22 inches of wire, one battery, two paper clips and magnets. The number of magnets needed will vary with the strength of the magnet and the age of the batteries. Two small ceramic magnets are usually sufficient. To save time, you may want to make a class set of coils in advance so students just have to place the coil into the paper clips.
3. Pass out "Student Sheet: Get Your Motor Running" and allow students to work through the motor design and answer the questions. Students will have to be persistent to get the coil to turn. Stress the importance of the coil being straight and level to get the motor to work properly.
4. As a class, discuss the importance of each piece of the motor and trace the energy conversions needed to make the motor work using batteries (chemical to electrical to mechanical, sound and thermal). Note that the coil will show a preference to spin in one direction.
5. If time permits, allow students to investigate on their own, the effect of different variables on the motor such as the

gauge (thickness) of wire used, number of magnets, number of windings in the coil, type of battery used, etc. As a class, determine which variables affected motor performance and why that may be. For example, what are the advantages and disadvantages of using a heavier gauge of wire? What is the best balance between weight and electrical resistance? How do you keep the motor cost-effective? Students should formulate a question, make a hypothesis and design an experiment to test that hypothesis.

6. Have students share their observations and conclusions on the variables which affect motor performance.

To Know and Do More

1. Allow students to view motors taken from household appliances and compare them to the motors they built. How do DC and AC motors differ?
2. In addition to demonstrating energy transformations, this activity can be used to show an electrical circuit, assist in a discussion about DC versus AC circuits, show an application of an electromagnet (the coil of wire) and let students experience heating due to resistance of a wire!

Answers to Questions on "Student Sheet: Get Your Motor Running"

1. The coil should wobble and eventually spin if it has been balanced correctly.
2. The battery contains chemical potential energy, which is converted to electrical kinetic energy in the paper clips and coil. The electricity is then converted to mechanical kinetic energy in the movement of the coil, thermal kinetic energy (heat) due to resistance in the wire and a bit of sound energy. You may want to point out that heat and sound are not usable forms of energy, so the energy transfer is not 100% efficient.
3. It will spin in only one direction (direct current).
4. Variables include the number of turns on the coil, thickness of the wire, strength of the permanent magnets and voltage of the battery.
5. By increasing any of the above factors, you increase the speed of the motor. New batteries work better than old ones, but they lead to much more thermal energy.

Student Sheet: Get Your Motor Running

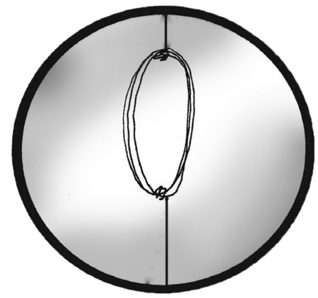
This activity lets you create your own direct current (DC) motor and see many energy transformations firsthand.

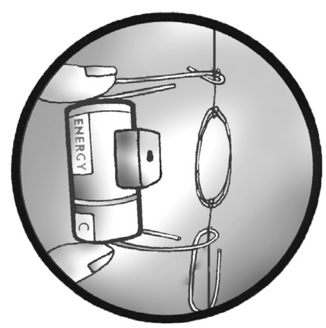
Materials

C or D dry cell battery, two large paper clips, ceramic magnet, fine sandpaper, enamel coated wire, wire cutters or scissors, rubber band or tape (optional)

Procedure

1. Cut 22 inches of wire and wrap it around the battery five times (be sure to leave wire sticking out on both ends).
2. Trim the ends of the wire so that they are about 1 inch long and stick out from opposite sides of the coil as shown to the right.
3. Remove the coil from the battery and wrap the ends around the coil two or three times to help hold the shape. It is very important that the ends are directly opposite each other as in the diagram.
4. Using sandpaper, remove the insulation coating from the ends of the wire from coil to tips. The wire should now be shiny. Be sure the ends are straight as shown in the top picture. Crooked coils will not work!
5. Bend the paper clips into an L shape (be sure to bend it in the direction that forms a loop in the clip) and place the longer end of the clips on the ends of the battery, sticking up into the air as high as possible. You can use a rubber band or tape to hold the paper clips or just squeeze them with your fingers.
6. Place the magnet on the battery as shown in the picture at right and put the ends of the coil through the ring formed by the paper clips. **Do not** bend the coil when inserting it. Be sure the coil is level on both sides and can spin without hitting the magnet.





