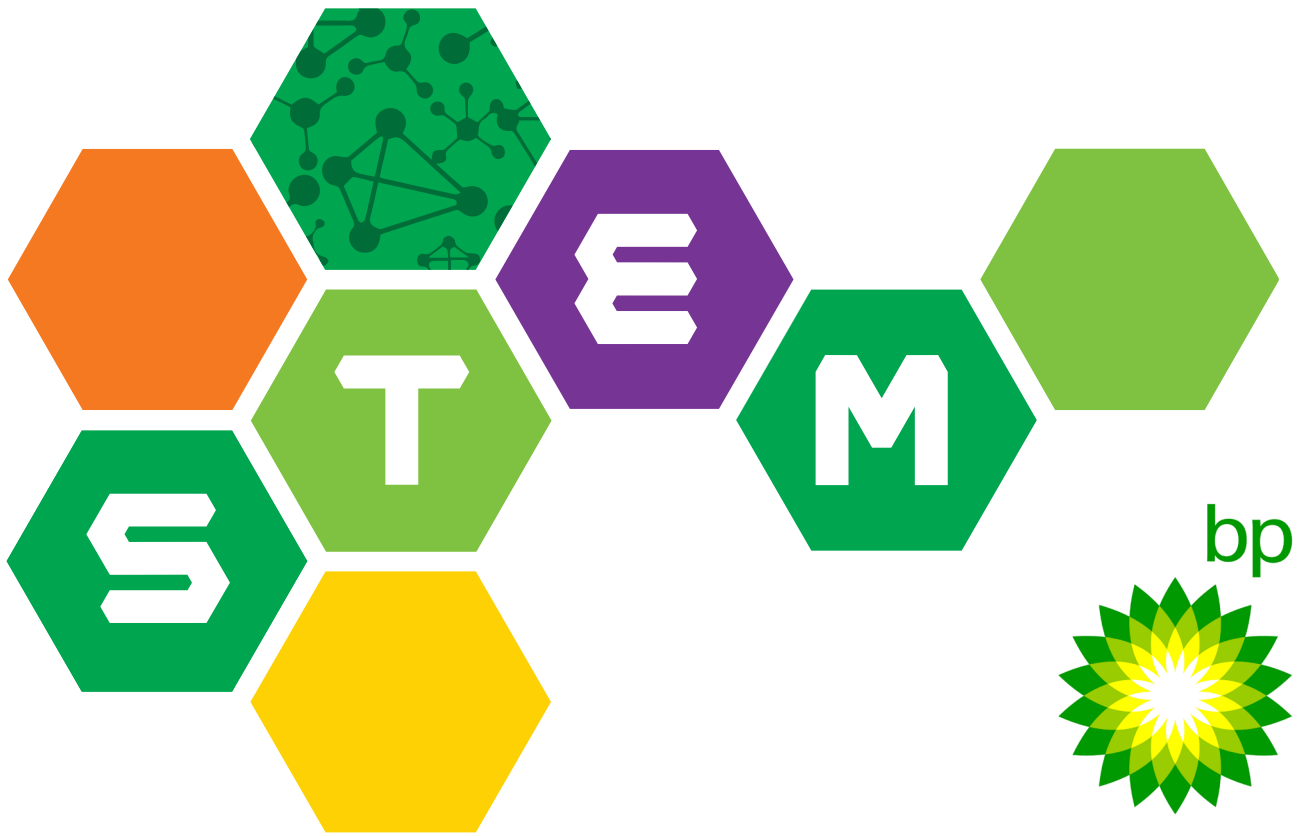




MIDDLE SCHOOL ENERGY EXPERIMENTS

INTERMEDIATE





FUELING THE NEXT GENERATION OF INNOVATORS

Science, technology, engineering, and math (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, technology-driven 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. The information and activities in this booklet will help you understand the important role STEM plays in the energy industry.



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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.

