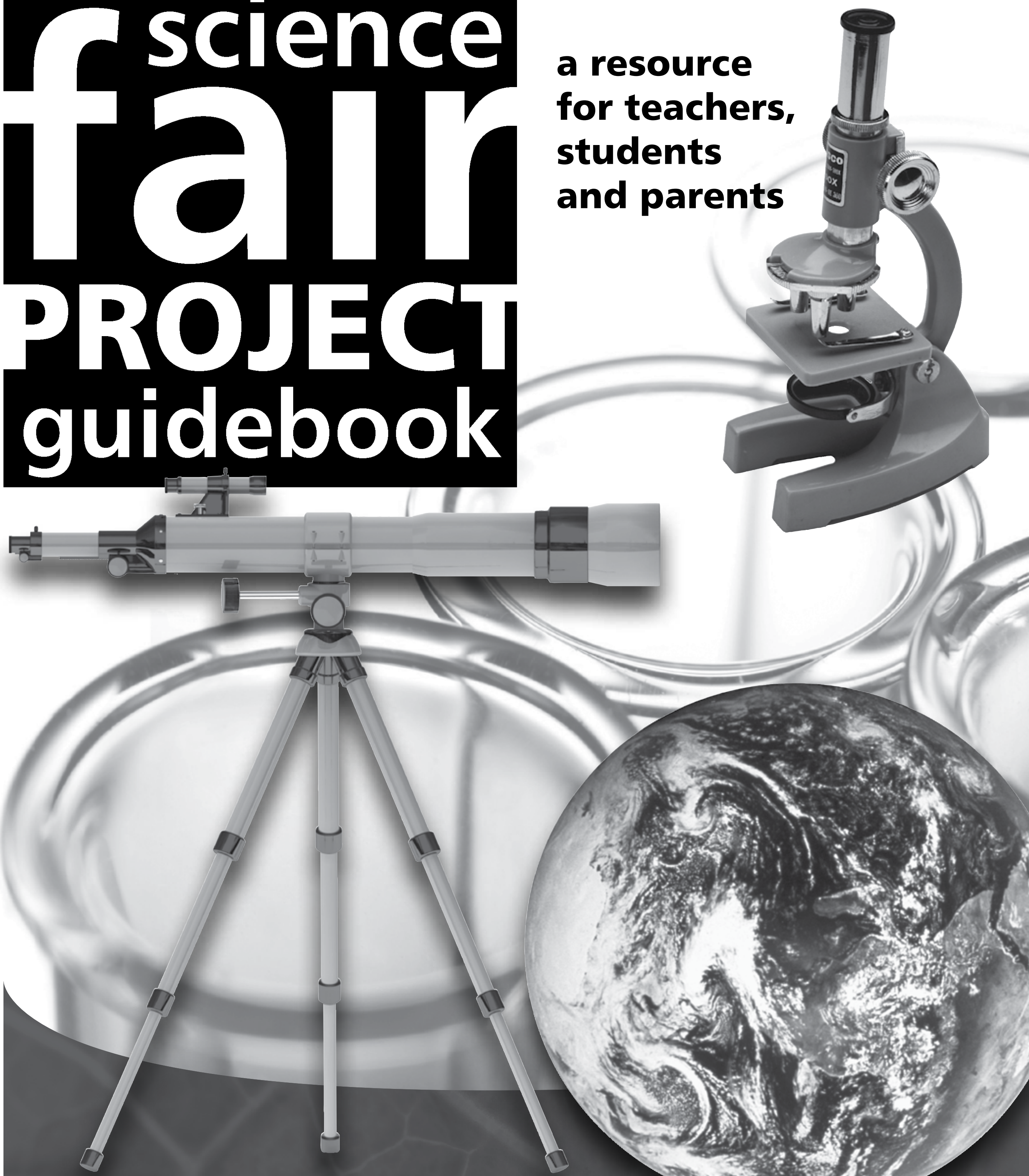
science fair PROJECT guidebook

a resource for teachers, students and parents



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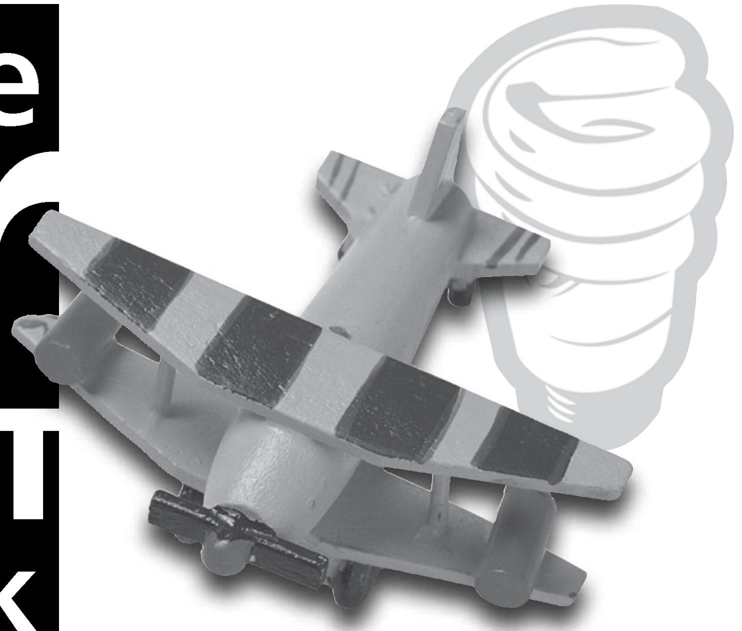


a resource for teachers, students and parents

Contents ...

Acknowledgements

Thank you to Joyce Brown, E.L. Wright Middle School and Linda Mobley, Richland Northeast High School for their review and recommendations on this guidebook.

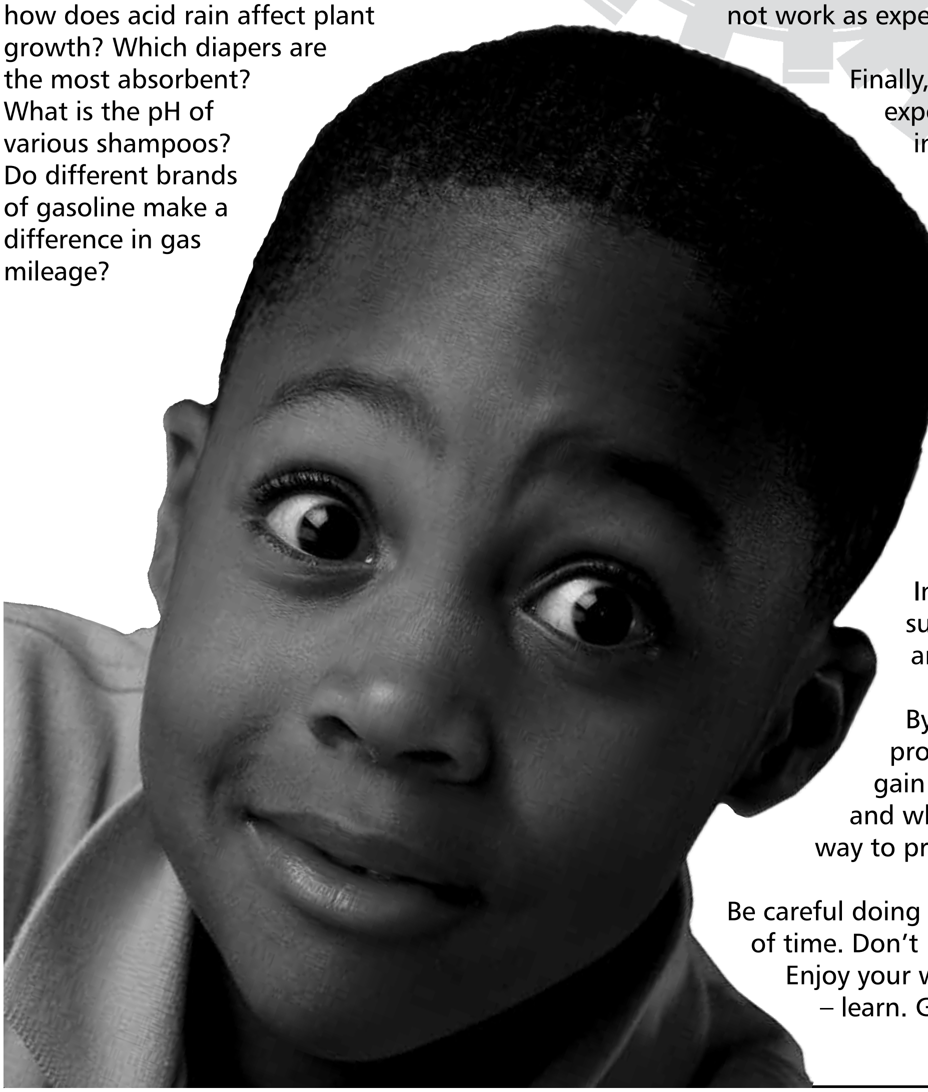
Introduction ...