Questions

1. What happens to the coil when the magnet is added to the battery?

2. What energy transformations do you see and feel? Write the types and forms of energy beginning with the battery and ending with the coil.

3. Will the coil spin in either direction or just one?

4. What variables affect the speed of the coil?

5. How could you make the coil spin faster?

To Know and Do More

1. Pick one of the variables from your answer to question 4 and design an experiment to test the outcome of changing this variable. Be sure to record your independent variable, dependent variable, variables controlled, data table and results in the space below. How do your conclusions compare to those of your classmates? How would you determine if your experiment and those of your classmates have valid results?

2. Research how the motor was invented and developed. What scientific principles does it use? What household devices contain motors? How do DC and alternating current (AC) motors differ?

A Bright Idea!

Objective
Students will study an example of potential energy converted to energy in the forms of heat and light.

Curriculum Focus
Science

Materials
- Several general purpose C dry cell batteries
- A string of holiday lights, cut apart and stripped at the ends or small bulbs and sockets with wires
- Battery operated toy and batteries
- Small flashlight bulbs and sockets
- Copies of "Student Sheet: A Bright Idea!"

Key Vocabulary
chemical energy, circuit, closed circuit, current, electrode, electrolyte, kinetic energy, open circuit, parallel circuit, potential energy, radiant energy, series circuit, thermal energy, transformation, voltage

Science Correlations
5-PS1.B
5-ESS3 – 1
5-ESS3.C
MS-PS3 – 3
MS-PS3.B
MS-LS2 – 1
MS-ESS3.A

Introduction

Alessandro Volta, an Italian physicist, made the first battery in 1799. Volta placed two different metal electrodes in an electrolyte solution (a chemical mixture which will conduct an electrical current). The chemical reaction caused an electromotive force. A common misconception is that batteries store electrical energy. This is not really true; batteries convert chemical energy to electrical energy. They store chemical energy that can be released during a chemical reaction. By using metals or carbons that have different chemical properties and an acid or base that will allow the movement of electrical charges, an electric current can be produced.

Procedure

1. Demonstrate a battery operated toy with and without the battery. Explain that energy is the ability to do work or cause change, such as moving the toy or powering a light bulb.
2. Discuss:
   - How do we know the energy from the battery is working?
   - What kind of energy is the toy giving off? (possible answers include kinetic energy, mechanical, light, sound and heat)
   - The battery converts chemicals (chemical energy) to electricity (electrical energy) and the toy converts electricity to many possible forms of energy, including mechanical energy, heat (thermal energy), light and sound.
3. Have students use the materials provided to experiment with simple circuits by following the guided inquiry activity on the student sheet. As the students do the activity, have them note the light and heat energy given off.
4. Give students examples of types of potential and kinetic energy.

   Kinetic energy: a person riding a bike, a fire in a woodburning stove, a person running

   Potential energy: a lump of coal, a sandwich, a rock at the top of a hill

Discussion

Write the word choices on the board. Read the statements to the students and have them fill in the blanks using the words.

1. A battery converts chemical energy into ______________ energy.
2. Electricity is a form of ______________ energy.
3. The light bulb converts electrical energy into ______________ and ______________ energy.
4. A battery contains ______________ energy.

Word choices:

potential   electrical   heat   kinetic   light

Answers:

1. electrical   2. kinetic   3. light, heat   4. potential

To Know and Do More

Ask students if they believe batteries are important to our way of life today. Have students make a list of all the items they used yesterday that contained a battery. Their list might include:

Wristwatch	Tablet
Automobile	Video game controller
Cell phone	TV remote control
Laptop	

To continue this, have students add to the list all of the items they can think of that use batteries. Are your students surprised at how many items today depend on batteries to operate and how many battery operated items they depend on daily?

Career Awareness Activity

Search the internet for a company that produces batteries. Discover the various job opportunities and careers within that company. Your list might include: scientists, chemists, research analysts, accountants, purchasing agents and administrative assistants.

Student Sheet: A Bright Idea!

Alessandro Volta, an Italian physicist, made the first battery in 1799. Volta put sheets of two different types of metal in a jar of water with a chemical that could carry electricity (an electrolyte). The chemical reaction between the electrolyte and the metal plates caused electrons to move when the plates were connected with a wire. The flow of electrons moving in a wire is called an electric current or electricity.

Using one battery and one light, make the bulb light up. Congratulations, you have made an electrical circuit!

