

MIDDLE SCHOOL ENERGY EXPERIMENTS







SEEKING INNOVATORS Are you ready to energize the world?

Science, technology, engineering, and mathematics (STEM) affect nearly every aspect of our lives — from the cars we drive, to the food we eat, to the smartphones we use to communicate.

Innovation is the key to helping the U.S. stay competitive in today's globalized, technologydriven world. As a result, STEM jobs are in high demand and typically pay significantly better than non-STEM fields. To fill the high-skilled jobs that will power the American economy in the future, the U.S. needs more students to study STEM.

Additionally, BP depends on people with strong foundations in STEM to help solve the world's energy challenges. These engineers, scientists and other professionals find ways to produce and deliver the energy that heats our homes, powers our schools, cooks our food and fuels our cars.

To meet these challenges, we strive to help students discover how STEM shapes the world around them so that they understand its importance and pursue careers in these fields.

The information and activities in this booklet will help you understand the critical role STEM plays in the energy industry. Have fun exploring the world of energy, and we hope you learn some interesting new things along the way.

Be sure to check out more hands-on activities and STEM resources at bp.com/STEM resources.

TABLE OF CONTENTS

Introduction to Energy and STEM	4
Introduction and Instructions	4
Safety for STEM	5
Student Text	б
Clean Air	8
Corroding Metals	9
Cryogenic Roses	10
Energy from Garbage	11
Cooling Fan	12
Heavy Backpacks	13
Insulation 1	14
Insulation 2	15
Insulating With Air	16
Natural and Man-Made Fibers	17
Natural Herbicide	18
Natural Plastic	19
Saving Hot Water	20
Seeds and Needs	21
Solar Distillation	22
Waste Heat	23

Wind Around Your Home	24
Energy in Motion	25
Biodegradability	26
Burning Popcorn	27
Absorbing Solar Energy	28
Solar Oven	29
STEM Challenge: Solar Water Heater	30
STEM Challenge: Petroleum Pull	32
STEM Challenge: Wind Can Do Work	34



Introduction and Instructions

Science, Technology, Engineering, and Math are for everyone. They are also lots of fun! Energy is the ability to do work, or make some change. STEM and Energy are very connected! The activities in this booklet aim to help you experiment with energy – doing work and making changes – while practicing and perfecting your STEM process skills.

Get Ready

Start by picking an activity that sounds interesting and meets your grade level.

• If you are too young for the grade level listed, ask an older friend or adult to help you with the experiment. If the activity is for younger students, try it out and work with a friend in a younger grade or a sibling. Show them that STEM explorations are fun!

•Read through the entire activity.

Read through the Safety for STEM Checklist, and check off any items you will have to be careful to do.

Get set

Clear a work space for yourself. It may be necessary to place newspaper or a table cloth down to protect floors, tables, or counters.
 Gather the materials on the supply list for your activity.

Find your safety glasses!

- Re-read the activity procedure to make sure you're prepared and can complete all of the steps safely.
- •Write or create a hypothesis for what you think may happen.

G0!

Put on your safety glasses!

Follow the steps in the experiment.

Record what you see happening. Take pictures and video. Write down notes. Draw pictures.

Answer the analysis and conclusion prompts.

Was your hypothesis correct? Re-test the experiment. Try to design a test to answer any additional questions you might have.

Clean up your materials.

Pick a new activity to try!

STEM Challenges

At the end of your booklet is a STEM challenge. Now that you've explored STEM and Energy in a hands-on, guided way, let's challenge ourselves to think beyond the instructions to solve a problem. This challenge will provide you a problem to solve and list of materials to use, but no instructions. Solve the problem however you can. Design something to make it happen, test it out, and re-design it until it works! And, don't forget to have a good time!



Safety For STEM Checklist

Eye Safety

□ Always wear safety glasses when performing experiments.

Fire Safety

- □ Do not heat any substance or piece of equipment unless specifically instructed to do so.
- □ Be careful of loose clothing. Do not reach across or over a flame.
- □ Keep long hair pulled back and secured.
- Do not heat any substance in a closed container.
- □ Always use tongs or protective gloves when handling hot objects. Do not touch hot objects with your hands.
- □ Keep all lab equipment, chemicals, papers, and personal items away from the flame.
- □ Extinguish the flame as soon as you are finished with the experiment and move it away from the immediate work area.

Heat Safety

- □ Always use tongs or protective gloves when handling hot objects and substances.
- Keep hot objects away from the edge of the experiment surface—in a place where no one will accidentally come into contact with them.
- □ Remember that many objects will remain hot for a long time after the heat source is removed or turned off.

Glass Safety

- □ Never use a piece of glass equipment that appears to be cracked or broken.
- □ Handle glass equipment carefully. If a piece of glassware breaks, do not attempt to clean it up yourself. Inform an adult.
- Glass equipment can become very hot. Use tongs or gloves if glass has been heated.
- □ Clean glass equipment carefully before packing it away.

Chemical Safety

- $\hfill\square$ Do not smell, touch, or taste liquids unless instructed to do so.
- □ Keep liquid containers closed except when using them.
- □ Do not mix any materials without specific instructions.
- Do not shake or heat liquids or solids without specific instructions.
- Dispose of used lab materials as instructed. Do not pour chemicals back into a container without specific instructions to do so.
- □ If a liquid or solid accidentally touches your skin, immediately wash the area with water and inform an adult.
- □ Keep long hair pulled back and secured.
- □ Be careful of loose clothing.



Introduction to Energy

What Is Energy?

Energy makes change; it does things for us. It moves cars along the road and boats over the water. It bakes a cake in the oven and keeps ice frozen in the freezer. It plays our favorite songs and lights our homes. Energy makes our bodies grow and allows our minds to think. Scientists define energy as the ability to do work.

