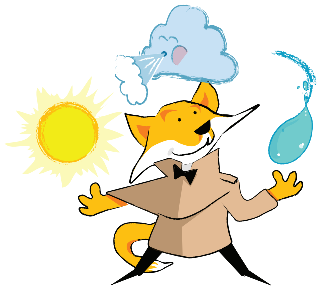


Lesson 8: Energy: We're All Connected – *Energy Knowledge into Action*

Overview

In this lesson, students examine the personal and collective, direct and indirect aspects of energy use and the implications of energy use in terms of sustainability and overall impact on our planet. They deepen their understanding of energy through the examination of renewable and nonrenewable energy sources. Finally, students put their energy knowledge into action through the development of a culminating display intended to makes others aware of the pervasive connections people have to energy and its use.

Teacher Background

Living within the Earth's limits and protecting the Earth for the future are key aspects of sustainability. Sustainability is a word that has different meanings to different people; people do not necessarily agree on its definition. However, the way people use energy is indisputably a major piece of sustainability. From an energy perspective, sustainability includes thinking about how best to ensure an adequate energy supply for everyone on the planet -now and in the future - while protecting the environment. Sustainability often refers to using the Earth's resources in such a way as to not deplete them or cause irreparable damage or pollute the Earth. At www.sustainabletable.org sustainability is described in this way: "*The ability to provide for the needs of the world's current population without damaging the ability of future generations to provide for themselves. When a process is sustainable, it can be carried out over and over without negative environmental effects or impossibly high costs to anyone involved.*"

While many people recognize a number of issues around energy use today, they may not regularly consider the cumulative effects of an individual's energy use, "hidden" or "indirect" energy use, or take into account the growing number of energy "users" – processes, products, and people that have dramatically increased the energy demands on the planet. Never before has there been a more important time to seriously examine our collective energy use, as the way we use energy is undeniably impacting the Earth and jeopardizing its sustainability. Our global dependence on fossil fuels presents an environmental problem. As fossil fuels are burned, carbon dioxide gas and particulate matter is released into the air. Carbon dioxide builds up in the atmosphere creating a blan ket that traps heat. Scientists believe that the excessive build up of "greenhouse" gases like carbon dioxide is the primary cause of global warming. Elevated amounts of particulate matter in the air contribute to health problems, such as asthma, and contribute to acid rain and global warming. Smog is the direct result of dust and smoke released into the air from burning fossil fuels.

Middle school students have undoubtedly heard terms such as sustainability, energy –efficiency, global warming, greenhouse gases, and climate change. Be advised that the topic of climate change and global warming is disturbing to many students. Consider the following recommendations outlined in the Edutopia article *"Truth and Consequences: Teaching Global Warming Doesn't Have to Spell 'Doom' "* as this subject matter is broached. The article suggests being selective and honest about what is shared. Focus conversations on positive things that are happening, and give students something tangible they can do to make a difference. This may reduce fears. (Visit http://**www.edutopia.org/global-warming-fear** to read the article in its entirety.)

This culminating lesson pulls together several concepts that have been developing throughout the *Energy for Maine* unit. A comparison of students' typical energy use to that of a person from a developing country links personal energy use to collective energy use on the planet. Demand for energy continues to increase as new ways of using energy emerge and as more of our world develops. A close examination of the "hidden" or "indirect" use of energy deepens students' recognition of energy connections and sets the stage for revisiting and expanding upon the connections between their Energy Discovery Box item and energy. An in-depth look at renewable and nonrenewable energy sources enables students to add another layer of understanding to energy consumption. Students create a product showcasing their knowledge of and aimed at teaching others about energy and its pervasive presence in everything we do.

There are a number of activities built into this lesson to provide a concrete way for engaging middle school students in a complex topic – the need to use energy responsibly. Depending on students' familiarity, proficiency, and interest, certain components of this culminating lesson can be abbreviated, omitted, and/or expanded. Students need to feel empowered and recognize that their actions to conserve and use energy efficiently do indeed make a difference to the overall health and sustainability of the planet. Using energy wisely is everyone's responsibility and something that all individuals, no matter what their age, can actively do by putting knowledge into action.

Key Ideas

- There are a growing number of energy "users" – processes, products, and people that have dramatically increased the energy demands put on the planet.
- Some energy sources are renewable and some energy sources are nonrenewable.
- It's everyone's responsibility to use energy efficiently or wisely. Conservation of energy is linked to our use of natural resources, which impacts our environment, economy, and national security.

Lesson Goals

Students will:

- see their individual roles in global energy use.
- recognize that energy use changes as countries become more industrialized.
- discover the interconnectedness of their energy demands on energy resources.
- identify and describe steps that can be taken to conserve energy and reasons for doing so.
- create a product that will make others aware of an individual's connections to energy and actions for conserving energy.

Vocabulary

conservation: reduction of wasteful or excessive use of energy resources.

energy efficiency: using less energy to perform the same function.

fossil fuel: a fuel such as coal, oil, or natural gas formed in the earth from plant or animal remains.

renewable resource: resources that replenish in a short period of time as part of natural cycles.

nonrenewable resource: resources that do not replenish as part of natural ecological cycles in a short period of time.

sustainability: using the Earth's resources in such a way as to not deplete them, cause irreparable damage, or pollute the Earth.

Preparation

1. Locate and review "A Day in the Life of Terese." http://www.geni.org/globalenergy/research/ruralelectrification/adayinthe-life/index.shtml. Prepare to read the first few paragraphs of the article, stopping perhaps at "The Consequences" section. Also consider omitting the second sentence in boldface type: **"Terese's day is built around chores that become obsolete with electricity."** As the article is discussed, students will come to this conclusion.

2. Preview Energy Source online resources (see Step 4) and gather additional print and human resources, if applicable for students to use.

3. Gather students' annotated drawings of their Energy Discovery Box items.

4. Review the culminating student project description and criteria. Decide on the level of student choice in the final project. Modify Student Handout 8.3: The Energy Connection accordingly. Gather appropriate print, online, and human resources to support students.

5. Determine a format and audience for the public sharing of students' culminating project. Sharing can take a variety of forms, depending on time and space available. Students may present their final projects to one another, to another class, and/or to an outside audience (e.g. parent night, PTA, administrators, town officials, etc.).