1. What did you have to do to get the light to come on and complete the circuit? How was it touching the battery?

2. What do you have to do to make the light bulb turn off and then back on?

3. What do you think the electrical terms open circuit and closed circuit mean?

4. How do you think a light switch works?

5. What type and form of energy is in the battery?

6. The battery's energy was transformed into what other forms of energy?

Using one battery, try to light up two lights.

1. Sketch how the wires are connected to the battery when you light two lights.

2. Are the lights the same brightness as when you lit only one or are they dimmer?

3. A series circuit has only one path that electrons can follow as they are pushed from one side of the battery to the other. A parallel circuit has more than one path and the electrons can go more than one way to get from one end of the battery to the other. Which type of circuit did you make and draw?

4. Experiment with multiple batteries connected together, placing the positive end of one battery touching the negative end of another battery. What effect does the number of batteries have on the brightness of the bulbs?

5. If you leave the battery connected to a bulb long enough, you will feel the wire and the ends of the battery getting warm. What do you think is causing this?

6. Can that heat be useful? Can it be dangerous? Give an example to prove your point.

7. Wash your hands when you are finished.

Where Do Fossil Fuels Come From?

Objective
Students will investigate and model the production of natural gas and oil from ancient life.

Curriculum Focus
Health and Wellness
Science
Social Studies

Materials (per student group)
- Container to represent the ocean, preferably clear
- Sand or dirt
- Baking soda "plankton"
- Vinegar (20%) and water (80%) "ocean" mixture
- Cup or scoop
- Safety goggles

Key Vocabulary
Physical properties
Odorant
Mercaptan
Combustible

Science Correlations
5-PS3 - 1
5-ESS3 – 1
5-ESS3.C
MS-ESS3.A

Introduction

Natural gas is a combustible, gaseous mixture of simple hydrocarbon compounds, usually found in deep underground reservoirs in porous rock. The prevailing scientific theory is that natural gas was formed millions of years ago when tiny sea plants and animals were buried by sand and rock. Layers of mud, sand, rock, plant and animal matter continued to build up until the pressure and heat from the overlying sediment turned them into a tar like substance called kerogen. As temperatures continued to increase and the kerogen continued to heat, more complex compounds of carbon and hydrogen we know as oil were formed. Natural gas is generated at the same time as oil, and, as it forms, the natural gas molecules migrate from the shale source rock into more porous areas such as sandstone. Natural gas continues to move into cracks and spaces between layers of overlying rock. The impermeable rock layers cause natural gas accumulation to occur.

NOTE: Do this activity as a demonstration or in small groups.

Procedure

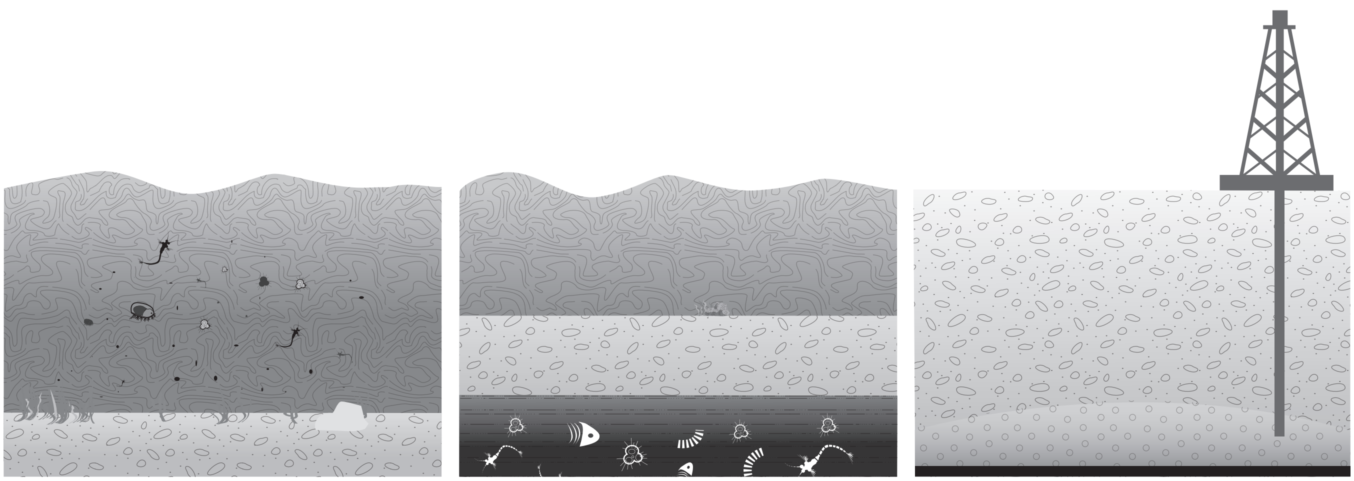
1. Explain to students that you will show them a model of how oil and natural gas form in the ocean. A very similar process takes place on land with plants to form coal.
2. Have students use safety goggles to avoid splashing vinegar water in their eyes. It is harmless, but uncomfortable.
3. Have students sprinkle a small amount of sand to cover the bottom of the container. The ocean floor is covered with sediments and the sand represents these sediments.
4. Next, have students sprinkle baking soda over the sand, liberally covering the bottom of the container. This represents plankton (microscopic plant life and animal like creatures called protists) that have died and settled down to the bottom of the ocean.
5. Explain that over time, sediments build up on the ocean floor. Students should completely cover the "plankton" with sand. (You can gently push the sand down with your hands to simulate the pressure and weight of the overlying sediments on the plankton.)
6. The ocean has water in it, so pour some of the vinegar/water "ocean" mixture into the container. Bubbles and foam begin to appear. You can see the bubbles bursting and can hear the gas being released to the air. Point out that this is a sign of a chemical change.