It seems that nothing strikes fear in the hearts of students and parents like these three words: ***science fair project***.

But it doesn't have to be that way. A science fair project is an opportunity to research and learn about things that interest you. And through your studies you will learn how science is basic to everything around us.

You will benefit beyond your improved science knowledge. Science fair projects teach you problem-solving skills, improve your written and oral communication skills and give you the satisfaction of completing a well-done project.

The ideas for projects are endless; you are limited only by your imagination. For example, does dirty dish water affect the growth of plants? Or how does acid rain affect plant growth? Which diapers are the most absorbent? What is the pH of various shampoos? Do different brands of gasoline make a difference in gas mileage?



The first key to a successful science fair project is picking a topic that interests you. The reason is simple: you will be motivated to do a better job on the project and will have fun doing it. And remember, a good science fair project doesn't have to be complicated. It is important that you understand your project and that you have explored the scientific and technical issues related to your project.

The second key is careful planning. After discussing your project with your teacher and getting approval for your idea, allow yourself plenty of time for research, experiments, observation and analysis. In other words, don't wait until the last minute. Projects take time.

Ask questions about your project, but do the work yourself. If you do the work yourself, you will get a much better understanding of why things do and do not work as expected.

Finally, don't get upset if your experiments prove your hypothesis incorrect. Throughout history, some of the most important experiments were those that didn't prove the original hypothesis.

On the following pages are basic ingredients for a science fair project and tips for a great display as well as suggestions for making a great presentation. Best of all, there are 19 science fair projects complete with easy-to-understand instructions. In addition, there are different subjects, including air, energy, water and recycling.

By performing one of the science projects in this guidebook, you will gain a better understanding of science, and who knows, maybe you'll find a new way to protect the environment.

Be careful doing your project. Give yourself plenty of time. Don't be afraid of making mistakes. Enjoy your work and have fun. But most of all – learn. Good luck.

What is a Science Fair Project?

A science fair project is an investigation of a question that involves research, planning and application of the scientific method to find the answer.

The Scientific Method

The SCIENTIFIC METHOD is a tool that scientists use to find answers to questions. The tool involves the following steps:

- doing research;
- identifying a problem;
- stating a hypothesis;
- conducting project experimentation; and
- reaching a conclusion.

Research

Your RESEARCH begins when you select your project topic. Once you have chosen it, begin your project research.

HERE'S A TIP: Choose a catchy title. Make it specific. Usually, it's best for the title to be a question or something like this:

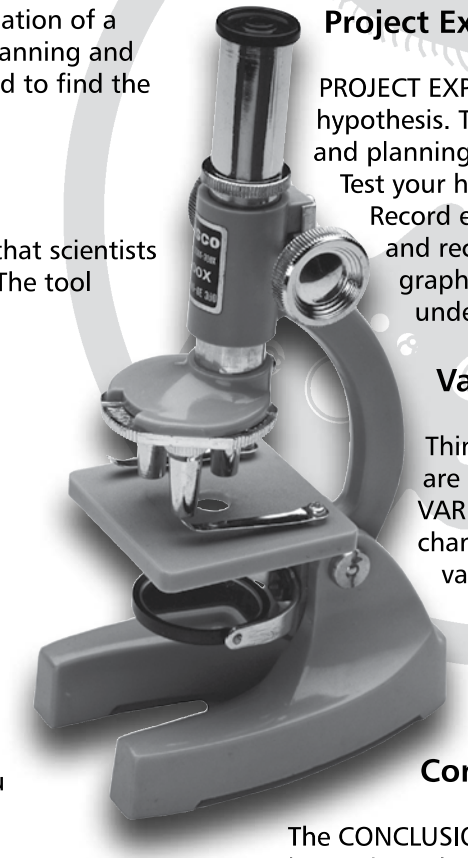
- The Effects of...
- The Study of...
- An Investigation of...
- A Comparative Study of...
- The Observation of...

Problem

The PROBLEM is the question to be answered.

Hypothesis

The HYPOTHESIS is simply your best guess as to what will happen.



Project Experimentation

PROJECT EXPERIMENTATION means testing your hypothesis. This includes more research, designing and planning for experimentation and testing. Test your hypothesis carefully by experimenting. Record everything you do. Make observations and record the results. Make charts and graphs or take pictures so others can understand what you have done.

Variables

Things that can affect your experiment are called VARIABLES. The INDEPENDENT VARIABLE is the variable you purposely change. The DEPENDENT VARIABLE is the variable you are observing that changes in response to the independent variable. The variables that are not changed are called CONTROLLED VARIABLES.

Conclusion

The CONCLUSION is a summary of what you have learned. Analyze your data and decide if your hypothesis was correct. Is more work needed? What else would you do to work on this problem?

Tips on How to Choose a Science Fair Project

- List your favorite activities and subjects. Now select a project from one of those areas.
- What are some of the materials you could use with your experiment? Are the materials available at your home? You may want to select materials that are inexpensive and easy to find.
- Your school library and local public library are good places to go for more information to complete your science fair project.

Getting Started ...

Choose a topic.

Again, don't wait until the last minute to start your project. Choose a topic that is interesting to you. If you need an idea, begin by looking through newspapers and magazines, visiting the library, watching the news and educational shows and exploring the Internet. Ask your parents, teachers and friends. Visit a museum or zoo. Make sure the topic you choose is one you can do by yourself. Can you get all the necessary equipment and supplies?

State the purpose.

What do you want to discover?

Make a hypothesis.

What do you think will happen based on your knowledge?

Decide on a procedure.

What do you need to do to find the answer? What steps do you need to take? What materials will you need? What background information will you need? Gather information about your topic. Record all of your information and sources in a logbook.

Experiment.

Test your hypothesis carefully by experimenting. Make observations and record the results. Draw pictures and make graphs so that another person can understand what you have done.

Draw conclusions.

Analyze your data and decide if your hypothesis was correct. Is more work needed? What else would you do to work on this problem? Give a one sentence conclusion to your experiment.