Materials

Item	Quantity
Scientist's Notebook	1 per student
Computers with Internet access	1 per student or pair of students
Student Handout 8.1: A Washing Machine's Energy Pathway	1 per student
Student Handout 8.2: Evaluating Energy Sources	1 per student
Energy Discovery Box Items (from Lesson 1)	1
Students' Annotated Drawings of Discovery Box items (from Lesson 1)	1 for the class
Student Handout 8.3: The Energy Connection Project Guidelines and Sample Rubric	1 per student

Safety

No specific safety guidelines for this lesson.

Time Required: 4-6 sessions

Session 1: comparison of energy use, introduction to "hidden" or "indirect" energy use

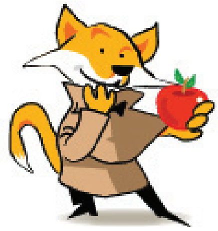
Session 2: research, evaluation and discussion of energy sources

Session 3: brainstorm session about energy literacy, introduction of the energy connections culminating project

Sessions 4-6: work sessions for and presentation of culminating project

Connection to *Maine Learning Results (MLR)*, *National Science Education Standards (NSES)* and *Benchmarks for Science Literacy (BSL)*:

- Technology influences society through its products and processes. Technology influences the quality of life and the ways people act and interact. Technological changes are often accompanied by social, political, and economic changes that can be beneficial or detrimental to individuals and to society. NSES F (5-8)
- Industrialization brings an increased demand for and use of energy. Such usage contributes to having many more goods and services in the industrially developing nations but also leads to more rapid depletion of the earth's energy resources and to environmental risks associated with some energy resources. BSL 8C/H4* (9-12)
- Different ways of obtaining, transforming, and distributing energy have different environmental consequences. BSL 8C/M2 (6-8)
- Some resources are not renewable or renew very slowly. Fuels already accumulated in the earth, for instance, will become more difficult to obtain as the most readily available resources run out. How long the resources will last, however, is difficult to predict. The ultimate limit may be the prohibitive cost of obtaining them. BSL (SFAA) 8C/M10** (6-8)
- By burning fuels, people are releasing large amounts of carbon dioxide into the atmosphere and transforming chemical energy into thermal energy which spreads throughout the environment. BSL 8C/M11** (6-8)
- Sunlight is the ultimate source of most of the energy we use. The energy in fossil fuels such as oil and coal comes from energy that plants captured from the sun long ago. BSL 8C/H8** (9-12)



Teaching The Lesson

Engage

1 Compare and contrast energy use of Maine students to that of a person from a developing nation.

Explain to students that they will listen to a narrative “Energy Snapshot” from woman named Térese. Make note that students will learn more about Térese after they’ve listed to the narrative.

Read the first few paragraphs of the article, omitting the second sentence in boldface type: *“Térese day is built around chores that become obsolete with electricity.”* As the article is discussed, students will come to this conclusion. Stop reading the article just before the section *“The Consequences.”*

After reading the article, ask students to share their reaction to Térese’s story. Include the following in the discussion:

- *How does the energy used by Térese compare to the energy used by a Maine teenager or young American adult on a typical day?* Encourage students to think about the snapshots they created in earlier lessons as they discuss differences.
- *What do you think accounts for this difference?* Accept students’ answers. Bring to the discussion the term “developing nations.” Clarify what is meant by “developing nations” as students may not be familiar with this idea.
- *In what ways do you think a nation’s energy use changes as it develops?* Discuss with students the idea that as countries like Térese’s develop, their energy use changes and the demand for energy sources increases. It may be helpful to have students give specific examples of devices that may be introduced in developing countries and how their implementation and/or availability impacts energy use. For example, a grain-grinding machine was mentioned in Térese’s story.

Make certain that students recognize that the way all people use energy is part of the global energy picture.

> **Note:** *As the idea of developing nations is being discussed, make certain that students do not misinterpret “developed” or “industrialized” to mean “superior.” Bring to students’ attention that countries around the world have different lifestyles, ideas, and beliefs about*

what things enhance their quality of life. While progressing toward a more industrialized society may have benefits, there are also drawbacks that need careful consideration.

2 Connect efficiency data collected in Lesson 7 to personal energy use.

Have students consider the specific electrical energy measurements they made by investigating electrical nameplates and using the Kill A Watt meters. Discuss the following:

- *In what ways do you think we, as people living in a developed or industrialized country, use electricity or energy inefficiently or unnecessarily?* Accept students' answers but make certain that they back up what they say with evidence and/or reasoning. Encourage students to refer to their energy measurements and/or Energy Star label findings as evidence.
- *Are there tasks that you or your family do that could be accomplished by using energy differently or perhaps using a different form of energy?* The idea here is to get students to begin to consider some different ways tasks can be done using less energy or using energy that is not energy generated by a power plant. (ex: hanging clothes outside to dry rather than using an electric dryer, combining errands to conserve gasoline, taking a shorter shower to reduce energy needed to heat hot water, etc.) Ask students to work in small groups to brainstorm a list. Discuss students' ideas as a large group. Discuss the practicality, benefits of, and trade offs for various ideas.
- *Do you think industrialized nations' energy use will continue to climb?* Accept students' answers, again making certain they back up what they say with evidence and/or reasoning.

Consider sharing with students the statistic from the Teacher Background in Lesson 6: "The United States has 5% of the world's population yet accounts for 30% of the energy used worldwide" or this quote from Maurice Strong, Senior Advisor to the United Nations and World Bank: "A citizen of an advanced industrialized nation consumes in six months the energy that has to last the citizen of a developing country his entire life." Help students make the connection that if industrialized nations' energy use is projected to increase and developing countries' energy use increases, the global energy demand will only become greater - and that this is problematic.

Summarize this opening discussion by making sure students recognize that our need for and interactions with energy is something that connects all people, regardless of where they live and that because there are limited energy resources on Earth, it is everyone's job to use energy responsibly.