Forms of Energy

POTENTIAL

Chemical Energy



Elastic Energy



Nuclear Energy



Gravitational Potential Energy



KINETIC

Electrical Energy



Radiant Energy



Thermal Energy



Motion Energy



Sound 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 crude oil deposits in a short time.

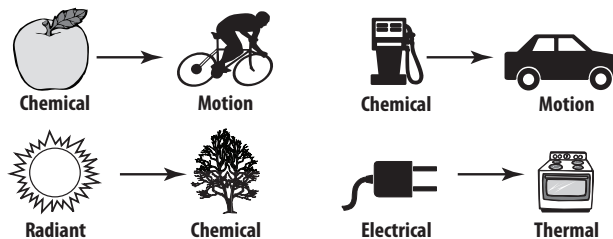
Renewable energy sources include biomass, geothermal energy, hydropower, solar energy, and wind energy. They are called renewable because they are replenished in a short time. Day after day, the sun shines, the wind blows, and the rivers flow. We use renewable energy sources mainly to make electricity.

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., coal 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



U.S. Energy Consumption by Source, 2013

NONRENEWABLE, 90.5%

RENEWABLE, 9.4%



Petroleum 35.2%
Uses: transportation, manufacturing



Biomass 4.7%
Uses: electricity, heating, transportation



Natural Gas 26.6%
Uses: electricity, heating, manufacturing



Hydropower 2.6%
Uses: electricity



Coal 18.5%
Uses: electricity, manufacturing



Wind 1.6%
Uses: electricity



Uranium 8.5%
Uses: electricity



Solar 0.3%
Uses: electricity, heating



Propane 1.7%
Uses: heating, manufacturing



Geothermal 0.2%
Uses: electricity, heating

Data: Energy Information Administration
*Total does not equal 100% due to independent rounding.



Clean Air

Grade Levels: 4-6

Background

More than 60% 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.

Question

Does indoor or outdoor air have more particles?

Possible Hypothesis

_____ air has more particles.

Materials

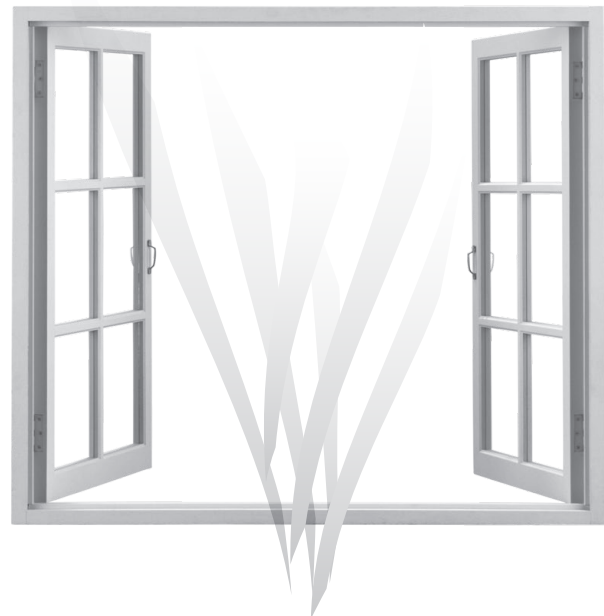
- 14 White index cards
- Petroleum jelly
- Cotton swabs
- Tape
- Magnifying glass

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: 4-9

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.

Vocabulary

▪corrosion: a slow breakdown of a metal

Questions

What types of metal are susceptible to corrosion?

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: 4-9

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.

Vocabulary

▪ cryogenic: a material at a very low temperature

Question

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: 4-6

Background

The average person in the United States creates about four pounds of trash every day! This includes materials like aluminum, 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 peas
- 6 Airtight clear plastic bags
- Water

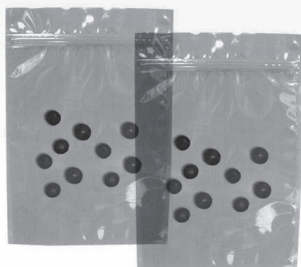
Procedure

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.