Forms of Energy

Energy is found in different forms, such as light, heat, sound, and motion. There are many forms of energy, but they can all be put into two categories: potential and kinetic.

POTENTIAL ENERGY

Potential energy is stored energy and the energy of position, or gravitational potential energy. There are several forms of potential energy.

- •Chemical energy is energy stored in the bonds of atoms and molecules. It is the energy that holds these particles together. Biomass, petroleum, natural gas, propane, and the foods we eat are examples of stored chemical energy.
- •Elastic energy is energy stored in objects by the application of a force. Compressed springs and stretched rubber bands are examples of elastic energy.
- •Nuclear energy is energy stored in the nucleus of an atom; it is the energy that holds the nucleus together. The energy can be released when the nuclei are combined or split apart. Nuclear power plants split the nuclei of uranium atoms in a process called **fission**. The sun combines the nuclei of hydrogen atoms in a process called **fusion**.
- •Gravitational potential energy is the energy of position or place. A rock resting at the top of a hill contains gravitational potential energy because of its position. Hydropower, such as water in a reservoir behind a dam, is an example of gravitational potential energy.

KINETIC ENERGY

Kinetic energy is motion; it is the motion of waves, **electrons**, atoms, molecules, substances, and objects.

- •Electrical energy is the movement of electrons. Everything is made of tiny particles called atoms. Atoms are made of even smaller particles called electrons, protons, and neutrons. Applying a force can make some of the electrons move. Electrons moving through a wire are called **electricity**. Lightning is another example of electrical energy.
- •Radiant energy is electromagnetic energy that travels in vertical (transverse) waves. Radiant energy includes visible light, x-rays, gamma rays, and radio waves. Solar energy is an example of radiant energy.



- •Thermal energy, or heat, is the internal energy in substances; it is the vibration and movement of the atoms and molecules within a substance. The more thermal energy in a substance, the faster the atoms and molecules vibrate and move. Geothermal energy is an example of thermal energy.
- •Motion energy is the movement of objects and substances from one place to another. Objects and substances move when an unbalanced force is applied according to **Newton's Laws of Motion**. Wind is an example of motion energy.
- •Sound energy is the movement of energy through substances in longitudinal (compression/rarefaction) waves. Sound is produced when a force causes an object or substance to vibrate; the energy is transferred through the substance in a longitudinal wave.

Conservation of Energy

Your parents may tell you to conserve energy. "Turn off the lights," they say. To scientists, **energy conservation** is not just about saving energy. The **Law of Conservation of Energy** says that energy is neither created nor destroyed. When we use energy, it doesn't disappear. We change one form of energy into another.

A car engine burns gasoline, converting the chemical energy in gasoline into motion energy. Solar cells change radiant energy into electrical energy. Energy changes form, but the total amount of energy in the universe stays the same.

Efficiency

Energy efficiency is the amount of useful energy you get from a system. A perfect, energy efficient machine would change all the energy put in it into useful work—a technological impossibility today. Converting one form of energy into another form always involves a loss of usable energy.

Most energy transformations are not very efficient. The human body is a good example of this. Your body is like a machine, and the fuel for your machine is food. Food gives you the energy to move, breathe, and think.

Your body isn't very efficient at converting food into useful work. Most of the energy in your body is transformed and released as thermal energy (heat). You can really feel that heat when you exercise! This is very much like most energy transfers. The loss of useable energy is often in the form of thermal energy (heat).

Sources of Energy

We use many different energy sources to do work for us. They are classified into two groups—renewable and nonrenewable.

In the United States, most of our energy comes from **nonrenewable** energy sources. Coal, natural gas, petroleum, propane, and uranium are nonrenewable energy sources. They are used to make electricity, heat our homes, move our cars, and manufacture all kinds of products. These energy sources are called nonrenewable because their supplies are limited. Petroleum, a **fossil fuel**, for example, was formed hundreds of millions of years ago from the remains of ancient sea plants and animals. We can't make more petroleum deposits in a short time.

Renewable energy sources include biomass, geothermal energy, hydropower, solar energy, and wind energy. They are called renewable because they are replenished in a short time. Day after day, the sun shines, the wind blows, and the rivers flow. We use renewable energy sources mainly to make electricity.

Electricity

Electricity is different from the other energy sources because it is a **secondary source of energy**. We must use another energy source to produce electricity. In the U.S., natural gas is the number one energy source used for generating electricity.

Electricity is sometimes called an **energy carrier** because it is an efficient and safe way to move energy from one place to another, and it can be used for so many tasks. As we use more technology, the demand for electricity grows.

Energy Transformations $\overbrace{Chemical} \longrightarrow finite formations$ $\overbrace{Chemical} \frown finite formations$ $\overbrace{Chemical} \frown finite formations$ $\overbrace{Chemical} \frown finite formations$



©2020 The NEED Project 1.800.875.5029 www.NEED.org



Grade Levels: 5-8

Background

More than 50% of a school's energy bill is spent on heating, cooling, and ventilating buildings to keep the air safe to breath and the right temperature.

OQuestion

Does indoor or outdoor air have more particles?

Possible Hypothesis

air has more particles.

Materials

- 14 White index cardsPetroleum jellyCotton swabs
- Tape
- Magnifying glass

✓ Procedure

- 1. Label the index cards I-1 to I-7 and O-1 to O-7. (I is for "Inside" and O is for "Outside".)
- 2. Smear petroleum jelly on cards I-1 and O-1 using a cotton swab and tape them to the same window: I-1 on the inside and O-1 on the outside. Close the window. Avoid placing the cards near a door.
- 3. After 24 hours, take the cards down and repeat the procedure with the cards labeled I-2 and O-2. Make a note of the weather each day, and what you see happening to the petroleum jelly.
- 4. Do this for a week, replacing the cards each day. Examine the cards closely and compare them to each other and to previous sets.
- 5. Record your observations, noting any differences.
- 6. Repeat the experiment in a different location or at a different time of year.