Discussion

- Discuss with students that natural gas in the ocean is produced much like in your demonstration, but that the process takes **many** years. In the ocean, plankton is buried under miles of sediment. The weight of this sediment causes high temperature and pressure which cooks the plankton deep underneath the ocean floor. The heat and pressure changes the plankton into oil and natural gas. Natural gas floats on top of the oil produced.
- Discuss how this model is different from real life. The gas produced in the experiment is carbon dioxide rather than natural gas, and since our container is open, the gas escapes into the air. In the ocean, there are usually impermeable layers that keep natural gas and oil trapped beneath the surface until we drill down and release it.

To Know and Do More

Go to **eia.gov** and research where we can find natural gas deposits. Are there natural gas deposits in your state? Find the natural gas pipelines that are located across the United States.



Insulation, It's a Wrap!

Objective

Students will understand how natural gas or other fuels used to heat a home can be saved through use of insulation and other practices.

Curriculum Focus

Science
Math

Materials

- Copies of "Student Sheet: Insulation, It's a Wrap"
- Beverages in plastic containers, recently removed from the refrigerator
- Thermometers
- Tape and rubber bands
- Materials to use for insulation such as paper, cloth, bubble wrap, cardboard or cotton balls
- Stopwatch or clock with second hand

Key Vocabulary

Energy
Temperature
Insulation

Science Correlation

5-PS1 – 3
MS-PS3 – 3

Introduction

The largest use of energy in your home is for heating. Many homes are heated with natural gas. Other heating fuels include electricity, fuel oil, kerosene, and propane. To control energy use, it is important to make sure your home is well insulated. The purpose of insulation is to stop heat from flowing to areas where it is not wanted. Heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature.

Procedure

1. Have a volunteer hold a thermometer in a closed fist. Record the temperature of their hand when the thermometer stops rising. Place the thermometer in the center of a chilled beverage and record the temperature when it stops falling. Ask students to hypothesize about what will happen to the temperature of the volunteer's hand when they grasp the drink for 30 seconds.

2. Have the volunteer hold the beverage for 30 seconds. Record the temperature of the volunteer's hand as before. Compare the temperature of the volunteer's hand before and after holding the can. Which way did the heat flow, from the hand to the can or from the can to the hand?

3. Divide students into groups. Review the types of insulation material available to design and engineer a drink insulator, often called a koozie. Give each group a few minutes to discuss the design of their koozie and gather their insulating materials.

4. Pass out the copies of "Student Sheet: Insulation, It's a Wrap." As students read the introduction, pass out cold water bottles and have students take their first temperature reading.