Tips for Building a Great Display

You have worked hard on your project so it is important to display it well.

The keys to a good display are simplicity, neatness and clarity. Do not attempt something elaborate. You should have a three-fold standing display and a logbook. If you have an interesting piece of equipment, you also may want to display it. Remember, at presentation time there should be no food, no live animals or plants, no chemicals, nothing hot or electrical and nothing valuable. A good display takes as much planning as the project. You will need the following:

- a white, three-fold cardboard backboard (colored backgrounds sometimes work, but simple is best);
- bright colored letters for your title and categories (computer-generated or adhesive lettering);
- colored construction paper behind your neatly typed pages of explanation to set them off from the backboard, and neat charts and graphs;
- at least one drawing or photograph; and
- a logbook recording how you conducted your experiment.

Your display should contain the following categories:

- a title;
- a purpose statement;
- an abstract (required for high-level competition);
- a hypothesis;
- the procedure;
- data/results charts, graphs, analysis; and
- a conclusion.

Your logbook should contain the following:

- a title page;
- a table of contents;
- a purpose statement;
- an abstract;
- a hypothesis;
- a list of materials;
- the procedure;
- all data;
- charts, graphs, other analyses of your data;
- a conclusion;
- background information (listed in correct bibliographic form); and
- acknowledgments. (Did a parent, teacher or librarian help you?)

Bringing It All Together ...

Other Helpful Hints

- Color coordinate your display. Make it eye-catching.
- Make it so that the judge can get some good information just by glancing at your display. Keep it simple and clear.
- Have magazine articles, pamphlets, etc., to display along with your logbook. Attract people to your display.
- Triple-check your spelling (nothing is more of a turn-off than poor spelling on a display).
- Make sure everything is neat (no sloppy erasures, crossed-out words, graphs falling off, etc.).

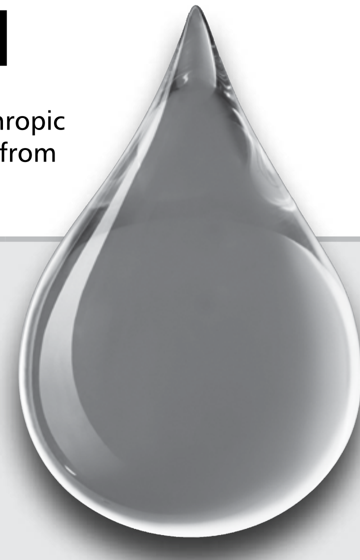
If You Have to Answer Questions or Make a Presentation ...

Frequently, you'll have to answer questions about your science fair project to science fair judges, parents and teachers. And sometimes, you may have to make a classroom presentation.

Here are some helpful hints to prepare.

- Be confident. You've done the work, done it well and it will show!
- Smile, relax, stand straight and speak loudly.
- Introduce yourself and tell your age and grade.
- Give the title of your project.
- Explain the purpose of your project.
- How did you get interested in this topic?
- Explain your hypothesis and procedure.
- Show your results. Show your logbook and all charts and graphs of your results.
- List your conclusions. Explain how you interpreted your data.
- If you had problems or made mistakes, talk about them. Mistakes can be valuable data in science.
- Tell the judges what you would do next to continue working on this topic. If you were to change or redo this project, how would you go about it?
- Ask the judges if they have any questions.
- Thank the judges for their attention.

The Experiments: Part 1



The following projects are provided by the Charles Edison Fund (CEF): A Philanthropic Foundation. They are recommended for use in **Grades 4 – 5**. These projects are from CEF's booklet, "The Best of Edison" and are reprinted with permission.

Hot Water

Making water hot takes energy and lots of it. A typical family uses 15-20 million Btus of energy each year to heat water for washing everything from hands to dishes. It takes about 168 gallons of fuel oil, 19,900 cubic feet of natural gas or 4,500 kilowatt-hours of electricity to do the job.

The next two experiments have an important thing in common. They both show us how we may be wasting energy unintentionally.

Project #1: Should you shower or take a bath?

MATERIALS:

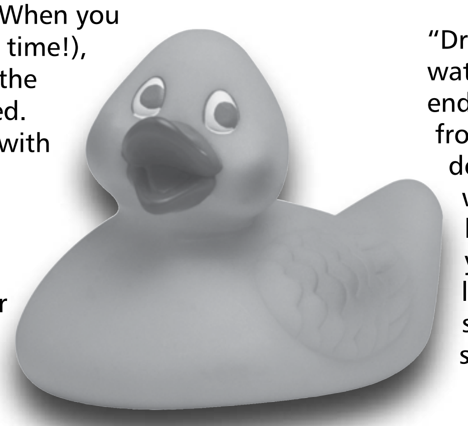
- Your bathtub
- A yardstick
- A bar of soap (optional)

Here's a surprising fact. If people who took baths took showers instead, we'd save a lot of energy. This experiment demonstrates what we mean.

Start by taking a bath. Fill your bathtub with water as usual, but before you step in, use your yardstick to measure the depth of the water in the tub.

Next, take a shower. (But not until you really need one!) Before you begin, though, do something unusual. Close the bathtub drain so the shower water will collect in the tub. When you are finished (take your time!), measure the depth of the water that has collected. Compare this reading with the bath water depth.

You will find that your shower used substantially less water ... probably less than half as much! A lot of this water is hot water. As a rule of thumb, figure that it takes an ounce of oil (or a cubic foot of gas, or 1/4-kilowatt-hour of electricity) to heat a gallon of water. So you can see that showering saves lots of energy.



Project #2: A little drip means a big energy waste.

MATERIALS:

- An 8-ounce graduated measuring cup
- A pencil
- Paper
- A faucet
- A clock

"Drip, drip, drip" goes the leaky faucet. Each drop of water is tiny, but add all the drops together and you end up with thousands of gallons of water dripping from the faucet each year. If hot water is dripping down the drain, you are wasting more than clean water. You are throwing away the energy used to heat that water. Here's an experiment that shows you how serious the problem is. If you have a leaky faucet, fix it. Otherwise, adjust your kitchen sink faucet (cold water, please) to produce a steady "drip, drip, drip."

Place the measuring cup underneath the dripping faucet and collect 15 minutes worth of drips. You may, for example, collect 4 ounces of water in 15 minutes.

Now you have to do some arithmetic to find out how much energy was wasted. Get your pencil and paper (and your thinking cap). We'll use the 4-ounce figure in the example below.

- **Step 1:** Multiply the number of ounces of water you collected by four – this gives you the number of ounces per hour leaking through the faucet.

4 ounces X 4 = 16 ounces per hour

- **Step 2:** Multiply the answer from Step 1 by 24. This gives the number of ounces per day leaking through the faucet.

16 ounces per hour X 24 =
384 ounces per day

- **Step 3:** Multiply the answer from Step 2 by 365. This gives the number of ounces per year leaking through the faucet.

384 ounces per day X 365 =
140,160 ounces per year

- **Step 4:** Divide the answer from Step 3 by 128. This gives the number of gallons per year leaking through the faucet.

140,160 ounces per year ÷ 128 =
1,095 gallons per year

That's a lot of water. And if it was hot water dripping, it took a lot of energy to make it hot.

You can figure out approximately how much oil, gas or electricity was wasted by doing the following calculations.

- **For an oil-fired water heater:** Divide the answer from Step 4 by 110. This gives the approximate number of gallons of oil wasted.