***** Analysis and Conclusion

How does the air inside and outside compare? How does it compare in different weather, different locations, and in different seasons? How clean would you say the air is in your neighborhood?





Corroding Metals

Grade Levels: 6-9

Background

Everything has energy. You eat food because its chemical energy gives you energy to run and talk and play. Chemical energy is also stored within the tiny particles, called atoms, within a material. Those atoms are held together in a bond. If a bond is broken or created, chemical energy is transferred in something called a chemical reaction. Sometimes when materials mix together, chemical reactions occur, and energy is released.

Occabulary

corrosion: a slow breakdown of a metal

OQuestions

What types of metal will corrode?

What kinds of liquid promote corrosion?

🗮 Possible Hypothesis

__ will / will not corrode when exposed to ___

Materials

- Bowls
- Water
- Orange juice
- 2 Pieces of steel wool
- 2 Stainless steel teaspoons
- 2 Pennies
- 2 Squares of aluminum foil

✓ Procedure

- 1. Fill two bowls one with water and the other with juice.
- 2. Put one piece of each of the metal objects in each bowl.
- 3. Leave the metals in the liquids for a week where they will not be disturbed.
- 4. After one week, take out the metal samples and examine them. Record your observations.

***** Analysis and Conclusion

Which liquid caused more corrosion? Which metals were more susceptible to corrosion? Was there a combination of liquid and metal that caused the most corrosion? When can you use metals that corrode and when should you use metals that don't corrode?









Cryogenic Roses

Grade Levels: 6-9

Background

When living things die, they slowly break down or decay over time. This is a chemical reaction where chemical energy is transferred. Adding heat or removing heat can cause a chemical reaction to speed up, or slow down. Heating or cooling a material can also change how quickly its energy is released or absorbed.

Occabulary

•cryogenic: a material at a very low termperature

OQuestion

Can ice be used to preserve once-living things?

Possible Hypothesis

Ice can/cannot preserve once-living things.

Materials

■5 Rose buds just beginning to open

- 4 Plastic bowls
- Water
- Freezer

✓ Procedure

1. Fill four plastic bowls with equal amounts of water.

- 2. Observe the five rose buds and record any differences in the fragrance, texture, appearance, or color.
- 3. Submerge one rose bud in each bowl of water and put the bowls in the freezer, keeping one rose bud at room temperature for a control. Observe the control daily and record your observations.
- 4. After one week, allow one rose bud to thaw and observe, comparing it to the control and to the observations made before freezing. Place the thawed rose bud with the control.
- 5. Repeat this procedure the next week with another frozen rose. Do this weekly until all roses have been thawed and observed.

***** Analysis and Conclusion

Did ice preserve the roses well? Did the length of freezing have an effect? What happened to the roses once they were thawed? How did the freezing affect the decaying process?

Real World Connection

What practical applications could this technique be used for?





Energy from Garbage

Grade Levels: 5-8

Background

The average person in the United States creates a little more than four pounds of trash every day! This includes materials like plastic, paper, and food and yard waste. Some of these materials break down at the landfill. Have you ever driven by a landfill? Why do you think it smells? Decaying garbage creates an odor because a gas is being created as the trash decays. You can't see the gas, but you can smell it! That trash, even when it's decaying, contains energy!

Questions

Can you produce a gas from decaying garbage?

Can you control the amount of gas produced from decaying garbage?

🗮 Possible Hypotheses

A gas is/is not produced when garbage decays.

The amount of gas from decaying garbage can/cannot be controlled.

Materials

Packet of dried beans or peas6 Airtight clear plastic bagsWater

✓ Procedure

- 1. Soak the beans or peas in water overnight.
- 2. Place 10 beans or peas into each bag and squeeze out all the air before you seal them.
- 3. Put two bags in a warm, sunny place, two bags in a warm, shady place, and two bags in a totally dark place for a week and observe what happens. Record your observations.

** Analysis and Conclusion

Did the decaying beans produce a gas? Which environment was best for producing gas? Do you think the gas could be used as a source of energy? Why and how?





Cooling Fan

Grade Levels: 5-8

Background

Over half of the energy that we use in our house is used for heating and for cooling. In the summer, some people suggest that you turn on a fan instead of your air conditioner (or raise the temperature of your air conditioner and use a fan) as a way to save energy and save money.

Question

Does a fan really cool the air?

Possible Hypothesis

A fan does/does not cool the air.

Materials

Portable fanThermometer

✓ Procedure

- 1. On a hot day, place a portable fan on a table. Use a thermometer to record the temperature in the room.
- 2. Turn the fan on and hold the thermometer three feet from it, so that the air blows on the thermometer. After one minute, record the temperature.
- 3. Hold the thermometer two feet from the fan. Record the temperature after one minute.
- 4. Repeat Step 3 with the thermometer one foot away.

** Analysis and Conclusion

At what distance was the temperature the coolest? What locations might be best for putting fans in your home? Explain using observations and data from your experiments.





Heavy Backpacks

Grade Levels: 5-8

Background

Doctors say it isn't healthy for students to carry more than ten percent of their weight in their backpacks. It requires energy to lift the books off of the ground.

Question

Are the students in your school carrying too much weight in their backpacks?

Possible Hypothesis

Students are/are not carrying too much weight in their backpacks.