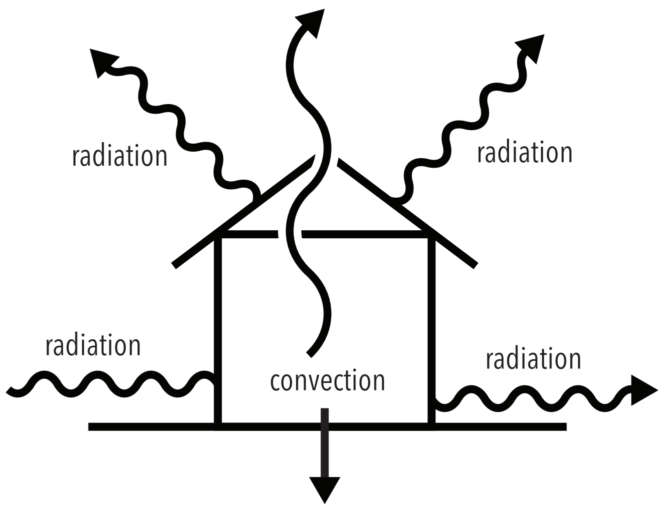
5. Begin timing for 15 minutes while groups build their koozies around their bottles. Make sure the tops of the bottles will be open to insert the thermometer into the beverage. Then have students take their first temperature reading.

6. Set the timer for 10 minutes while the koozies sit in a warm place and students complete questions 4 and 5 on the handout.
7. Have students take the second temperature reading when time is up.
8. If time allows, have more than two temperature tests. Have students calculate the temperature difference from the first temperature to the last.
9. Discuss results and have groups complete the answers to question 8 on the handout. Distribute awards, if desired.

Student Award Extension: Insulation, It's a Wrap!

Have students create award ribbons individually or in groups. Ribbons should be labeled with an award category such as Best Insulating Koozie, Most Interesting Koozie or Best Understanding of Insulation. Have students present ribbons to other students or groups.

Student Sheet: Insulation, It's a Wrap!



Many homes are heated with natural gas. The heat in your home can be lost in one of three ways. The first is conduction or heat transfer between objects that are physically touching. The second is convection, which is the transfer of heat by the motion of a fluid, which may be a liquid or a gas. Lastly, radiation is the transfer of heat through space as electromagnetic radiation.

What keeps hot air outside in the summer and inside in the winter? Insulation! Homes with insulation in their walls, ceilings and floors use less energy, stay more comfortable, and can reduce the cost of heating and cooling. One type of home insulation is a layer of fiberglass installed behind the surfaces of walls, above ceilings, and under floors. Other types are loose fill, which is blown in, and rigid foam. Caulking, weather-stripping or use of surfaces that block the sun's heat and light also keep the temperature comfortable in your home.

In this activity, you will construct the perfect koozie, a sleeve that is designed to thermally insulate a beverage container. It will keep your drink cold by slowing heat flow from your hand and the air to your beverage.

Materials

Bottled water recently removed from the refrigerator, thermometers, various insulation materials such as paper, cloth, bubble wrap or cotton balls, and a stopwatch or clock with a second hand

Procedure

1. Use your insulation materials to design your koozie. Attach it with tape or rubber bands to your beverage. The top of the drink must be clear of insulation material so that a person could drink from the container.
2. When your teacher says it is time, remove the bottle lid and place the thermometer in the center of your water. When the temperature stops changing on the thermometer, record your temperature reading under Test 1, then remove the thermometer and replace the lid.

Record your temperature reading in this table.

Temperature Test 1	Temperature Test 2	Temperature Test 3	Temperature Test 4

To learn more, visit thinkenergy.org/XcelEnergy.

3. Place your koozie in a warm location as directed by your teacher. When your teacher announces that time is up, take your temperature again and record it in the data table. While you wait, work together to answer questions 4 and 5 below.

4. Sketch or describe your container and the materials used here.

5. Why did you choose these materials?

6. When time is up again, take the temperature of your water a second time and record it in the table. Your teacher may choose to repeat the test additional times. If so, record your additional temperature measurements in the data table.

7. Calculate the difference in temperature from the first test to the last so that you can compare your results with others

Test 1	
	–
Last Test	
	=
Temperature Difference	

8. Write down answers to the following questions:
   - How did your koozie perform compared to others?
   - What are some common factors in those insulators that performed well?
   - How could you improve your koozie?
   - From what you have learned about insulation and heat transfer, how could your family reduce heat transfer in your home?

Where's the Water?

Objective

Students will understand how water is used in their homes and community, water conservation principles, the relative amounts of fresh and salt water, and how much water is available for human use.

Curriculum Focus

Math
Science

Materials (per team or for demonstration)

- 100 small cups
- 2 even smaller cups
- Markers
- *Water Poster* from the National Energy Foundation (NEF)

Key Vocabulary

Conservation
Consumption
Contamination
Fresh water
Groundwater
Nonpotable
Potable

Science Correlations

5-ESS2 - 2
MS-ESS3 - 4
MS-ESS3.A

Introduction

Earth is the water planet but fresh water is very limited. In this activity, students will see the tiny percentage of the earth's water that is actually usable and the importance of using it efficiently. Transporting and heating water also uses energy, as does treating waste water. By using water efficiently we also use energy more efficiently.