1,095 ÷ 110 = 9.95 gallons of oil per year

- **For a gas-fired water heater:** Multiply the answer from Step 4 by 1.2. This gives the approximate number of cubic feet of gas.

1,095 X 1.2 = 1,314 cubic feet of gas per year

- **For an electric water heater:** Multiply the answer from Step 4 by 0.25. This gives the approximate number of kilowatt-hours of electricity wasted.

1,095 X 0.25 = 274 kilowatt-hours per year

Here's an IDEA ...

If you do not understand something, keep trying to find the answer. Search the Internet, ask a teacher or mentor, look through books or articles, etc.

Heating and Air Conditioning

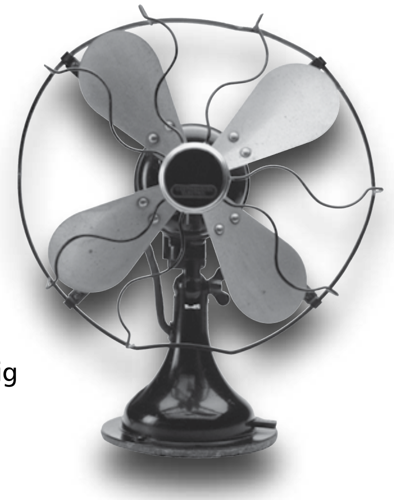
Here's an interesting fact. A typical American family uses more energy to heat their home in winter than for any other purpose except powering their automobile.

"Space heating" (that's the technical term) uses more than one-fourth of an average family's total energy budget. That's more than 100,000,000 Btus! It's equivalent to more than 800 gallons of oil or 100,000 cubic feet of natural gas.

This experiment will teach you a lot about keeping heat where you want it – which, after all, is the secret of conserving energy used for space heating. You see, during the winter, you want to keep heat INSIDE your home. The better job you do, the less fuel you have to burn.

If your home is air conditioned, the same thing is true – in reverse! During the hot summer months, the idea is to keep the heat OUTSIDE. By doing this, you cut down on the energy needed to run your air conditioner.

Project #3: How does insulation work?



MATERIALS:

- A small water glass
- An inexpensive fish tank thermometer
- A cardboard box (Find one made out of corrugated cardboard; it should be just big enough to hold the water glass.)
- A handful of cotton balls

During the winter, the insulation in your home's walls slows down the movement of heat from indoors to the cold outdoors. To understand how insulation works, you must first study how quickly heat will flow from a warm object to cold air when no insulation is present.

Fill the glass with water that is at room temperature (about 70^{0}F). Use your thermometer to measure the exact temperature. Put the thermometer into the glass. Then, place the glass inside your refrigerator. Check the water temperature every five minutes. You will find that the water temperature drops quickly – probably 3 or 4 degrees every five minutes. The reason, of course, is that heat is flowing out of the relatively warm water and into the relatively cold surrounding air inside the refrigerator.

Now let's add some insulation. Here's how. First, refill the glass with water at room temperature. Then, place a layer of cotton balls inside the bottom of the cardboard box and rest the glass on top of the layer of cotton. Finally, pack the empty space between the glass and the sides of the box with cotton balls.

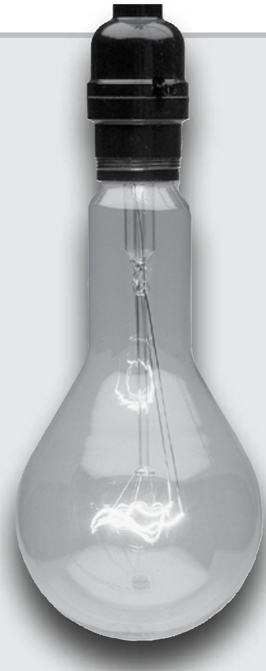
Put the thermometer in the glass and measure the exact temperature. Place the glass, cotton and box in the refrigerator and check the temperature every five minutes. You'll find that the temperature will drop much less quickly this time – maybe only a degree or so every five minutes. The cotton insulation is slowing down the loss of heat from the water in the glass. The insulation in your home's walls is not made of cotton (it's probably made of fiberglass), but works much the same way.

You may be surprised to learn that many homes are poorly insulated. They have no insulation in their walls and ceilings, or too little to effectively slow down the movement of heat from inside to outside. Because of this, their owners must burn more fuel in order to stay warm. This is a major cause of energy waste.

Here's an IDEA ...

Before you begin a project, ask your teacher which categories will be judged at your regional science fair competition.

Appliances and Lighting



The next chance you get, go on a "scavenger hunt" around your home for things that use energy. You'll probably find several dozen electric lights (don't forget the bulb inside your refrigerator!), a dozen or more different appliances (refrigerator, TV, toaster, washing machine, etc.), a few electric clocks, a stereo and maybe even an electric toothbrush.

It has been estimated that a well-equipped home consumes more than 35,000,000 Btus of energy each year keeping these "energy eaters" well fed. A lot of this energy is wasted. That's bad news. But here's the good news. It's easy to conserve much of the energy we are currently wasting.

The following two experiments will turn you into an energy-saving expert. But before you begin, let's spend a few moments discussing how you can determine how much energy each of the electrical appliances in your home uses. It's really very easy. All you have to do is look on the back or bottom of the appliance to find the electrical "ratings" information. You will see a group of numbers pretty much like the numbers in the chart on this page.

Ignore all the numbers EXCEPT the wattage rating. This number is the key to energy consumption. Once you have an appliance's wattage rating, consult the table on the left. It tells you how much electrical energy (measured in kilowatt-hours) the appliance consumes during ONE HOUR of operation. The table also shows about how much oil or coal was burned at your power station to produce this amount of electrical energy.

Be sure you ask for permission before you turn over any kitchen appliances, and don't try to move big appliances without help from an adult.

Project #4: Does Your Clothes Dryer Waste Energy?

MATERIALS:

- About an hour of spare time on Washing Day
- A clock

The heart of a clothes dryer is a source of hot air. Wet clothes tumble through the hot air and are dried. It takes many thousands of Btus of energy per hour to heat the air, so we should never run a clothes dryer unnecessarily.

Many people, however, do just that. They set the dryer's timer for longer than is necessary and the machine rumbles on long after the clothes inside are completely dry.

This simple experiment will tell the tale. Start by getting permission. Learn how to restart the machine after you stop it by opening the door. Now you are ready to begin.

The next time there is a load of clothes in the dryer, pull up a comfortable chair and start watching the clock. After fifteen minutes go by, open the dryer