Materials

Weight scale

✓ Procedure

- 1. Make a chart with the names of all the students in your class, as shown.
- 2. Weigh all of the students in your class and calculate ten percent of their weight. Record this on the chart.
- 3. Weigh all of the student backpacks before they go home every day for a week. Record the weights on the chart.
- 4. Circle the backpacks that are overweight.

** Analysis and Conclusion

How many students in the class carry overweight backpacks? Is it a major problem? Talk to your classmates and teacher about ways to remedy the problem.

Student Name	Woight	10% of		Weig	ht of Back	packs	
Student nume	Weight	м	Т	W	Т	F	
Sarah	80	8	10	7	12	8	9
Jorge	100	10	5	6	12	5	9
Мау	65	6.5	10	9	12	9	10

Real World Connection

What if you have to carry extra books? How can you reduce the amount of energy required to lift your books?



Insulation 1

Grade Levels: 6-8

Background

Over half of the energy that we use in our houses is used for heating and for cooling. We can keep the warm or cool air inside by insulating our homes. Saving energy can also save families money on their energy bills.

OQuestion

Which materials make good insulators?

Possible Hypotheses

Foam is a good/poor insulator.

Cloth is a good/poor insulator.

Paper is a good/poor insulator.

Materials

- 2 Shoeboxes
- Scissors
- 2 Thermometers
- I Piece of Styrofoam about one inch thick
- Newspaper
- Towel
- Black construction paper
- Tape
- Sun or lamp

✓ Procedure

- 1. Tape black construction paper to the outside bottoms of the shoeboxes.
- 2. Place the box tops in a sunny place with the thermometers inside facing up. Record the temperatures.
- 3. Invert one box onto a top so the black bottom is toward the sun or lamp. This is your control.
- 4. Tape a piece of Styrofoam to the inside of the bottom of the second box, and then place it upside down over the second top.
- 5. Record the temperatures of both boxes after 15 minutes.
- 6. Remove the Styrofoam and tape thick pieces of newspaper in the bottom of the box. Repeat the procedure and record the temperatures.
- 7. Remove the newspaper and tape a towel into the bottom of the box. Repeat the procedure and record the temperatures.

** Analysis and Conclusion

Which material was the best insulator? What other substances might make good insulators?





Insulation 2

Background

Many times, it is important to keep heat from moving. In cold seasons, we want to keep heat in our homes. In hot seasons, we want to keep heat out of our homes. One way we do that is by insulating our homes to make it difficult for heat to move in or out.

Questions

What materials make good insulators?

Do materials insulate the same way when water is included?

🗮 Possible Hypothesis

____ will insulate the can and water the best.

∎2	Metal soda cans	■1 Thermomete	er	Scissors	■Ta	ape	
•1	1000 mL Pitcher	Insulating mat	erials	 Water 			
/	Procedure						
١.	Choose the material insulate the floor, wa	ls you think would make t alls, and ceiling of one can	he best insulat	tors and insulat	e the outside of your can. Yo	our can represe	nts a house, s
2.	Fill the pitcher with your insulated can i	1000 mL of water. (If you a n the freezer, you will fill it	re putting you with hot wate	r insulated can r.)	in the sun, you will fill it with	cold water. If y	ou are putting
3.	Fill both the insulate	ed and uninsulated cans w	ith the same a	mount of wate	r.		
1.	Measure and record	the temperature of the w	ater of both ca	ins.			
	BEGINNING	Insulated Can	°F	°C	Uninsulated Can	°F	°C
5.	Fill the insulated car back into the pitche the same way.	n with the water and place r and measure and record	e it in the sun the temperate	or freezer. Wait ure. Empty the	15 minutes, then pour the v pitcher. Record the tempera	vater from you ture of the unir	r insulated can nsulated can in
	AFTER 15 MINUTES	Insulated Can	°F	°C	Uninsulated Can	°F	°C
~	Data						
Cal	culate the change in t	emperature of the water i	n the insulated	d and control ca	ins:		
	CHANGE IN TEMPERAT	IURE Insulated Can	°F	°C	Uninsulated Can	°F	°C
* **	Analysis and Conclus	ion					



Insulating with Air

Grade Levels: 5-8

Background

We fill the walls of our homes with foam and fluff called insulation. This insulation helps keep the air in our homes the temperature we like it. In that case, we are using a solid to insulate a gas. Can a gas be used to insulate the thermal energy of a liquid?

Question

Can you use air as an insulator?

Possible Hypothesis

A heat store will/will not keep a liquid warmer.

Materials

- Big jar with lid
- Small jar with lid
- Small glass
- Warm water
- Aluminum foil
- Tape
- Cork (diameter matching small jar)
- Thermometer

✓ Procedure

- 1. Wrap aluminum foil around the sides of the small jar. Be sure to have the shiny side of the foil facing inward, toward the jar.
- 2. Pour warm water into the small jar and the glass. Record the temperature of the water. The water should be the same in the jar and the glass. Put the lid on the jar.
- 3. Place the cork inside the large jar. Now place the small jar with the warm water in the large jar on top of the cork. Put the lid on the large jar.
- 4. After ten minutes, check the temperature of the water in both the small jar and the glass (by itself) with the thermometer.
- 5. Repeat step 4 after ten more minutes.

** Analysis and Conclusion

Was there a difference in the temperatures? Did the air help retain heat in the water? What about the foil—try repeating the experiment, but also wrap the glass in the foil. Try the test with no foil. Does this change your results?

🔜 Real World Connection

Can you think of any item you find in your kitchen that uses the method you experimented with?





Natural and Man-Made Fibers

Grade Levels: 6-9

Background

Our clothes are made out of different materials. "Natural" fibers and fabrics come from plants or animals. For example, cotton is a plant, and silk comes from the cocoons of silkworms. Some fabrics are called "man-made" or "synthetic" because man produces them from chemicals. For example, polyester is made from a petroleum product. Even our fashion choices are related to energy!