Explore

3 Introduce "hidden" or "indirect" energy use.

Ask students: *Do you think the energy measurements captured all of the energy associated or connected to a particular task? In other words, what "hidden" or "indirect" ways can you think of that energy has been used in association with a particular task?*

The idea here is to begin to get students thinking about an objects' energy pathway. Provide students with an example to get them started. Encourage students to add to the following example as they get the idea:

If a task involved using a washing machine to wash clothes, not only does the machine use electricity but energy is also used when the water pump in the basement starts up to work to fill the machine. If the clothes are being washed in warm or hot water, the water heater burns heating oil (a fossil fuel) in the furnace to heat up the water. The washing machine came from the appliance store in town and the store received the machine from a washing machine manufacturer. The washing machine was transported to the retail store and the person's home by a delivery truck that burned gasoline or diesel fuel (a fossil fuel).

How are washing machines made? Washing machines are made up of individual washing machine parts. Some of the parts are made of metal, some are made of plastic. Energy is used in the mining of the raw materials for the metal, in the transport of the raw materials to a steel plant, and in the transport of the sheet metal used for washing machine parts to the manufacturer. The plastic parts such as the control knobs, hoses, and sealants, are made from petroleum. Plastic parts are also made off site, packaged and shipped to the washing machine manufacturing facility. Energy is used to put all of the smaller parts together (sub-assembly) to the make bigger parts (assembly) of the washing machine. These activities take place in a washing machine manufacturing facility that requires electricity to light the building and operate the facility and fuel to heat and cool the facility. Workers drive to and from the washing machine facility. Washing clothes also involves using a detergent…. and so on.

> **Note:** *Consider eliciting the help of student volunteers to take turns describing various aspects of the washing machine's energy pathway by reading the script found on Student Handout 8.1: A Washing Machine's Energy Pathway.*

4 Connect energy use with energy sources.

Say to students: *"You are becoming more and more aware of how everything we do and have is connected to energy. Energy is used in the production of materials, to fuel transportation, to warm our homes and businesses, and to power a myriad of electronic devices. At the beginning of this lesson, another aspect of energy use was introduced – the idea of increased demand for energy due to an increasing number of people using energy."*

Say to students: *In addition to looking at the way people use energy, it is important to consider the sources of energy.* Write the following focus questions on the board:

- *What sources fuel our energy use?*
- *What are the benefits and drawbacks of using these sources?*

Provide each student with a copy of Student Handout 8.2: Evaluating Energy Sources. Explain that students will work with a partner to complete the question set for one of the energy sources listed on the handout. Emphasize the importance of each pair working in a thorough way as others in the class ultimately depend on them for information about the particular energy source they researched. Each pair should use the questions on their handout to prepare for a 3 minute "briefing" about their energy source. Students may want to include in their briefing a picture representative of their energy source. As the energy sources are selected by or assigned to students, review what fossil fuels are and remind students that energy sources are categorized as renewable or nonrenewable.

> **Note:** *Amend Student Handout 8.2 to reflect energy sources about which students can readily access information. If necessary, omit tidal and hydrogen depending on the availability of comprehensible resources. Consider supplementing with select print material.*

Direct students to the web resources below listed on the *PowerSleuth* website under *Energy for Maine*, Lesson 8.

Energy Sources
http://tonto.eia.doe.gov/kids/energy.cfm?page=2

Energy Info Zone
http://www.sciencemuseum.org.uk/on-line/energy/site/EIZinfogr.asp

Renewable Energy Resources
http://www.nrel.gov/learning/

Chewonki's Interactive Renewable Energy Poster
http://www.chewonki.org/pathways/interactive_poster/default.shtml

What You Need to Know About Energy from the National Academy
Select "Sources"
http://needtoknow.nas.edu/energy

US DOE: Renewable Energy
http://www.energysavers.gov/renewable_energy/

Connecticut Energy Education
http://www.ctenergyeducation.com/video_games.htm

Energy Resources
http://www.darvill.clara.net/altenerg/

Assist students as needed as they complete their research and plan for their 3 minute presentations.

5 Present and summarize energy sources findings.

Review the logistics of the energy source briefing presentations. Instruct students to jot down key notes in their scientists' notebooks about each energy source as each group is sharing information. Explain that at the conclusion of the briefings, students will be engaging in a discussion about future energy demands. Students will be expected to use their notes to support their thinking.

Once all student groups have shared their briefings, discuss the following with students:

- *Why do you think a variety of materials or substances are used as energy sources?* Accept students' answers and help students surface some of the benefits and drawbacks of various energy sources. Make certain that students recognize that there are no perfect solutions to meeting people's ongoing energy needs. As energy consumers we have some choice about the energy sources we use to meet our energy needs. When making these choices, there are several factors that need careful consideration.

Reflect and Discuss

6 Brainstorm why "energy literacy" is important.

Distribute one piece of chart paper and a marker to each group of 4. Direct each group to list reasons why they should be cognizant of their energy use. Ask *"Why," in terms of thinking about the way we as individuals, as Maine residents, and as people living on the Earth, should we think about the way we use energy. Why is it important that people understand energy and know about how it is used?*

Allow students 5 minutes to brainstorm a list. Post, review, and summarize students' lists. Leave these lists posted as they will serve as a reference to students' final project.

Consider revisiting Palmer Putnam podcast (www.powersleuth.org, *Energy for Maine,* Lesson 6.) Ask students to think about the narrator's comment "We (the world) use a lot of energy… but it is bad?")

7 (Optional) Connections to conservation and using energy efficiently.

Provide each student with a copy of Student Handout 8.1: A Washing Machine's Energy Pathway. Ask students to reexamine the description and to make suggestions as to how energy could be used more efficiently or conserved at various instances along the washing machine's energy pathway. Encourage students to identify opportunities for redirecting energy more efficiently by underlining passages from the script and writing in the right-hand margin a description of how energy could be used more effectively. Allow students a few minutes to complete this exercise and then discuss some of the students' suggestions.

8 Revisit energy connections of Discovery Box items.

Once again place the Energy Discovery Box in a place visible to all students. Place students initial annotated drawings of the different items next to the box. Say to students: *At the very beginning of the Energy for Maine unit, you were asked to make an annotated drawing showing the energy connections between the item you selected and energy.* Randomly select one of the items out of the box and hold it up. Display the corresponding annotated drawing and say: *Let's reflect for a moment on all that you've learned about energy in the last few weeks. What additional energy connections can you now make? What new questions do you have?* To get students started, review the connections described in the drawing. Ask students to describe the item's energy "trail" – connections to "hidden" and/or "indirect" uses of energy.