Procedure

You may have an NEF *Water Poster*. Display the poster for students to review.

1. Ask students to help you list all the ways that water is used in their homes. Write answers on the board as students give them. Make a list of 10 or more ways that water is used in homes. Examples:
   - Shower
   - Brush teeth
   - Flush toilet
   - Cook
   - Wash dishes
   - Clean the floor
   - Wash clothes
   - Wash the car
   - Water the lawn or garden
   - Fill a swimming pool
2. Share that on average more than half of the community's water is used indoors and the rest is used outside.
3. Ask students if they ever worry about using water. Are there any water rules in your community? (For example, some communities have lawn watering rules.)
4. Almost three-quarters of the earth's surface is covered with water. There is so much that it is sometimes hard for students to understand why it is important to conserve water. Do the following as a demonstration to discover how much water on earth is available for human consumption.
   a. Line up 100 small cups. Tell students that you are going to imagine that all of the water in the world will fit in these 100 cups. Each cup will be labeled with the type of water it represents.
      - 97 cups will be labeled Ocean
      - 2 cups will be labeled Icecaps and Glaciers
      - 1 cup will be labeled Groundwater

   b. Put an ice cube into each of the cups labeled Icecaps and Glaciers.

c. Mix a pitcher of salt water by adding approximately 1 cup of salt to a gallon of water. Fill the Ocean cups with the saline solution.
d. As you fill the cups with the appropriate water, ask students if they know about groundwater. Explain that groundwater is water that is below the surface trapped in layers of rock and clay. Energy is used to pump the water to the surface and bring it to our homes. Water is also found in rivers and lakes. This water is important to people but makes up a very small fraction of the water on the planet.
e. Pour clean, fresh water into the last cup. Lift the cup labeled Groundwater and explain that less than one percent of all of the water on the earth is available for people to drink, cook, bathe or wash dishes.
f. Pour approximately half of the water from the Groundwater cup into the two smaller cups. Contaminate the water of one with dye or dirt or something visible to your students. Show the contaminated cup and explain that of the small amount of the earth's water available for use, not all of it is potable. (Potable means fit to drink and nonpotable means not fit to drink.)
g. Hold up the last small cup and take a sip. Say "that is really good water!" Help students to understand that this small percentage of water is all that is available for everyone to drink and use.
h. Discuss the following points:
   - This small amount of water out of the earth's big supply is the reason that it is important for us to conserve our fresh, potable water. Water conservation means being careful about how much water we use and it also means protecting our water from contamination.
   - Would you believe that one of the largest users of energy in your home is water? In fact, you can use a lot of energy heating and pumping water from the ground to use in your home.
   - We can save water and the energy used to pump it and heat it by using technologies such as faucet aerators and high efficiency showerheads and with simple behaviors such as fixing leaks quickly and taking short showers.

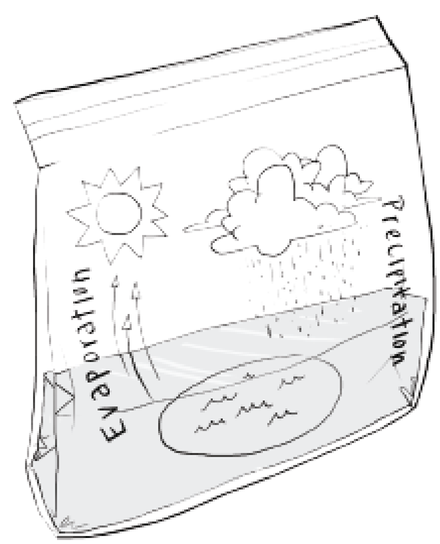
5. Assess student learning by asking students to put together a collection of 100 items (it can be anything portable like buttons, candy, pebbles, grains of rice, etc.). From their collection of items, ask students to identify the number that represents the amount of ocean water (97%). Ask students to identify the number that represents the amount of potable water available (a portion of one).

To Know and Do More

Do the activities on the back of the *Water Poster*.

Read *A River Ran Wild* by Lynne Cherry.