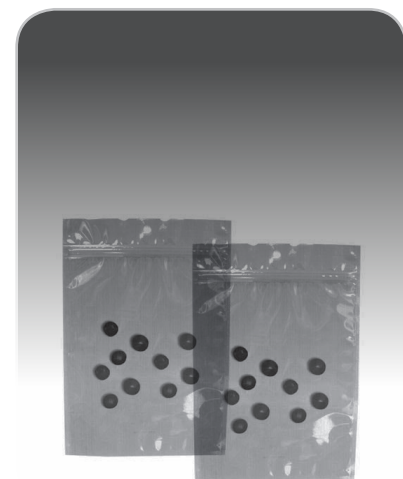
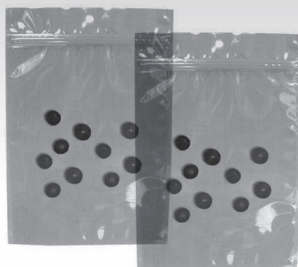
Analysis and Conclusion

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?

Sunny



Shady





Cooling Fan

Grade Levels: 4-6

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

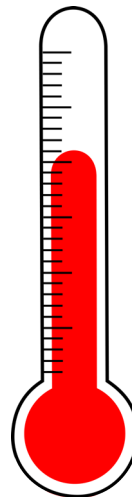
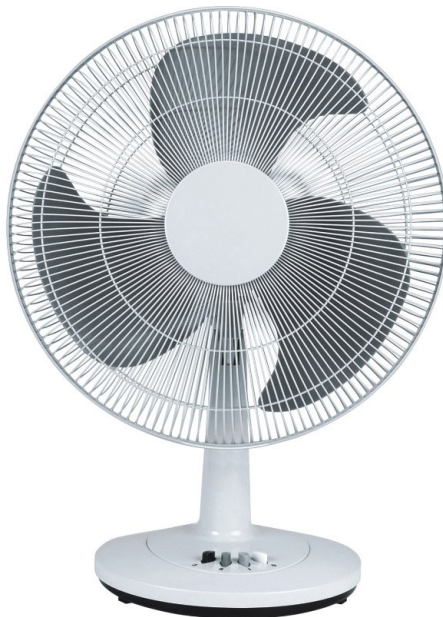
- Portable fan
- Thermometer

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: 4-6

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	Weight	10% of Weight	Weight of Backpacks				
			M	T	W	T	F
<i>Sarah</i>	80	8	10	7	12	8	9
<i>Jorge</i>	100	10	5	6	12	5	9
<i>May</i>	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

Grade Levels: 4-6

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.

Question

Which materials make good insulators?

Possible Hypotheses

Foam is a good/poor insulator.

Cloth is a good/poor insulator.

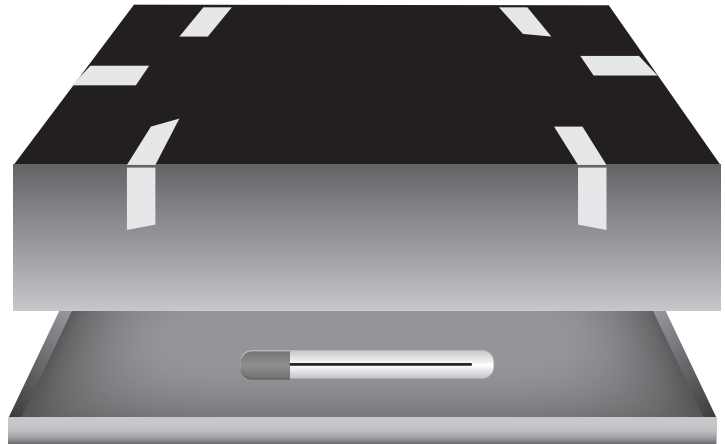
Paper is a good/poor insulator.

Materials

- 2 Shoeboxes
- Scissors
- 2 Thermometers
- 1 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?



Natural and Man-Made Fibers

Grade Levels: 4-9

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!

Vocabulary

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

Question

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: 4-6

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.