- *What energy forms are involved?*
- *What transfers and transformations are involved?*
- *What energy sources are involved?*
- *Are these renewable or nonrenewable resources?*
- *What role do fossil fuels play?*
- *What are the connections to energy efficiency or conservation to this item?*
- *What is the connection to the environment?*

Encourage students to brainstorm as many connections as they can. Ask probing questions to help students extend their thinking. If new questions about the item arises, ask students how they can find out. Suggest that students do additional research to clarify and/or to add to their existing knowledge.

Ask students: *Do you think people are aware of the energy connections of the items they use every day? How do you think people might use items differently if they recognized the energy connections of every day items?* Accept students' answers.

Ask: *What other items could be put in the Energy Discovery Box and why?* Students should clearly recognize that anything they put in the box has extensive energy connections.

9 Introduce culminating project.

Distribute a copy of Student Handout 8.3: The Energy Connection to each student. Explain that students are to create a product to "make public" the energy connections of a particular item. Students may use their Energy Discovery Box item or be allowed to select an item of choice (pending teacher approval). Point out that the Discover Box items were chosen because they have interesting and intriguing (often not obvious) energy connections. If students are allowed to select new items, encourage them to select items that perhaps have interesting or intriguing connections as well. If students are allowed to choose a new item, it may be helpful to brainstorm items with them. Remind students that they can add additional energy connections to the Discovery Box item they already chose.

Review the project criteria and rubric outlined in Student Handout 8.3. Students will create a product clearly showing the energy connections for a selected item. Students may create a tri-fold table top display, PowerPoint or Keynote presentation, comic strip using Comic Life, an "infomercial" (short video clip), pamphlet, or other approved product. Students may use print and online resources or consult with local experts to research and fortify additional energy connections.

Answer students' questions and clarify criteria. Make certain that students recognize their product needs bring about an awareness of their item's energy connections and relate efficiency issues to their item.

10 Share projects.

Once students have completed their projects, have students share them. Consider involving students in making the decision about how their products will be shared. Ask students to reflect on their efforts and make suggestions as to how the products they created can be made public to a wider audience. Public sharing is a positive action that empowers students and can bring about energy-saving actions in the school and community.

Extension

Students may:

- identify "ordinary" items around the school and create engaging "posters" using Comic Life describing the energy connections to the ordinary item and energy. The poster would offer tips related to energy conservation and efficiency. For example, posters could be developed and placed near light switches, water fountains, recycling bins, doors or windows, computers, and in cafeterias to promote buying locally grown foods, etc.
- Take the "It's Up2me for kids" challenge. Students may learn how to initiate change in their school or community by taking one of several challenges outlined on the Up2me site. Learn how to reduce waste, energy use, car travel and water use. Generate ideas about how to grow food and take care of the biodiversity in the home and school environments. http://www.up2meforkids.com.au/
- learn simple measures they can take to conserve energy. http://www.powerscorecard.org/reduce_energy.cfm
- participate in NEED's Great Energy Debate. Students critique the advantages and disadvantages of the major energy sources in an innovative debate format. http://www.need.org/Guides-Grade.php.
- investigate the history of energy by visiting the Energy Information Administration's Energy for Kids Energy Timelines page: http://tonto.eia.doe.gov/kids/energy.cfm?page=timelines.
- plan for an Energy Fair. Determine a purpose for holding an Energy Fair. Who would be the audience? Where and when would it take place? What types of displays would be included? What community groups, individuals, and/or businesses can be elicited for help?
- compare the energy use in terms of kWh and oil of various household devices and receive tips on ways to optimize the way energy is used for these devices. This interactive tutorial accompanies PBS's Frontline episode "What's up with the Weather" and includes carbon dioxide emissions. http://www.pbs.org/wgbh/warming/carbon/playalready.html

Connection to Maine Agencies

MEEP (Maine Energy Education Program) has a Great Energy Debate Game (4th to 12th grade). What are the pros and cons of renewable versus nonrenewable resources? In this debate, students take on the real world challenge of convincing others that a particular energy source is the best choice for their situation. A MEEP representative will come to interested schools, free of charge, to guide this activity.

MEEP also has a Coal-Fired Power Plant Activity. Students learn how electricity is made in a power plant and discuss the pros and cons of using coal. Then they discover alternative ways to spin a turbine to run a generator. For more information contact MEEP at www.meepnews.org/classroomactivities

For schools in Aroostook County, a Maine Public Service (MPS) representative will come to interested schools, free of charge, to guide and support concepts developed in this lesson. A description of programs is available at www.mainepublicservice.com. Click on the education section of the site. To schedule a presentation contact Nancy Chandler at 207.760.2556 or nchandler@mainepublicservice.com.

Online resources and references

Portions of this lesson modeled after Climate Change North's "The Energy Trail" intermediate lesson plan. http://www.climatechangenorth.ca/section-LP/LP_11_HI_S_energy.html

The Sustainable Table
http://www.sustainabletable.org/home.php

eHow
http://www.ehow.com/how-does_5001829_how-washing-machines-made.html

Reference with clickable graph showing Global Energy Demands broken down in various views http://news.bbc.co.uk/2/hi/science/nature/3995135.stm

A Washing Machine's Energy Pathway

If an Energy Snapshot included using a washing machine to wash clothes, not only does the machine use electricity but energy is also used when the water pump in the basement starts up to work to fill the machine. If the clothes are being washed in warm or hot water, the water heater burns heating oil (a fossil fuel) in the furnace to heat up the water. The washing machine came from the appliance store in town and the store received the machine from a washing machine manufacturer. The washing machine was transported to the retail store and the person's home by a delivery truck that burned gasoline or diesel fuel (again a fossil fuel). How are washing machines made? Washing machines are made up of individual washing machine parts. Some of the parts are made of metal, some are made of plastic. Energy is used in the mining of the raw materials for the metal, in the transport of the raw materials to a steel plant, and in the transport of the sheet metal that the washing machine parts are stamped out of to the manufacturer. The plastic parts such as the control knobs, hoses, and sealants, are made from petroleum. Plastic parts are also made off site, packaged and shipped to the washing machine manufacturing facility. Energy is used to put all of the smaller parts together (sub-assembly) to the make bigger parts (assembly) of the washing machine. These activities take place in washing machine manufacturing facility that requires electricity to light the building and operate the facility, and fuel to heat and cool the facility. Workers drive to and from the washing machine facility. Washing clothes also involves using a detergent.... and so on.	**Connections to Conservation and Efficiency**

Evaluating Energy Sources

Guiding Questions

Review the websites for your energy source as instructed by your teacher and answer the questions. You may write your responses on a separate sheet of paper or in your scientist's notebook.