Create a mini water cycle in a clear, quart size plastic bag. Draw some of the major processes of the water cycle: precipitation, condensation, evaporation. Pour 2 ounces of water into the bag. Mark the water line using a permanent marker. Tightly seal the bag and hang it in a sunny, hot area for daily observations. Discuss how energy from the sun transforms water in the hydrologic cycle. What happens when the sun is present? (heat energy transforms water from liquid to vapor/gas) What happens when the sun goes down? (heat energy decreases, water transforms from vapor/gas to liquid)



Go Against the Flow

Objective	Materials	Key Vocabulary	Science Correlations
Students will be able to calculate flow rates of water, gallons of water, and energy saved by replacing old fixtures with more efficient ones. **Curriculum Focus** Math Science	• Flow test bag • Stopwatch or clock with a second hand	Aerator Flow rate	5-ETS1 – 2 5-ESS3 – 1 MS-ETS1 – 1

Introduction

This activity highlights the amount of water that must be heated to do everyday tasks such as washing dishes or taking a shower. Students will measure water output from a typical showerhead and faucet aerator, then calculate the amount of water and energy used. This activity will need to be done over 2 days, allowing for time to test at home.

Procedure

1. Discuss the fact that heating water is one of the largest energy uses in the home and that most people have no idea how much water they use each day. Excessive water use and improper settings on water heater thermostats waste energy in many homes. Remind students that experts recommend setting the water heater temperature at 120 F. Brainstorm ways to use less hot water (for example, taking showers rather than baths, taking 5 minute showers, and washing laundry in cold water).
2. Review how to use the flow test bag.
3. Have students test the flow rate of their showerheads and faucets at home and record their answers.
4. The next day, discuss how much heated water and energy was used in student homes for showers and faucets. Why do the numbers vary? Variables include the number of people in the home, the water pressure, and the efficiency of faucet aerators and showerheads.
5. Discuss ways to reduce the water and energy used in our homes. What actions can we take to be more efficient in our water use?

To Know and Do More

Have students use a timer to try taking showers in 5 minutes or less, with the stipulation that they must actually get clean!

How Do You Rate?

Objective

Students will conduct a home survey to determine how they can use energy more efficiently by changing their habits and improving conditions and thereby improve the environment in which they live.

Curriculum Focus

Language Arts
Science
Social Studies

Materials

- Copies of "Student Sheet: How Do You Rate?"

Key Vocabulary

Conservation
Efficiency
Environment
Natural resources
Quality of life

Science Correlations

5-ESS3 – 1
5-ESS3.C
MS-LS2 – 1
MS-ESS3 – 3
MS-ESS3.A

Introduction

We use natural resources every day. Sometimes we use them just as they come from earth or the atmosphere. At other times we alter their makeup to fit our needs. For instance, we use the sun just as it is to dry clothes, but we use photovoltaic cells to capture the sun's energy and convert it to electricity, a secondary energy source. We use coal just as it comes to us from the earth to make electricity, or we use coal to provide coke for steel manufacturing. Many natural resources we use every day are nonrenewable, once we use them they are gone; others are renewable, they can be replaced through natural and/or human processes.

It is responsible to use all resources efficiently and wisely. When we do, we reduce energy use, save money and preserve the environment. Making wise decisions today will have a positive impact on our future.

Imagine the difference we could make if we all used energy more efficiently. We would conserve natural resources for the future and enjoy better air quality and a better life. Each one of us can truly make a difference. All it takes is knowledge and action.

Procedure

Using energy efficiently and conserving our natural resources are responsible and easy actions that students can take today to show they respect the environment and have a desire to protect and preserve it.

1. Pass out "Student Sheet: How Do You Rate?" Discuss the actions that may apply to the school (e.g., windows and doors have weather-stripping; drapes or blinds are open on cold, sunny days and closed on hot days; thermostats are adjusted at night; lawns are only watered early or late in the day). As you discuss each action, write a T for true or F for false on the board to see how the school rates. What can the students do to improve energy use at school?
2. Decide on several actions the students can take at school to help save energy and protect the environment. One action might be to use both sides of their paper and then recycle. If a room is empty during lunch or at other times, they can be sure lights are turned off and computers are on sleep mode.
3. Have the students take the survey home and complete it with their parent's or guardian's help. Explain to students

that it is important to record their true energy use and not mark what they think they should be doing.

4. How did the students' homes rate? Discuss the results of the home survey. Help students to become enthusiastic about conserving natural resources and using energy more efficiently.