Occabulary

deteriorate; to become worse, break apart, to decay
decompose; to rot, to separate into original elements

OQuestion

Do natural fibers decompose faster than man-made fibers?

🗮 Possible Hypothesis

Natural fibers will decompose faster/slower than man-made fibers.

Materials

Old 100% cotton t-shirt (natural)
Old nylon stocking or tights (synthetic)
Old wool sock or yarn (natural)
Old acrylic or polyester sweater (synthetic)
Plot of soil
Water
Glass jar with lid

✓ Procedure

- 1. Cut three four-inch squares from each material.
- 2. Bury one square of each material, making sure you mark the spot where they are buried.
- 3. Put squares of each material in a jar, fill it with water, and put a lid on it. Place the jar inside in a sunny place.
- 4. Place the third set of squares in a dark place where they will not be disturbed.
- 5. After one month, remove the samples from the ground, the dark place, and the jar. Examine the squares and record your observations.

***** Analysis and Conclusion

Which fibers deteriorated? Which environment made the materials deteriorate more quickly? Can you find out why?





Natural Herbicide

Grade Levels: 5-7

Background

Herbicides, or more often, pesticides, are chemicals that are used to kill unwanted plant life, like weeds. All plants, including weeds, use energy from the sun to grow. A process called photosynthesis allows them to turn the light from the sun into sugar for food. Using a herbicide stops a plant from being able to make the food it needs to continue growing and gathering light from the sun.

OQuestion

Can you make a natural herbicide?

🗮 Possible Hypothesis

_ can be used as a natural herbicide.

Materials

■20 Leaves from a black walnut tree

4-quart Pot and stove

Draining spoon

Water

✓ Procedure

- 1. Put the leaves in the pot and fill it half-full with water. Have an adult boil the mixture on the stove for 10 minutes.
- 2. Remove the leaves using the draining spoon and boil the rest of the mixture for 20 minutes. This liquid is the herbicide for testing.
- 3. Locate weeds around your home. Each day at dusk pour about two ounces of the herbicide on half of the weeds and the same amount of water on the other half of the weeds. These will be the control weeds.
- 4. Do this for seven days, recording your observations each day.

** Analysis and Conclusion

Did the natural herbicide work? Do research on the black walnut tree to discover its properties. Do you think using natural herbicides is a good idea? Do you think the leaves of other trees would work, too?





Natural Plastic

Grade Levels: 6-8

Background

Plastics are materials that we use every day. You probably can look around the room and point to several items that have plastic in them or on them. Many of the plastics we use today are made from petroleum, or oil we drill from the earth. Making plastics uses energy. Plastics are useful because they can be very strong. Do plastics decompose as quickly as natural materials?

Questions

Can you make your own natural plastic? Does natural plastic decompose better than petroleum-based plastic?

🗮 Possible Hypothesis

_ plastic decomposes better than ____

plastic.

Materials

- 2 Glass jars
- ■4 ounces (120 ml) Whole milk
- Teaspoon of vinegar
- Pot and stove
- Plastic spoon
- Waxed paper
- Plot of soil

✓ Procedure

- Pour the milk into the pot and boil it until it separates into soft masses called curds and clear liquid. Slowly pour the liquid into one glass jar and spoon the curds into the other.
- Add the vinegar to the curds and allow the mixture to sit for two hours. The mixture will turn into a solid yellowish mass. Pour off any liquid.
- 3. Knead the mass into a dough, mold it into a spoon and place it on waxed paper to dry overnight.
- 4. Compare your spoon to the plastic spoon. Record your observations.
- 5. Bury both spoons in a plot of soil. After two weeks, dig up the spoons and observe any difference.



* Analysis and Conclusion

How did the plastics compare to each other before and after burial? Do some research on the cost to make natural plastic compared to petroleum-based plastic. What are some pros and cons to using natural plastic?



Saving Hot Water

Grade Levels: 5-8

Background

About 13% of the energy we use in our houses is used to heat water. If we can save water when we shower or take a bath, we are also saving the energy that it takes to heat the water.

Question

Does it save more water to take a shower or a bath?

Possible Hypothesis

It takes _

____ water to take a shower than a bath.

Materials

Bathtub with a showerRulerThermometer

- ✓ Procedure
- 1. Have each member of your family plug the drain when taking a shower for one week.
- 2. Measure the amount of water they used with your ruler. Write down how high the water was for each person in your family each time they showered for a week.
- 3. The next week, have each person take a bath instead of a shower. Use your ruler to measure how much water they use for their bath. (Make sure the person isn't in the tub! That will change your measurements!)
- 4. During the showers and baths, also have your family take the temperature of the water.

** Analysis and Conclusion

Compare the amount of water used for baths and showers for each member of your family. Which saved more water and energy: a shower or a bath? Which member of your family used the least amount of water? Who is using the most energy to heat the water?

💻 Real World Connection

Low-flow showerheads use less water than regular showerheads, but it feels like a regular shower. Does your family have low-flow showerheads? You may want to put them into your shower and try your experiment again? Did they really use less water? Also, try taking colder showers for a month. Do you notice a change in your utility bill?





Seeds and Needs

Grade Levels: 5-7

Background

Plants need energy from the sun, water, and oxygen to grow. Which of these items is the most useful?

Questions

Will seeds grow faster with more water?

Will seeds grow faster with more sunlight?