Circle your energy source:

oil (petroleum)	natural gas	coal
uranium	biomass	geothermal
hydro	solar	wind
tidal	hydrogen	

1 How is this energy source used? Give some examples of how this energy source is currently used.

192 **2** Is this energy source a renewable or nonrenewable energy source? What makes it renewable or nonrenewable?

3 What are some of the environmental impacts associated with using this energy source?

4 Is this energy source widely used today? Why or why not? (ex: cost, availability, etc.)

5 What are the greatest advantages of this energy source?

6 What are the biggest drawbacks of this energy source?

The Energy Connection

Product Guidelines and Sample Rubric

Create a product that clearly describes the connections between the item you selected and energy. Create a tri-fold table top display, a PowerPoint of Keynote presentation, a comic strip using Comic Life, an "infomercial" (short video clip), pamphlet, or other approved product to creatively showcase these connections. You may use print and online resources. Consider consulting local experts to research and fortify additional energy connections. Include connections your item has to using energy responsibly, in energy conservation, or to energy-efficiency.

As you are planning and developing your product, consider the following:

- What associations do you think people typically make between energy and your item? How could this be used to draw people's attention to your product? (Incorporate into a catchy title, intriguing question or riddle?)
- What form(s) of energy are associated with your item?
- What energy transformations are connected to your item?
- What are some of the "hidden" or "indirect" connections between your item and energy? (Think of the item's "energy trail")
- How is your item related to an energy source? Is it related to a renewable or non-renewable energy source?
- Has your item changed over time? Has this changed the way it is connected to energy?
- How is your item connected to Maine and energy?
- What conservation or efficiency considerations can be associated with your item?

Sample Product Rubric

	Exceeds Standard (4)	Meets Standard (3)	Partially Meets Standard (2)	Does Not Meet Standard
Energy Connections	Product clearly describes 10 or more accurate connections to energy. At least 2 of the connections relate to and promote using energy responsibly through conservation of energy and/ or using energy efficiently.	Product clearly describes 7-9 accurate connections to energy. At least 1 of the connections relates to and promotes using energy responsibly through conservation of energy and/ or using energy efficiently.	Product describes 4-6 accurate connections to energy. At least 1 of the connections relates to and / or promotes using energy responsibly through conservation of energy and/ or using energy efficiently.	Product describes 3 or fewer accurate connections to energy.
Organization, Mechanics and Grammar, Style	Product is organized in a creative and/or innovative way. Contains no punctuation, spelling, or grammatical errors. Makes excellent use of color, graphics, layout, and effects to enhance presentation.	Product is organized creatively. Contains few errors in punctuation, spelling, or grammar that do not interfere with meaning. Makes good use of color, graphics, layout, and effects to enhance presentation.	Product is somewhat organized. Contains some punctuation, spelling and/ or grammatical errors that interfere with meaning. Makes use of color, graphics, layout, and effects but occasionally these detract from content.	Product is not well organized. Contains numerous punctuation, spelling, and/ or grammatical errors that make the product difficult to understand. Use of font, color, graphics, layout, effects but these often distract from the content.

Master Materials Checklist

✔	Quantity	Item	Lesson(s)
❑	1 per student	Pre-Post Unit Assessment	1, 8
❑	1 per student	Scientist's Notebook	1-8
❑	1 per student or 1 per student pair	*Computers with internet access*	1-8
❑	1 set per class (Select a variety of items and enough items so that each pair of students has an item.)	For "Energy Discovery Box" – a cardboard box or plastic tub large enough to hold a variety of props such as: • Small sample of coal (in plastic bag) • Energy bar or drink • Ear of corn • Subway ticket or map or some item representative of public transportation • Wind up or other "human-powered" mechanical toy or device • Mitten • Reusable foil-lined insulated shopping bag • Solar powered calculator • Instant cold pack • Battery (D-cell) or battery operated flashlight • Cell phone or other representative consumer electronics item • Bottle of water • Pinwheel • Clothespin • Energy-efficient light bulb picture or package • Power strip • Picture of Speed Limit 55 road sign • TV remote control	1, 8
❑	1 sheet per pair	Chart paper	1 ,3 ,4, 6
❑	enough for each pair	Markers (for Lesson 4 make certain there are green and red markers for each pair in the set)	1 ,3 ,4 , 6
❑	1 roll per class	Masking tape	1, 3, 4
❑	1 per student	Student Handout 1.1: Energy Snapshots Recording Sheet	1
❑	1 for teacher	Teacher Resource 1.1: Descriptions of Energy Connections for Items in Energy Discovery Box	1
❑	1 for teacher	Teacher Reference 1.2: Sample Energy Snapshots	1
❑	1	Digital camera (optional: for capturing images of students' annotated drawings)	1

Master Materials Checklist *(continued)*

✔	Quantity	Item	Lesson(s)
❑	1 set	For opening demonstration: • Text book • Pinwheel • Paper spiral suspended by a piece of thread or string • Lamp with 100 watt incandescent light bulb or other safe heat source	2 , 3 , 4
❑	1 per student or pair of students	For student practice: • Wind up car with visible gears • Poppers • Safety goggles	2 , 3
❑	1 per student	Student Handout 2.1: Mapping Energy Sources and Energy Receivers	2
❑	1 per student	Student Handout 2.2: Mapping Multiple Energy Sources and Energy Receivers	2
❑	1 per student	Student Handout 2.3: Scientists' Meeting Minutes – Reflection and Discussion of Interaction Stations	2
❑	1 for teacher	Teacher Resource 2.1: Writing Claims and Evidence Frame-work	2
❑	Make 2 sets or multiple required to accommodate class size.	Teacher Resource 2.2: Interaction Station Directions	2, 3
❑	1 for teacher	Teacher Resource 2.3: Interaction Station Teacher Notes	2, 3
❑	1 for teacher	Teacher Resource 2.4: Paper Spiral Template	2, 3