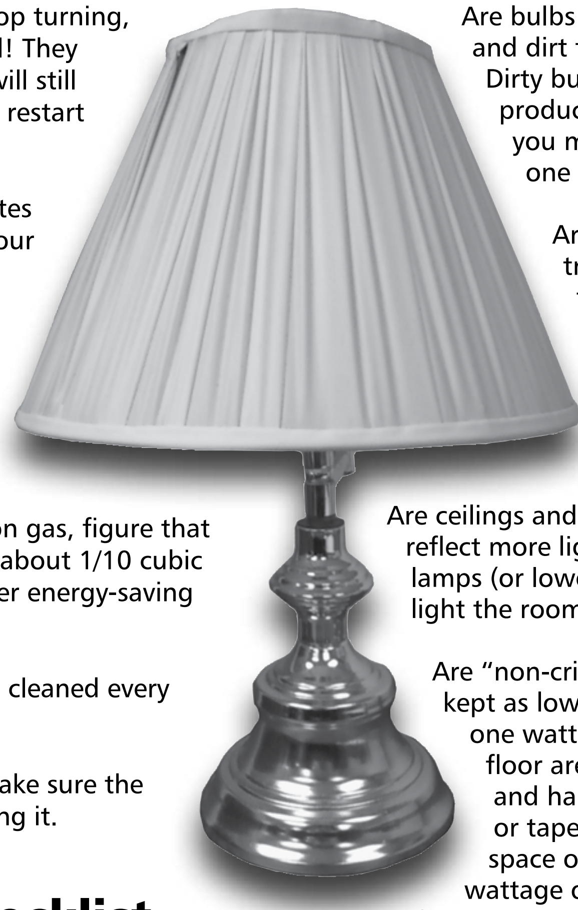
Electrical Appliance Energy Table

APPLIANCE WATTAGE RATING	KILOWATT-HOURS OF ENERGY USED HOURLY	OUNCES OF OIL BURNED HOURLY	OUNCES OF COAL BURNED HOURLY
10	1/100	1/10	13/100
25	1 /40	1/4	33/100 (or 1/3)
40	I /25	2/5	1/2
60	3/50	3/5	4/5
110	1/10	1	1 1/3
150	3/20	1 1/2	2
200	I/5	2	2 2/3
300	3/10	3	4
500	1/2	5	6 2/3
750	3/4	7 1/2	10
1000	1	10	13 1/3
1500	1 1/2	15	20
2000	2	20	26 2/3
5000	5	50	66 2/3

door, wait for the drum to stop turning, then feel the clothes. (Careful! They may be hot.) They probably will still be damp. Close the door and restart the dryer.

Do this again every five minutes until the clothes feel dry to your touch. Look at the timer and see how much longer the dryer was set to run. If your dryer is electric, you can figure that every wasted minute burned about 4/5 ounce of oil (or one ounce of coal) back at the power company. If your dryer runs on gas, figure that every wasted minute burned about 1/10 cubic feet of gas. Here are two other energy-saving tips for dryers.

- Make sure the lint filter is cleaned every time the dryer is used.
- Don't dry "half loads." Make sure the machine is full before using it.



Project #5: Checklist for Energy-efficient Lighting

MATERIALS:

- A yardstick or tape measure
- A pencil
- Paper

How much energy is used to light your home? Your household probably uses about 2,000 kilowatt-hours of electrical energy each year. Your local electric power plant burns about 150 gallons of oil (or more than 3/4 ton of coal) to generate that much electricity.

With this much energy "going up in light," it makes good sense to learn to use lighting efficiently. This simple lighting checklist will give you a head start. Walk through your home – with pencil and paper in hand – and see how well the lights in your home measure up. Tell your parents about your findings.

Are bulbs and lampshades free of dust and dirt that block light transmission? Dirty bulbs and shades waste the light produced inside the bulbs. As a result, you may turn on two lights when only one is really necessary.

Are lampshades light colored and translucent (so light can pass through them) rather than dark colored and solid? It doesn't make sense to use energy to produce light and then block the light with a dark lampshade.

Are ceilings and walls light-colored? Light colors reflect more light than dark colors so fewer lamps (or lower-wattage bulbs) can be used to light the room.

Are "non-critical" lighting levels in your home kept as low as possible? As a rule of thumb, one watt of lighting per square foot of floor area is adequate for general room and hallway lighting. Use your yardstick or tape measure to measure the floor space of rooms and halls. Check the wattage of the bulb(s) in the room to see if the lighting level is too high. For example, a 100-watt bulb in a 50-square-foot hall is too much. Of course, "critical" tasks (such as reading, sewing, building model airplanes and doing your homework) require more light.

Does every member of your family turn off lights after he or she leaves a room? Not doing this is an out-and-out waste of valuable energy! You may hear some people say they purposely leave lights on. These people mistakenly believe that the sudden surge of electricity that flows through a light bulb when it is turned on represents a lot of energy. They think keeping the bulb lit – and thereby avoiding starting surges – somehow saves energy. They are wrong. A light bulb consumes less energy during its starting surge than during a single second of normal operation. Always turn lights off when they are unnecessary, even if it's only for a few seconds.

Here's an IDEA ...

Save your old science fair project and expand on it each year.

The Experiments: Part 2

The following projects are provided by the National Energy Education Development Project (NEED). They are recommended for use in **Grades 7 - 12**. These projects are from NEED's "Science of Energy" booklet and are reprinted with permission. They have been modified for use in this guidebook.

Exploring Thermal Energy

These experiments investigate ENDOTHERMIC REACTIONS (reactions using heat) and EXOTHERMIC REACTIONS (reactions producing heat).

Project #1: Endothermic Reactions

MATERIALS:

- A bottle of vinegar
- A container of baking soda
- Four empty plastic sandwich bags
- A thermometer
- A spoon

PREPARATION:

- Study the sample script.
- Examine the equipment.
- Practice your presentation.

PROCEDURE:

- Explain that you are going to mix two chemicals together to make a third chemical. The reaction is an endothermic reaction. It requires energy in the form of heat to make the third chemical from the first two.
- Pour about an ounce of vinegar into an empty plastic sandwich bag.
- Feel the vinegar in the bag to note the temperature. Measure the exact temperature using the thermometer.
- Record the temperature of the vinegar. Leave the thermometer in the bag.
- Carefully pour about a teaspoon of baking soda into the bag with the vinegar. Be careful! The reaction will foam to the top of the bag.
- Watch the temperature on the thermometer drop. It should drop about 4 to 5 degrees Centigrade (5^0C) in 30 seconds.
- Record the time and temperature and remove the thermometer from bag.
- Feel the bag again to note the temperature.
- Carefully zip bag and put it aside.

ORAL PRESENTATION:

NOTE: This script is just a sample. You don't need to say it word for word. The important thing is to get the major concepts and facts across to your audience.

THE SCRIPT: During this experiment, you'll be learning about chemical reactions. Chemical reactions occur when you mix two (or more) chemical compounds together to form other compounds. All chemical reactions involve heat. Some give off heat and some use heat.

An endothermic reaction uses heat. ENDO means IN and THERMAL means HEAT. Endothermic – the heat goes in. Since the easiest way to measure heat is by its temperature, we'll use a thermometer to show the changes in heat.

This experiment is an endothermic reaction – it uses heat. I'm going to mix vinegar and baking soda together to make another chemical. First, I'll add the vinegar and check the temperature of it. (Pour about an ounce of vinegar into an empty plastic bag. Hold

the bag at the top and tilt it so that all the vinegar is in one corner. Take the temperature of the vinegar. It should be about room temperature. Let everyone touch the bag.)
It is _____ degrees.

Everyone touch the bag so you'll know what the temperature feels like. Now I'm going to add the baking soda. You'll be able to see a reaction taking place. (Leave the thermometer in the bag. Pour in about a teaspoonful of baking soda. Be careful; the reaction will foam very high.) Now, watch the temperature on the thermometer. (The temperature should drop 4 to 5^0C in 30 seconds. Let everyone touch the bag again.) The temperature has dropped about 4 to 5^0C. Now touch the bag and tell me how it feels. Do you feel the difference?

It feels colder because the reaction we just saw uses energy. (Take thermometer out of bag. Zip up bag and put to the side with the vinegar and baking soda.) Heat is a form of kinetic energy – the vibration of molecules. The more heat energy, the more the molecules vibrate and the hotter the object feels.