🗮 Possible Hypothesis

Seeds will/will not grow _____

_____ with more ____

Materials

- Packet of bean seeds
- Water
- Tablespoon
- 20 Snack-size zip-lock bags

✓ Procedure

- 1. Label ten bags from 1 to 10. Label the other ten bags 1-S to 10-S.
- 2. Place two seeds in each bag.
- 3. Add one tablespoon of water to bags 1 and 1-S, two tablespoons of water in bags 2 and 2-S, and so on until all the bags have water.
- 4. Place the bags in a sunny place. Leave the bags marked with an S in the sun all the time. Leave the other bags in the sun for two hours a day.
- 5. Compare the beans in the bags after one week. Record your observations.

** Analysis and Conclusion

What effect did the amount of water have on seed growth? What effect did the amount of sunlight have on seed growth? Do you think the seeds would grow better if they were in sunlight 24 hours a day?





Solar Distillation

Grade Levels: 6-9

Background

Hydropower is considered a renewable energy source because the water on Earth is constantly going through the water cycle because of the sun's energy. Here's another way we may be able to use the sun to make water more useful.

Vocabulary Vocabulary

distill: to turn something into a gas (vaporization) and then back into a liquid (condensation) to purify it

Questions

Can you distill clean water from muddy water?

Can you distill clean water from salty water?

₩ Possible Hypotheses

You can/cannot make clean water from muddy water.

You can/cannot make clean water from salty water.

Materials

- 2 Large plastic containers
- Clear plastic wrap
- Masking tape
- 2 Small rocks
- 2 Small glasses
- 2 Tablespoons of dirt
- 2 Tablespoons of salt
- Water

✓ Procedure

- 1. Fill both plastic containers with one inch of water. Mix the dirt into the water in one and the salt into the other.
- 2. Place one empty glass upright into the middle of each plastic container. Make sure it remains empty.
- 3. Cover both plastic containers tightly with plastic wrap and seal them with tape. Place a small rock in the middle of the plastic wrap, directly over each glass but not touching it.
- 4. Place the stills in a sunny place for two hours. Examine any water that forms in the glass. Record your observations.

***** Analysis and Conclusion

Did the stills make clean water?

💻 Real World Connection

Can you explain how they worked? Can you imagine a situation in which knowledge could save your life? It is estimated that over 1 billion people worldwide drink water that is unhealthy. How could your project help them?







Waste Heat

Grade Levels: 5-8

Background

Energy is never created or destroyed, it simply changes form. A light bulb uses electricity to create light that lights your home. Light bulbs use the electricity to first create heat and then light. Some light bulbs need a lot more heat in order to illuminate.

Questions

Do	es a high wattage bulb produce r	nore heat than a low wattage bulk	o?	
*	Possible Hypothesis			
Α_		bulb produces	heat than a	bulb.
Í	Materials			
•La	mp			
•TI	iermometer I watt Halagan incandossont hull			
■3.	CFL bulb (similar number of lume	ns as Halogen incandescent bulb)		TT7
∎1	LED (similar lumens)	,		
~	Procedure			FA /
1.	Put the halogen incandescent b	oulb in the lamp and turn it on.		
2.	Hold the thermometer six inch Turn off the lamp.	es above the bulb for one minute	e and record the temperature.	
3.	Let the bulb cool, remove it, pu	t in the CFL bulb, and turn it on. Re	epeat Step 2.	
4.	Repeat the procedure with the	LED.		
* **	Analysis and Conclusion			
Wł	ich bulb produces the most heat	?		
Wł	ich light bulbs are more energy e	fficient—incandescent, fluoresce	nt, or LED?	



Wind Around Your Home

Grade Levels: 5-8

Background

Wind is simply air in motion. Wind is created when the sun heats the Earth. Winds can be fast or slow depending on the weather in your area, the land features around you, and even how high off of the ground you are. Wind can be used to make electricity.

Questions

On which side of the house would you put a windmill?

Is there more wind at higher altitudes?

🗮 Possible Hypothesis

A windmill would be best on the ______ side of the house because ______

Materials

- Pencils with erasers
- Thumbtack
- Thread—25 cm
- Paper
- Protractor
- Compass

✓ Procedure

- 1. Draw a diagram of your home. Be sure to draw the objects around your home such as trees, shrubs, and other items that might block the wind. Label the north, east, west, and south sides of your home with the help of a compass. Mark sites that represent the areas you will be testing and collecting evidence.
- 2. Make a device to measure wind strength. Push the thumbtack into the eraser of a pencil and tie the thread around the thumbtack.
- 3. Measure the power of the wind using your device. Hold the device in the air and observe the wind blowing the thread. Record the angle of the thread. The larger the angle, the higher the wind energy at the location. Repeat the experiment several times at different times of the day in different weather conditions, and (if possible), different heights or altitudes.
- 4. Make a chart to record the time of day, the weather conditions, and the angle of the thread at each site.

** Analysis and Conclusion

At what height was the wind strongest? Was this true at different times during the day? Where would you put a windmill around your house to provide the most energy? Is there only one good location or are several locations equally good?





Energy in Motion

Grade Levels: 5-8

Background

Moving objects have kinetic energy. Objects not moving are storing energy as potential energy. Gravity is the force that pulls objects toward the ground, making them move. Friction is the force that slows moving objects.