Master Materials Checklist *(continued)*

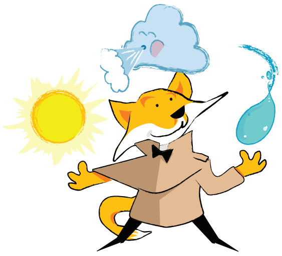
✔	Quantity	Item	Lesson(s)
❑	Make 2 identical sets or multiple required to accommodate class size.	For Interaction Stations: 1. **Hands:** no materials required 2. **Plastic Shopping Bag:** plastic shopping bag, small bits of paper (paper from hole punches work well), desk top 3. **Paddle Ball:** paddle ball toy 4. **Electric Circuit:** D cell, wires, incandescent light bulb, component holders, if available 5. **Solar Powered Propeller:** access to sunlight or lamp with full spectrum light bulb, solar panel, motor. 6. **Noise Maker:** disposable paper noise makers (1 per student) or sound tube 7. **In Hot Water:** access to "hot" tap water, ceramic mug, several metal spoons (Note: A spoon made of silver will conduct heat much more noticeably), electric cup warmer (optional), ice water (optional) 8. **Beads:** access to sunlight or lamp with full spectrum light bulb, UV beads strung as a bracelet or keychain, towel 9. **Spinning Top:** top, box lid or tray to contain top 10. **Yo-Yo:** yo-yo 11. **Pop Up Toy:** pop up toy 12. **Waves:** a dish pan or 9" x 13" baking tray ½ filled with water, small float tub toy (boat), towel	2, 3
❑	1 per student	Student Handout 3.1: Forms of Energy	3, 4
❑	2 per student and 2 for teacher	Student Handout 3.2: Frayer Model Template	3
❑	2 scenes per student minimally	Student Handout 3.3: Energy Scenes	3
❑	1 for teacher	Teacher Resource 3.1: Interaction Station Teacher Notes, Identification of Energy Sources, Receivers, and Forms	3
❑	1 for teacher	Teacher Resource 3.2: Energy Scene Teacher Notes	3
❑	1 per student	Student Handout 4.1: Building a Rubber Band Powered Spool Racer	4
❑	1 set per pair	For spool racers: • rubber band • empty thread spool • paper clip • tape • metal washer • cotton swab	4
❑	1 for teacher	Teacher Resource 4.1: Everyday Energy Interactions	4

Master Materials Checklist *(continued)*

✔	Quantity	Item	Lesson(s)
❑	1 for teacher	Teacher Resource 4.2: Possible Responses for Everyday Energy Interactions	4
❑	10-15 per pair	(optional) Index cards (3" x 5") or Self-stick notes	4, 5
❑	1 per student	(optional) Student Handout 4.2: Energy Map Words (precut and put into resealable bags or envelopes)	4
❑	1 set per pair	Counters (100 pennies or beans in small paper cups for Lesson 6; 20 for Lesson 4 - optional for Lesson 4)	4, 6
❑	1	(optional) Bicycle or picture of bicycle (as a prop)	4
❑	1 per pair	For water wheel/turbine construction: • 2-liter plastic bottles with caps (pre-drill hole in center of cap and bottom of bottle slightly larger than 3/8") • string, 1.2 meters (cotton – something not slippery) • a variety of blade/paddle making materials: index cards, Styrofoam meat trays, plastic and paper cups, waxed cardboard from milk / juice cartons • scissors • tape (duct tape or other water resistant tape is preferable) • rubber band (to place around neck of bottle – helps to keep string from slipping as wheel turns) • 50-80 gram weight (2 large washers attached to a paper clip work well. The paper clip can be easily attached to the string.)	5
❑	1 or more stations per class	For testing of water wheels/turbines: • 3/8" dowel rod (must be longer than the 2-liter bottle; 30" jumbo bamboo roasting skewers may be substituted) • funnel • water jug or pitcher	5
❑	1 or more per class	Device as required measure efficiency of water wheels (graduated cylinder, meter stick, stopwatch, etc. as determined by class.)	5
❑	1 per student	Student Handout 5.1 (optional): Water Wheel Design Challenge	5
❑	1 per student and/ or an overhead of this information	Maine Energy Consumption Data available from www.powersleuth.org, *Energy for Maine*, Lesson 6 or http://www.eia.doe.gov/emeu/states/state.html?q_state_a=me&q_state=MAINE	6
❑	1 per student	"Energy Consumption" article Energy Consumption from NEED (National Energy Education Project) http://www.need.org/needpdf/infobook_activities/IntInfo/ConsI.pdf	6

Master Materials Checklist *(continued)*

✔	Quantity	Item	Lesson(s)
❑	1 per pair	Teacher Resource 6.1: PowerSleuth puzzle sets and Teacher Resource 6.2: PowerSleuth puzzle descriptions (Download from www.powersleuth.org)	6
❑	1	Cup, container, or picture of "boiling" water (optional, prop)	6
❑	1 per student	Student Handout 6.1: Advance Organizer for Energy Consumption Article	6
❑	1 per student	Student Handout 6.2: Calculating the Efficiency of (Selected) Components of an Electrical Power Plant	6
❑	1 per student	Calculator (optional)	6, 7
❑	3-4 appliances for each student group and one set for opening demonstration	Variety of household electric devices Include devices that have a "standby" power feature and others that have on and off switches. Utilize electrical devices such as computers, printers, speakers, pencil sharpeners, TVs, VCR/DVD players, digital clocks, desk lamps, and overhead projectors that are readily available in the school to minimize preparation time.	7
❑	One for each group	Hand lens	7
❑	One power strip for opening demonstration / additional power strips or extension cords, as needed.	Power strips and/or extension cords	7
❑	4 (one for each group)	Kill A Watt meters from the school and/or public library	7
❑	1 per student	Student Handout 7.1: Kill A Watt Challenge	7
❑	1 per student	Student Handout 7.2: Nameplate Data	7
❑	1 per student	Student Handout 7.3: Kill A Watt Data	7
❑	1 per student	Student Handout 7.4: (optional): Calculating Annual Energy Costs	7
❑	1 for teacher	Teacher Resource 7.1: Using the Kill A Watt meter	7
❑	1 per student	Student Handout 8.1: A Washing Machine's Energy Pathway	8
❑	1 per student	Student Handout 8.2: Evaluating Energy Sources	8
❑	1 per student	Student Handout 8.3: The Energy Connection, Project Guidelines and Sample Rubric	8