Kinetic energy is required to break the bonds that hold molecules together and is released when bonds are formed. (Show the formulas for endothermic reactions provided below.) The top equation shows the reaction of vinegar and baking soda. The reaction takes more energy to break the bonds than to form the new bonds. The reaction takes the energy it needs from the surrounding environment, which is why the bag feels colder. The second equation is photosynthesis – another endothermic reaction. Sunlight – or radiant energy – is needed to combine water and carbon dioxide to form more complex chemical compounds.

Project #2: Exothermic Reactions

MATERIALS:

- Four handwarmers
- A sealed bag of iron oxide
- A container of calcium chloride
- Two empty plastic bags
- Scissors
- 2 ounces of water

PREPARATION:

- Study the sample script to learn the experiment.
- Examine the equipment.
- Practice your presentation.
- The sealed bag of iron oxide contains old filings from the handwarmers. This is called the old packet. A few minutes before your first

ENDOTHERMIC REACTIONS

VINEGAR AND BAKING SODA

Vinegar	+	Baking Soda	+	Heat	∅	Water	+	Carbon Dioxide	+	Sodium Acetate
CH_3COOH	+	$NaCO_3$	+	Heat	∅	H_2O	+	CO_2	+	$NaC_2H_3O_2$

PHOTOSYNTHESIS

Water	+	Carbon Dioxide	+	Radiant Energy	∅	Glucose	+	Oxygen
$6H_2O$	+	$6CO_2$	+	Radiant Energy	∅	$C_6H_{12}O_6$	+	60_2

EXOTHERMIC REACTION

IRON FILINGS

Iron	+	Oxygen	∅	Iron Oxide (Rust)	+	Heat Energy
4Fe	+	30_2	∅	$2Fe_2O_3$	+	Heat Energy

presentation, cut open a new packet and pour it into an empty plastic bag. Keep the bag open so that oxygen in the air can react with the black powder. This is called the new packet.

PROCEDURE: HANDWARMERS

- Explain that you are going to let oxygen come into contact with pieces of iron to produce a third chemical – iron oxide. The reaction is an exothermic reaction – it produces energy in the form of heat. Most reactions are exothermic.
- Show the package that held the iron filings.
- Feel the new packet to note the temperature.
- Seal the new packet to prevent oxygen from entering the bag.
- Let students feel the old packet and note the temperature.
- After performing the second part of the demonstration – driveway ice – let students feel the new packet that you sealed, pointing out the temperature drop after the bag was sealed and no oxygen could enter to keep the reaction going.

PROCEDURE: DRIVEWAY ICE

- Explain that calcium chloride is used to melt ice on sidewalks and driveways. When calcium chloride comes into contact with water, a reaction takes place that produces heat.
- Pour two ounces of water into a plastic bag. Record the temperature using the thermometer.
- Pour a teaspoon of calcium chloride into the water.
- Record the temperature.
- Seal the bag and put it aside.

ORAL PRESENTATION:

Most reactions don't take in heat like vinegar and baking soda. Most chemical reactions give off heat – they're exothermic. EXO means OUT and THERMAL means HEAT. Exothermic – the heat goes out. Let's watch a reaction that gives off heat.

A few minutes ago I opened this handwarmer. It was filled with iron filings. (Show audience the package the hand warmer came in.) Why do you think it was sealed in plastic? (Get answers from audience.) The plastic keeps air from reaching the iron. I put the iron filings into this plastic bag and left it open so that oxygen could get to it. (Hold up new packet.) The oxygen in the air is reacting with the iron to form a new chemical, iron oxide or rust.

Feel this packet. (Let everyone feel new packet. It should feel warm.) It feels warm. When iron comes in contact with oxygen, it makes rust and heat. You can see that most of the iron filings are still black. (Show the formulas for exothermic reactions on page 16.) They will slowly turn to rust as long as we let oxygen reach them. Now I'm going to seal the bag. No oxygen will be able to get to the iron filings. The reaction should slow down and stop. At the end of the presentation, we'll feel the bag again to see if the temperature has changed.

Here is a packet of filings that has been open for several weeks. (Hold up old packet. Let everyone feel it.) As you can see, all the iron has turned to rust. No more heat is being produced. Why do you think the handwarmer has a lot of iron filings instead of one chunk of iron? (Get answers from audience.) Because more iron can come in contact with oxygen when it is in small pieces.

Let me demonstrate another reaction. This container contains calcium chloride. It is used to melt ice on sidewalks and driveways. When calcium chloride comes in contact with water, a reaction occurs and heat is produced.

Let's put two ounces of water into this plastic bag and record the temperature. Now, let's put a teaspoon of calcium chloride in the water. Since this is an exothermic reaction, will the temperature of the water increase or decrease? (Get answers.) That's right. Since exothermic reactions give off heat, the temperature of the solution should increase. (Record temperature.) As you can see, the temperature of the water is now _____.

Feel the bag of iron filings that I sealed a few minutes ago. (Pass the new packet around.) The iron filings are cooler, aren't they? Sealing the bag kept oxygen from coming in contact with the iron. The reaction has stopped. No more heat is being produced.

Do you have any questions?

Electricity Project #3: The Potato Clock

This activity uses a common potato and two different metals to make enough electricity to run a small digital clock.

MATERIALS:

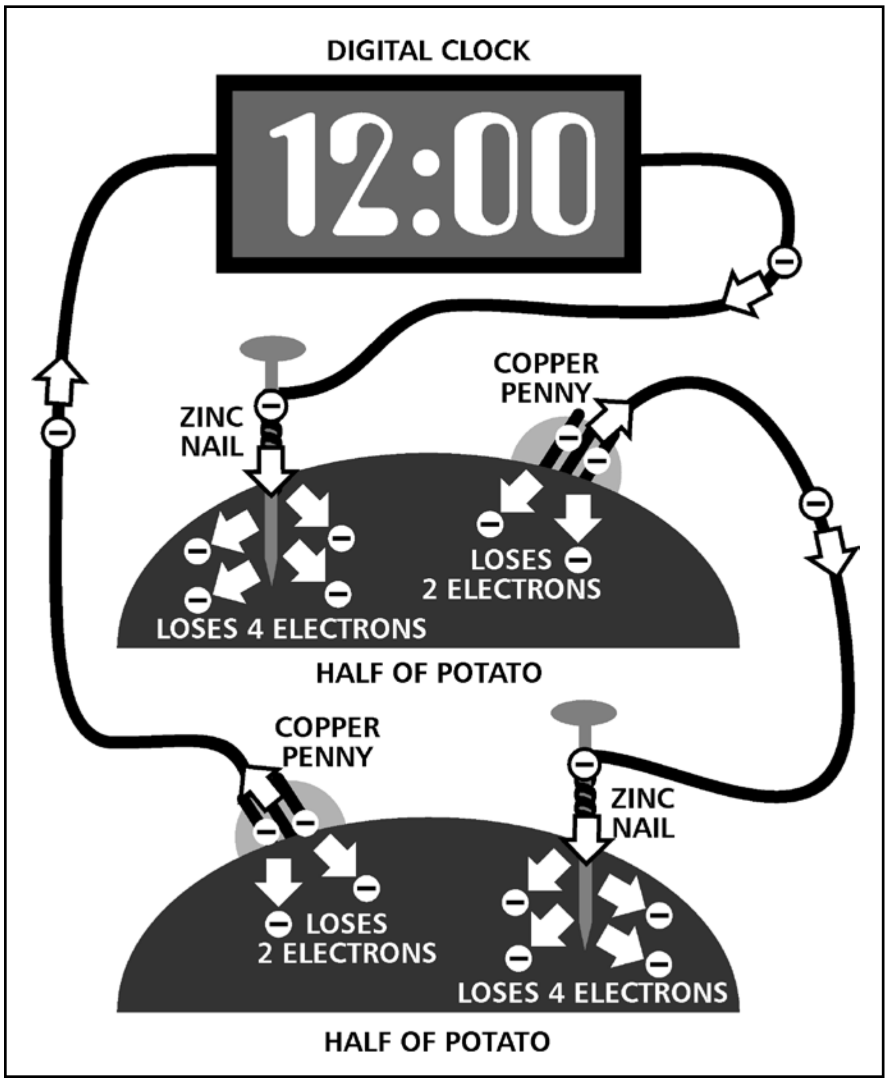
- One large raw potato
- Two pennies
- Two large galvanized (zinc) nails
- Three pieces of 6-inch long electrical wire (with about 2 inches of insulation stripped from each end)
- Small digital clock – The digital clock can be extracted from an inexpensive alarm clock or it can be purchased from an electronics store.