CQuestions

What happens to the potent	ial energy in a ball when it rolls down a ruler?		
Will a ball roll farther on a tile	e floor or on a carpeted floor?		
🗮 Possible Hypotheses			
A ball will	when it rolls down a ruler. It will		on the tile floor and
	on the carpeted floor.		
Materials			
■Superball			
 Meterstick 		<u></u>	RULED
Grooved ruler		<u>) BOOK</u>	

1. On a tile floor, place one end of a ruler on a book binding as shown in the picture to make a slide.

2. Place the superball at the top of the ruler and let it go. Do not push it.

3. Measure how far it rolls from the end of the ruler and record in the chart below.

4. Repeat Steps 2-3 three more times.

5. Repeat Steps 1–4 on a carpeted floor. Record your measurements in the chart below.

🗠 Data

		Distance the Ball Rolled			
	Trial 1	Trial 2	Trial 3	Trial 4	
Ball Roll on the Tile Floor					
Ball Roll on Carpet Floor					

***** Analysis and Conclusions

What form of energy was in the ball when you held it at the top of the ruler? What happened to the energy in the ball when you let it go? On which surface did the ball roll farther? Which surface applied more friction to the ball?



Biodegradability

Grade Levels: 5-7

Background

Each American makes a little more than 4 pounds of trash per day. This trash is made up of food scraps, plastic, packaging, glass, yard waste, paper, and metals. Much of this material is trucked to a landfill, and some is recycled. Items in a landfill break down over time. Some break down faster than others, and some take many many years to break down. Some items may never break down or decay!

Occabulary

biodegradable: waste that can be broken down or decays over time

Question

Which common materials are biodegradable?

🗮 Possible Hypothesis

_ are / are not biodegradable.

Materials

- 2 One-gallon plastic milk jugs
- Scissors
- Magnifying glass
- Shovel
- Square of soil

•Collection of 20 small items to fit in the milk jugs - 10 you think will biodegrade and 10 you think will not. Items should include things made of wood, paper, glass, plastic, metal, cloth, and food wastes.

Procedure

- 1. Cut the tops off the milk jugs and poke holes in the bottoms and sides to allow water to pass through the jugs.
- 2. Put 10 items in each jug.
- 3. Dig two holes about a foot apart and bury the containers. Let them remain buried for three months.
- 4. Dig them up after three months and examine the contents. Record your observations.

***** Analysis and Conclusion

After examining the items, remark on which ones showed signs of decay. Were your hypotheses correct? What do you think makes an object biodegradable or not? What are common characteristics of biodegradable objects?









Burning Popcorn

Grade Levels: 7-9

Background

Biomass is any organic material we can use for energy. We use chemical reactions, like burning biofuels to release the energy in the biomass fuel. Our bodies use biomass for energy, too. We burn food for its energy, and we measure its energy in calories.

OQuestions

Can the energy in food be transformed?

Can food be used to create thermal energy?

🗮 Possible Hypothesis

Popcorn has/does not have enough energy when burned to raise the temperature of water.

Materials

- 1 Package microwaveable popcorn popped and allowed to dry for 1 week
- I Empty soda can
- Lab tripod or campfire cooking grill stand
- Lighter with long stem or long matches
- Heavy metal pan
- Water
- Thermometer

✓ Procedure

- 1. Find a flat, paved surface outside, and away from buildings and materials that can ignite (sidewalk, parking lot, patio).
- 2. Pour a small amount of water into the beaker and place it on the tripod. Record the temperature of the water.
- 3. Place the bag of popped corn into a heavy metal pan. Place the pan under the tripod and can of water. Carefully light the bag on fire and observe the popcorn. STEP BACK.
- 4. Record the temperature of the water in the beaker after the popcorn has burned.

** Analysis and Conclusions

How much did the temperature of the water increase? What are the bag and the popcorn made from? How does this translate to energy use in your body?



Absorbing Solar Energy

Grade Levels: 5-8

Background

Matter comes in three forms: solid, liquid, and gas. In solids, the molecules are very close together and cannot move very much. In liquids, the molecules are a little further apart and can spin and move more. In gases, the molecules are further apart still; spinning and moving even faster. Thermal energy (heat) can affect the state of matter (heat turns an ice cube into water then into steam), but how does matter absorb radiant and thermal energy?

Question

What collects more solar energy: gases, liquids, or solids?

🗮 Possible Hypothesis

are able to collect and hold onto solar energy better.

🗐 Materials

- 3 Glasses
- Water (room temperature)
- ■Sand
- 3 Thermometers
- 2 Popsicle sticks
- Tape

✓ Procedure

- 1. Fill one glass 2/3 full of water. Fill another glass 2/3 full of sand. Leave the third glass empty.
- 2. Place the thermometer in the sand so that the bulb is in the center of the sand, not touching the sides of the glass. Using the popsicle sticks across the mouth of the other two glasses, tape the thermometers to the sticks, so that the bulbs are in the centers of the water and air.
- 3. Place the three containers in a sunny window.
- 4. Every five minutes, record and graph the temperature. Do this every five minutes for one hour.
- 5. Place the containers in an area away from the sun. Again record and graph the temperature every five minutes for one hour.
- 6. Compare your graphs.

***** Analysis and Conclusion

Which sample, if any, got the warmest? Which sample, if any, retained its heat after being removed from the sunlight? What effect does sunlight have on air, water, and sand? How would different gases, liquids, and solids be affected? How could you use this information in real life?





Grade Levels: 6-9

Background

The sun can be used to provide heat through a radiant energy transformation. Solar collectors are devices that capture the suns rays and trap them in as heat. Solar ovens are solar collectors that can cook food!

Question

How long will it take to cook food in a solar oven?

Representation Possible Hypothesis

It will take to cook in a solar oven.

Materials

- I Small pizza box Plastic wrap
- Aluminum foil
- ■1 Wooden skewer (12"-18")
- Marker

- Scissors Ruler Masking tape I Paper plate* Black construction paper
- Oven thermometer
- Food to cook
- Various materials provided by your teacher *NOTE: Dark-colored paper plates work best, if available.