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Master List of Student Handouts and Teacher Resources

Lesson 1

Teacher Resource 1.1: Descriptions of Energy Connections for Items in Energy Discovery Box

Teacher Resource 1.2: Sample Energy Snapshots

Student Handout 1.1: Energy Snapshot Recording Sheet

Lesson 2

Teacher Resource 2.1: Writing Claims and Evidence Framework

Teacher Resource 2.2: Interaction Station Directions

Teacher Resource 2.3: Interaction Station Teacher Notes

Teacher Resource 2.4: Spiral Template

Student Handout 2.1: Mapping Energy Sources and Energy Receivers

Student Handout 2.2: Mapping Multiple Energy Sources and Energy Receivers

Student Handout 2.3: Scientists' Meeting Minutes – Reflection and Discussion of Interaction Stations

Lesson 3

Teacher Resource 3.1: Interaction Station Teacher Notes

Teacher Resource 3.2: Energy Scene Teacher Notes

Student Handout 3.1: Forms of Energy

Student Handout 3.2: Frayer Model Template

Student Handout 3.3: Energy Scenes

Lesson 4

Teacher Resource 4.1: Everyday Energy Interactions

Teacher Resource 4.2: Possible Responses for Everyday Energy Interactions

Student Handout 4.1: Building a Rubber Band Powered Spool Racer

Student Handout 4.2: Energy Map Words

Lesson 5

Student Handout 5.1: Water Wheel Design Challenge

Lesson 6

Teacher Resource 6.1: PowerSleuth Puzzle Sets
www.powersleuth.org

Teacher Resource 6.2: PowerSleuth Puzzle Descriptions

Student Handout 6.1: Advance Organizer for Energy Consumption Article

Student Handout 6.2: Calculating the Efficiency of (Selected) Components of an Electric Power Plant

Lesson 7

Teacher Resource 7.1: Using a Kill A Watt Meter

Student Handout 7.1: Kill A Watt Challenge

Student Handout 7.2: Nameplate Data

Student Handout 7.3: Kill A Watt Data

Student Handout 7.4: Calculating Annual Energy Costs

Lesson 8

Student Handout 8.1: A Washing Machine's Energy Pathway

Student Handout 8.2: Evaluating Energy Sources

Student Handout 8.3: The Energy Connection Project, Guidelines and Sample Rubric

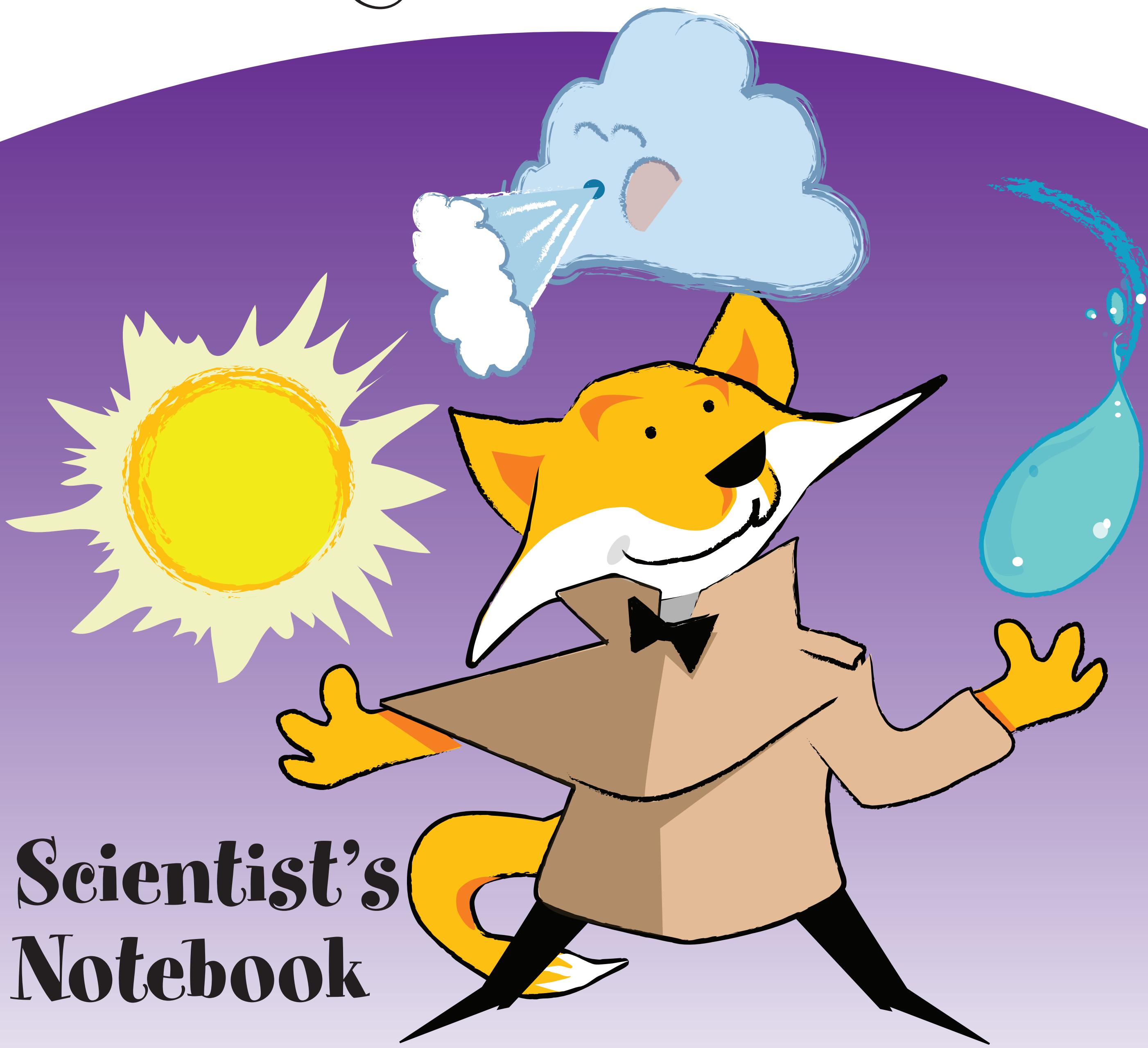
Lesson 1-8

Teacher Resource: Scientist Notebook Template
Teacher Resource: Pre/Post Unit Assessment