PREPARATION:

- Study the sample script to learn the experiment.
- Examine the equipment.
- Practice your presentation.

PROCEDURE:

1. Cut the potato in half. Place the halves next to each other with the flat side down on a plate.
2. Wrap one end of the first wire around one of the nails. Press the nail into one of the potato halves.
3. Wrap one end of the second wire around one of the pennies. Do this by first laying the penny across the exposed wire. Position the penny so it is centered on the wire and almost touching where the wire insulation begins. Fold the end of the exposed wire over the top of the penny. Pinch the penny and wire between your index finger and thumb on one hand and pinch the overlapping wire with the other hand. Twist the penny until the wire tightens around the penny. Press the edge of the penny about halfway into the other half of the potato.
4. Attach one end of the third wire to the remaining nail and the other end of the wire to the remaining penny as in step 3.
5. Insert the nail into the potato that already has the penny stuck into it. Then stick the penny into the potato that already has the nail stuck into it.
6. Remove the back off of the clock and take out the button battery.

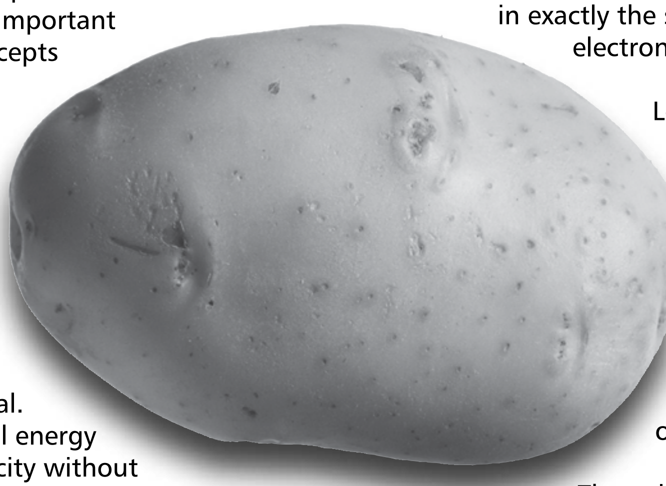


7. Place the digital clock so the audience can see the display.

8. Connect the two wires coming from the potato battery to the contact on the battery holder. If the clock does not illuminate the polarity might be incorrect. Touch the wires to the opposite contacts on the clock's battery holder.

ORAL PRESENTATION:

NOTE: This script is just a sample. You don't need to say it word for word. The important thing is to get the major concepts and facts across to your audience.



THE SCRIPT: Welcome to my power plant. I'm going to make electricity for you. Most of the electricity we use today is made with turbine generators, but I'm going to use a potato and some different pieces of metal. I'm going to use the chemical energy in the potato to make electricity without a turbine.

Chemicals are everywhere. Take this potato, for example. (Hold up the potato.) I'm going to use the phosphoric acid in this potato to show how a battery works.

First I'll cut this potato in half. Now I'll wrap the end of this first wire around this nail and push the nail into this potato half.

Next I'll wrap the end of this second wire around this penny and press the penny into the other half of the potato. Taking the last piece of wire, I'll wrap one end around the remaining nail and the other end around the remaining penny. (Insert this nail into the potato half that has the penny in it. Then insert the penny end into the potato half with the nail in it.)

Next I'll remove the back from the clock and remove the button battery. I'll connect the two free ends of the wires to the contact in the battery holder. As you can see by looking at the clock, I've produced an electric current. The question is, "How?"

When I put the zinc nails and copper pennies into the potato, both metals react with the phosphoric acid in the potato – freeing electrons. But they don't react in exactly the same way. The metals lose electrons in different amounts.

Let's say – to keep it simple – that for every two electrons the copper loses, the zinc loses four. This creates an imbalance. The copper becomes an electron donor. The zinc becomes an electron acceptor. (Show them the diagram on page 15.)

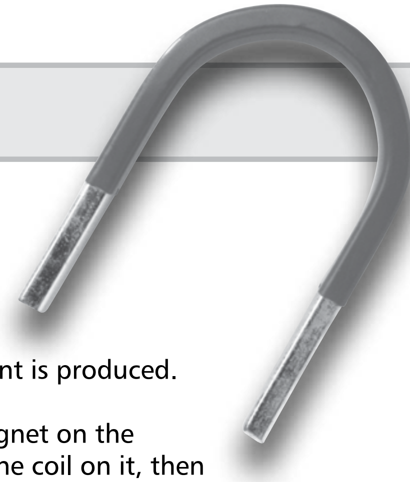
The galvanized nail provides the zinc needed for the reaction. The phosphoric acid dissolves the zinc in the nail and frees electrons from the zinc atoms. The freed electrons stay on the wire and the resulting zinc ions migrate into the acidic juices of the potato. This results in an excess of electrons on the zinc wire. If a wire is connected between the zinc nail and the copper penny, electrons will flow. This flow of electrons is the electrical current that makes the digital clock function.

This is the way all batteries work. There are chemicals in batteries and the electrons flow from one metal to another – converting chemical energy into electrical energy. Do you have any questions?

Here's an IDEA ...

Keep a detailed and up-to-date lab notebook with you regularly. It will help you organize your thoughts and if you ever need to go back to see how you did something, you can find out. Judges will want to see a lab notebook during the judging period.

Electricity and Magnetism



Project #4: Magnets

This project will explore ELECTRICITY and MAGNETISM. It will also investigate transforming mechanical energy into electricity.

MATERIALS:

- A large magnet
- A small magnet
- A voltage meter
- A small coil with many turns
- A large coil with few turns
- The illustration from page 22
- Clips for the voltage meter

PREPARATION:

- Study the sample script to learn the experiment.
- Examine the equipment.
- Practice your presentation.
- Attach clips to the leads of the meter. Place the meter so the audience can see its face. If the needle of the meter seems to stick, gently tap the face of the meter.

PROCEDURE:

- Using the illustration on page 22, briefly explain how power plants generate electricity.
- Connect the clips from the meter to the leads on the small coil with many turns. It doesn't matter which way you connect them.
- Slide the flat side of the large magnet back and forth over the coil several times, NOT TOUCHING THE COIL. Note the movement of the needle from side to side. Vary the speed with which you move the magnet and note the meter.
- Rest the magnet on top of the coil and note that no current is produced.
- Place the magnet on the table. Place the coil on it, then quickly pull it away. Note the meter.
- Rest the coil on the magnet. Move the magnet and coil together. Note that no current is produced.
- Demonstrate with both magnets to compare the strength of the magnet.
- Demonstrate with both coils, making sure to point out the difference in the number of turns of the wire.