✓ Procedure

- 1. Read over the general solar oven directions below and look at the materials list.
- 2. List all of the possible variables you could change in your solar oven design.
- 3. Gather the materials you need from the list and any additional materials you may use to vary your design.
- 4. Build your solar oven and test its efficiency using the oven thermometer.
- 5. Make any needed design changes that will enable your solar oven to cook food efficiently.

General Directions to Build a Solar Oven

- 1. On the top of the pizza box, use your marker to draw a square with edges spaced 1" from all sides of the box.
- 2. Use scissors to cut along the sides and front edge of the lid, leaving the fourth side along the box's hinge uncut.
- 3. Tape aluminum foil to the inside surface of the new flap you just cut, shiny side visible. This is to reflect sunlight into the box. Smooth out any wrinkles that might occur.
- 4. Tape plastic wrap to the original box flap so that it covers the hole you cut into the flap. Seal all four of the edges with tape.
- 5. Tape black construction paper to the bottom inside of the box. This will help absorb the incoming sunlight.
- 6. Cover any air leaks around the box edges with tape, making sure that the box can still be opened to place food inside or remove it later.
- 7. Go outside in the sunlight and place the solar oven on a level flat surface.
- 8. Place food items on a paper plate and place it inside the oven. Put the oven thermometer inside the oven where you will be able to see it without moving the oven.
- 9. Tape one end of a wooden skewer to the reflector lid, attach the other end to the box to adjust reflector.
- 10. Let the food cook and periodically check the reflector angle to make sure sunlight is getting inside the oven.

** Analysis and Conclusions

What factors contributed to the successful cooking of the food? How could you improve your design? What are the practical applications where solar ovens could be used?

©2020 The NEED Project 1.800.875.5029 www.NEED.org



STEM CHALLENGE: Solar Water Heater

Grade Levels: 6-9

Background

The sun can be used to provide heat through a radiant energy transformation. Solar collectors are devices that capture the sun's rays and trap them as heat. Solar water heaters are solar collectors that catch the suns rays and allow them to transform into thermal energy or heat. This transformation heats up a liquid that can then travel to your water heater. The water heater absorbs the energy from the solar-heated liquid and uses it to heat the water in your home.

OQuestions

How much temperature change can be created in water when placed in the sun?What is the most effective set-up for a solar water heater?

Materials

- Cardboard sheet
- Black tubing
- Glue, tape, and/or twist ties
- Water
- Turkey baster or cooking syringe
- Thermometer
- Foam cup
- Sunny day
- Other, found materials for re-design

🗮 Possible Hypothesis

✓ Procedure for Baseline Model

- 1. Lay tubing out onto your cardboard in a snake-like pattern.
- 2. Affix the tubing onto the cardboard using glue, tape or, twist ties. If using twist ties, it may be helpful to poke holes into the cardboard for easy attachment.
- 3. Find a sunny spot outdoors that will stay sunny for at least an hour.
- 4. Take the temperature of your water. Record this as a starting temperature. Using a turkey baster or syringe, squirt or pump water into your tubing until it's full while the system is flat on the ground. Using tape, cover the ends of the tubing temporarily.
- 5. Allow your system to stay in direct sun for 10 minutes.
- 6. After time has completed, remove the tape from one end of the tubing. Holding this end over the Styrofoam cup, tilt your system and use gravity to drain the water out of the tubing.
- 7. Quickly take and record the temperature of the water. Record your results.
- 8. Consider how you might redesign the system and what elements you could add to increase the temperature change. Make notes in the Redesign section and sketch your additions.
- 9. Redesign, re-build, and re-test.



a Results			
Redesign Notes			

🗠 Retest Results



STEM CHALLENGE: Petroleum Pull

Grade Levels: 5-8

Background

Petroleum and/or natural gas deposits are found underground by drilling to reach them. Because these materials are often several thousand feet below the Earth's surface, the pressure on the often pushes it to the surface naturally once an opening is created. However, as the well is accessed over time, the pressure in the well decreases and assisting devices called pumpjacks are needed to draw the resource out of the ground. Greater pressure may need to be applied depending on the viscosity (thickness) of the fluid, and the distance from the surface.

STEM Challenge Prompt:

Build a "pump" to pull "petroleum" (dark liquid) up from the reservoir (a cup) using pressure from your mouth. Plan out your design and build it using only the materials on the materials list in any combination or number. Test it, re-build and re-test.

- The pump must pull the liquid through 2 meters of well pipes (straws).
- Only one pump may be used at a time.

Question

•What will be the best design for my petroleum well?

Materials

Straws (any length or width)
Clay
Scissors

- Tape (any kind)
- Dark beverage (your petroleum)
- Small cup
- Meter stick
- Measuring cup

🗮 Possible Hypothesis and Design

** Redesign Notes



STEM CHALLENGE: Wind Can Do Work

Grade Levels: 6-8

Background

Before wind energy was used to generate electricity, it was used to do physical labor. Goods and people were transported using wind power. Old windmills ground grain into flour and wind power was used to pump water for livestock and farming. This challenge focuses on using wind energy to do physical work by lifting paper clips.

STEM Challenge Prompt:

Build a windmill that lifts paper clips 15 centimeters or more using only the materials on the list in any combination or number. Plan out your design and build it. Test it, re-build and re-test.

- The windmill must turn on its own.
- Lift as many paper clips as you can.
- Use a fan on medium speed or lower.
- Windmills can be made from any combination of materials on the list, but may NOT use a pre-formed windmill or pinwheel.

OQuestion

What will be the best design for my windmill?

Materials

- Cardboard
- Paper
- String, thread, or fishing line
- Pencils
- Cups
- Tape
- Glue
- Paperclips
- Popsicle sticks
- Straws

🗮 Possible Hypothesis

** Redesign Notes



These activities have been provided by The NEED Project. For more information please visit www.NEED.org.