PowerSleuth

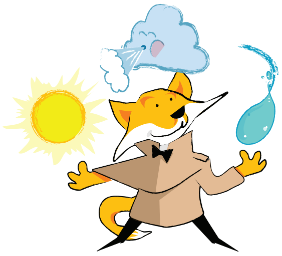
Maine Energy Education Curriculum

Energy For Maine!



Scientist's Notebook

Scientist: ______________________________



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Pre Unit Assessment

Directions: Read each statement. Put an **A** next to statements that you **agree** with and a **D** next to statements that you **disagree with**. Write a brief explanation of your thinking for each answer choice.

_____ **1. Sunlight is the ultimate source of most of the energy we use and becomes available to us in a number of ways.**

Explain your thinking about this idea. You may want to give an example to support your idea.

_____ **2. Energy is the ability to change an object in some way.**

Explain your thinking about this idea. You may want to give an example to support your idea.

_____ **3. Energy appears in many forms and one form can change into another.**

Explain your thinking about this idea. You may want to give an example to support your idea.

____ **4. Energy is a material that is stored in an object.**

Explain your thinking about this idea. You may want to give an example to support your idea.

_____ **5. Only things that are moving have energy.**

Explain your thinking about this idea. You may want to give an example to support your idea.

_____ **6. People cannot "see" energy but can detect evidence of energy.**

Explain your thinking about this idea. You may want to give an example to support your idea.

_____ **7. Energy can never be created or destroyed.**

Explain your thinking about this idea. You may want to give an example to support your idea.

_____ **8. When a flashlight is turned on, chemical energy is transformed into electrical, light, and heat energy.**

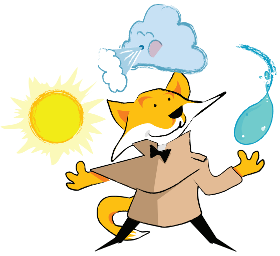
Explain your thinking about this idea. You may want to give an example to support your idea.

_____ **9. As energy is transferred and transformed some energy is transferred to places and forms that are "undesired" or "unwanted."**

Explain your thinking about this idea. You may want to give an example to support your idea.

_____**10. Energy efficiency and energy conservation mean the same thing.**

Explain your thinking about this idea. You may want to give an example to support your idea.



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Glossary

claim: a testable statement that answers the focus question of an investigation. (Lesson 2)

chemical energy: the energy stored in a material's chemical make up. (Lesson 3)

conservation: reduction of wasteful or excessive use of energy resources. (Lesson 8)

elastic (stored mechanical) energy: energy stored in objects or substances when they are stretched or compressed. (Lesson 3)

electrical energy: the energy in the movement of an electric charge. (Lesson 3)

energy: the ability to change an object in some way. (Lesson 1, 2)

energy efficiency: using less energy to perform the same function. (Lesson 4, 5, 8)

energy receiver: the object or substance to which the energy is transferred. (Lesson 2)

energy source: an object or substance that is the supplier of energy. (Lesson 2)

energy transfer: the movement of energy from one object, substance, or system to another (Lesson 3, 4)

energy transformation: energy changing forms. (Lesson 3, 4)

evidence: the data collected by the scientist during an investigation. (Lesson 2)

fossil fuel: a fuel, such as coal, oil, or natural gas formed in the earth from plant or animal remains. (Lesson 8)

generator: a device that converts mechanical/motion energy into electrical energy usually by passing magnets through an electric field (electromagnetic induction). (Lesson 6)

gravitational potential energy: the energy something has due to its place or position. (Lesson 3)

interaction: the influence (mutual or reciprocal action) that objects have upon one another. (Lesson 2)

kinetic energy: energy in motion (Lesson 3)

mechanical/motion energy: the energy of moving objects. (Lesson 3)

nonrenewable resource: resources that do not replenish as part of natural ecological cycles in a short period of time. (Lesson 6, 8)

parasitic or phantom load: electricity used by a device even when the appliance is turned "off." (Lesson 7)

potential energy: energy that is available, ready to be used but is not bringing about change at the moment (stored energy). (Lesson 3)

radiant energy: energy that moves in waves. (Lesson 3)

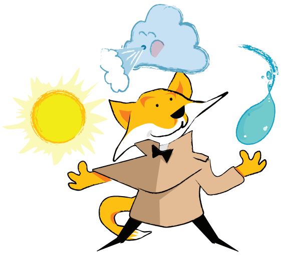
renewable resource: resources that replenish in a short period of time as part of natural ecological cycles. (Lesson 6, 8)

sustainability: using the Earth's resources in such a way as to not deplete, cause irreparable damage or pollute the Earth. (Lesson 8)

thermal energy: the collective energies (kinetic and potential) of molecular motion of a substance. Atoms and molecules make up all substances, and these atoms and molecules are always moving. The higher the temperature, the faster the atoms and molecules that make up the substance are moving and thus the more thermal energy the substance has. The amount of thermal energy a substance has takes into account the amount of matter in the substance. The greater the amount of matter, the more thermal energy a substance has. This is why an iceberg contains more thermal energy than a cup of boiling water. (Lesson 3)

turbine: a device made up of a series of blades that is turned by a fluid (gas or liquid) and as it turns, transfers mechanical/motion energy to a generator. (Lesson 5, 6)

Watt: a unit of power that is used measure electricity. (Lesson 7)



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Notes

Maine MATHEMATICS and SCIENCE Alliance

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PowerSleuth

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Curriculum Guide

Notebook Spine Cover