Question

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: 4-6

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

1. 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.
2. 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: 4-6

Background

Almost 20% 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 shower
- Ruler
- Thermometer

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: 4-6

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

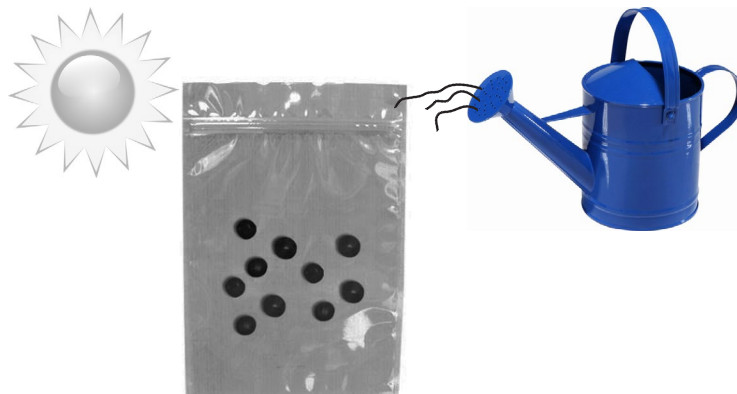
- Packet of bean seeds
- Water
- Tablespoon
- 20 Snack-size zip-lock bags

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: 4-9

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

▪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: 4-6

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 glow.

Questions

Does a high watt bulb produce more heat than a low watt bulb?

Does an incandescent bulb produce more heat than a fluorescent bulb?

Possible Hypothesis

A _____ bulb produces _____ heat than a _____ bulb.

Materials

- Lamp
- Thermometer
- 25-watt Incandescent bulb
- 100-watt Incandescent bulb
- 2 Fluorescent bulbs that produce lumens comparable to the incandescent bulbs

Procedure

1. Put a 25-watt incandescent bulb in the lamp and turn it on.
2. Hold the thermometer six inches above the bulb for one minute and record the temperature. Turn off the lamp.
3. Let the bulb cool, remove it, put in the 100-watt light bulb, and turn it on. Repeat Step 2.
4. Repeat the procedure with the fluorescent bulbs.

Analysis and Conclusion

Is more heat produced when more light is produced?

Which light bulbs are more energy efficient—incandescent or fluorescent?





Wind Around Your Home

Grade Levels: 4-6

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?





Biodegradability

Grade Levels: 4-6

Background

Each American makes about 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!

Vocabulary

▪ 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?





Insulating with Air

Grade Levels: 4-6

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?





Absorbing Solar Energy

Grade Levels: 4-6

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

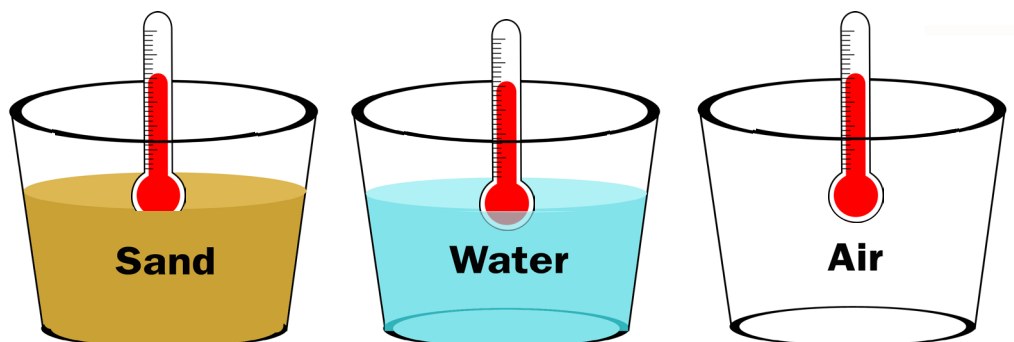
- 3 Glasses
- Water (room temperature)
- Sand
- 3 Thermometers
- 2 Popsicle sticks
- Tape

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?





These activities have been provided by The NEED Project.
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