5. Prepare a graph to show the results of the energy efficiency survey. Which efficiency tips are already practiced by most students? Which were least used? Graph the number of students marking "yes" for each item.

6. Find the mean, median, mode and range of the data on the home survey.

Discussion

Discuss the benefits of energy conservation. How will our energy use impact our future? Compare the benefits and possible inconveniences and their correlation to our quality of life.

To Know and Do More

Why do you think people do not practice all of the energy efficiency tips on the survey? Are there false assumptions that affect people's behavior? (Believing that turning things on and off uses more energy than leaving them on, for example.)

Discuss how people in other geographic areas and cultures would rate. Does everyone have a car, dishwasher or an air conditioner?

Career Awareness Activity

Have the students think of some careers that could have a big impact on your community's energy usage. Some areas to consider: teachers impact energy usage through education and by example; utility workers make an impact through installation and maintenance; government regulators influence energy usage through restrictions and rewards, such as financial benefits or tax breaks.

Student Sheet: How Do You Rate?

Are you using energy wisely in the building you live in? Together with your parents or guardians, answer the following questions to rate your home or apartment.

Circle T if the statement is true, F if the statement is false or NA if the statement does not apply to your living situation.

Heating and Cooling

Windows and doors have good weather-stripping.	T F NA
Window coverings are open on cold, sunny days and closed on hot days.	T F NA
Window coverings are closed at night when heat is on.	T F NA
Thermostat is set at 68 F or lower in winter.	T F NA
Air-conditioning is set as high as is comfortable in summer.	T F NA
Ducts are insulated in unheated/uncooled areas.	T F NA
Garage is insulated.	T F NA
Air filters on furnace and air conditioner are cleaned and changed regularly.	T F NA
An energy audit has been conducted from your local utility in the last 3 years.	T F NA
Thermostat is adjusted at night.	T F NA
Fireplace damper is closed when fireplace is not in use.	T F NA

Water

A pitcher of water is kept in the refrigerator for drinking.	T F NA
Faucets and toilets do not leak.	T F NA
Showers and faucets are fitted with energy-efficient showerheads and aerators.	T F NA
Showers last no longer than 5 minutes.	T F NA
Toilets are low flow or tanks use water displacement devices.	T F NA
Hot water heater is set at 120 F. • If someone in your household has a compromised immune system, consult your physician.	T F NA
Hot water pipes from water heater are insulated.	T F NA
Broom, not hose, is used to clean driveways and sidewalks.	T F NA
Faucet is shut off while brushing teeth and shaving.	T F NA

Appliances

Dishwasher is usually run with a full load.	T F NA
Automatic air-dry is used with the dishwasher.	T F NA
Washing machine is usually run with a full load.	T F NA
Cold water is used in washing machine most of the time and is always used for rinses.	T F NA
Clothes dryer is usually run with a full load.	T F NA
Clothes are often hung up to dry.	T F NA
Refrigerator is set between 35 F and 38 F.	T F NA
Lids are usually put on pots when boiling water.	T F NA
Oven preheating time is reduced or not preheated at all.	T F NA

Lighting

Lights are turned off when not in use.	T F NA
LED bulbs are used in at least one room.	T F NA
Security and decorative lighting is powered by solar energy.	T F NA
Light bulbs are kept dusted and clean.	T F NA
Sunlight is used whenever possible.	T F NA

Trash

Glass, cans and papers are recycled. T F NA

Plastic is separated and recycled. T F NA

Old clothes are often given to charities, secondhand clothing stores, etc. T F NA

Food scraps and organic waste are composted. T F NA

Overpackaged products are usually avoided. T F NA

Reusable bags are used for groceries. T F NA

Rechargeable batteries are used when possible. T F NA

Food is often bought in bulk. T F NA

Products made of recycled materials are favored. T F NA

Transportation

Car is properly tuned and tires inflated. T F NA

Family drivers obey speed limit on the highway. T F NA

Public transportation is used when possible. T F NA

Family members often walk or ride a bike for short trips. T F NA

Everyone carpools when possible. T F NA

Yard and Workshop

Lawns are watered early or late in the day. T F NA

Grass is mowed to a height of more than 2 inches. T F NA

Hand tools, like pruners and clippers (rather than power tools), are used whenever possible. T F NA

Native plants are used to decrease water use. T F NA

Score 1 point for True, 0 points for False and 0 points for Not Applicable (NA).

Total Points: ______________

Discuss the results of this survey with your family.

What can you and your family do to raise your score?