ORAL PRESENTATION:

NOTE: This script is just a sample. You don't need to say it word for word. The important thing is to get the major concepts and facts across to your audience.

THE SCRIPT: There are lots of different ways to make electricity, but I'm here to show you how the pros do it. More than 160 years ago, Michael Faraday discovered that if you move a magnet through a coil of copper wire, you produce an electric current in the wire. All of our major power plants produce electricity this way. (Explain the illustration of page 18.)

Power plants use energy to spin a huge turbine. The turbine rotates a magnet in a coil of copper wire to produce electricity. Lots of different kinds of energy are used to spin the turbines. In most power plants, coal is burned to make steam. The steam is used to spin the turbines. Windmills use the mechanical energy in the wind to spin the turbines.

Today, I'm going to use my mechanical energy to make electricity. Here I have a coil of copper wire I am attaching to a meter that measures electric current. And here I have a magnet. (Attach the small coil with many turns to the meter. Place the large, flat side of the magnet over the top of the coil – near BUT NOT TOUCHING. Move the magnet back and forth over the coil several times.)

When I use my mechanical energy to move the magnet over the coil, I make electricity. Watch the meter – notice the needle jump from side to side. That means the current is alternating from one direction to the other. I'm producing an alternating current. It's called an AC current and it's the kind of electricity we use in our homes. The electricity you get from a battery is direct – or DC – current. That means it always flows in one direction. Batteries produce DC current.

If I just rest the magnet on top of the coil, no electricity is produced. No mechanical energy is being used to make the electrical energy.

What do you think will happen if I put the magnet on the table and move the coil? Let's try it and see. (Place the coil over the magnet, then move it away several times.) It produces electricity. It doesn't matter whether we move the magnet or the coil, as long as one of them moves and the other doesn't. If I move both the magnet and the coil in the same direction at the same speed, no electricity will be produced. Watch. (Place the coil on top of the magnet and move them together.)

Let's see what we can do that affects the amount of electricity we produce. First, let's try speed. Do you think I can produce more electricity if I move the magnet quickly? First, I'll move the magnet slowly – let's see what the meter reads. (Slowly move the magnet over the coil several times, noting the reading on the meter.)

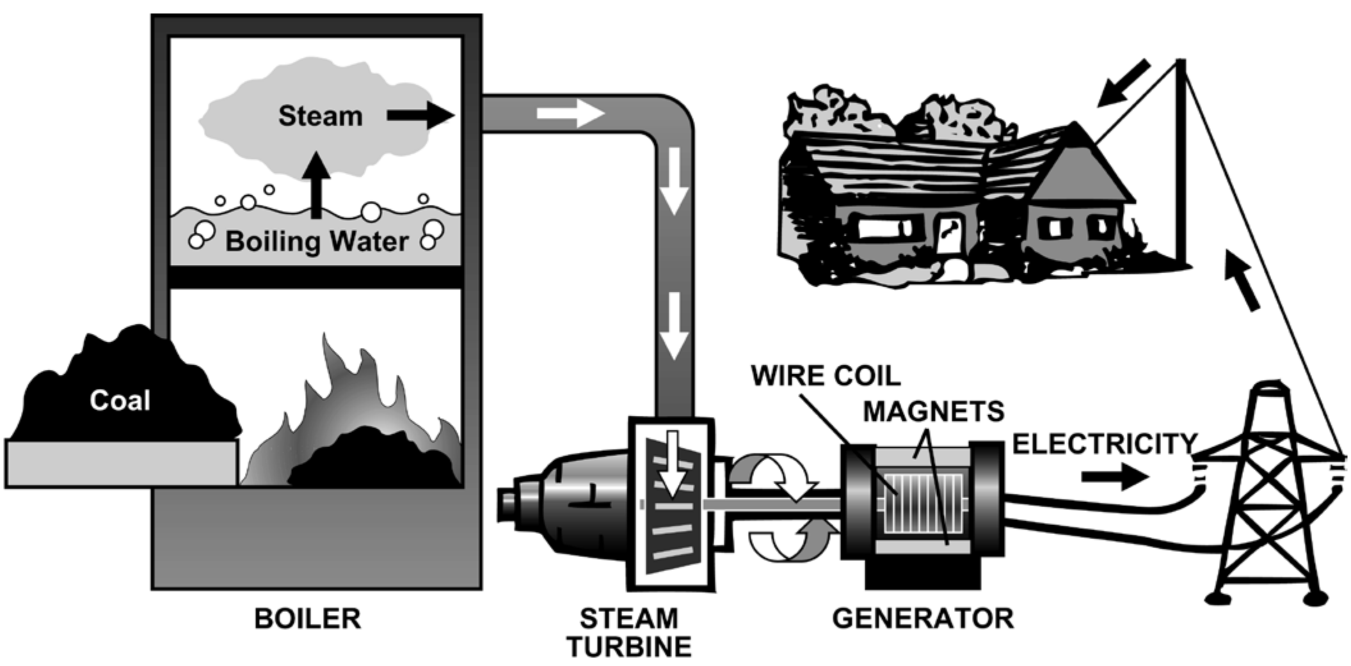
Now, let's try moving the magnet faster. (Move the magnet quickly.) I produce more electricity when I move the magnet faster, don't I? That's because I'm putting more mechanical energy into the magnet when I move it quickly.

Can you think of anything else that might affect the amount of electricity produced? How about the strength of the magnet? Here I have a smaller magnet. Let's see what happens when I move both magnets at the same speed. (Demonstrate with both magnets several times, trying to keep your speed the same.) The larger one produces more electricity. So a stronger magnet produces more electricity.

There's another thing that can affect the amount of electricity produced – the number of turns in the coil. I have two coils here, one with many more turns than the other. (Let the audience examine both coils.) Let's try the experiment again. (Demonstrate using both coils.) The coil with more turns produces more electricity, even though it's smaller.

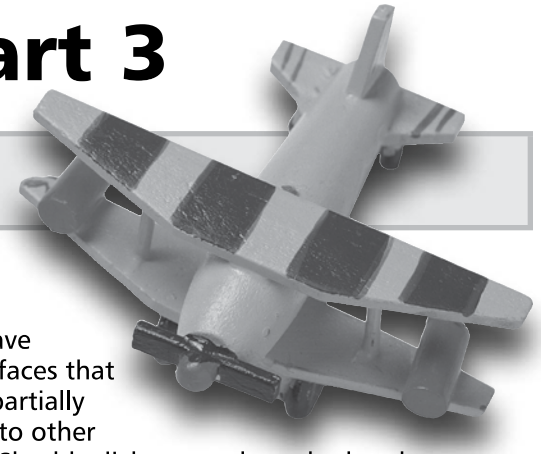
Today, we've learned that we can make electrical energy using mechanical energy to move a magnet across a coil of copper wire. We've also learned that the strength of the magnet, the speed of the magnet and the number of turns in the coil all affect the amount of electricity produced.

Do you have any questions?



The Experiments: Part 3

Air Quality



Project #1: Don't Take a Lichen for Air Pollution

BACKGROUND:

Leaf-like Lichen

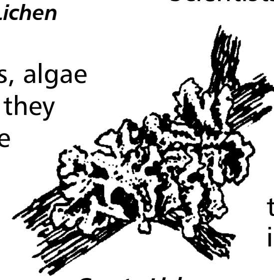
Plants called lichens are sensitive to air pollution, especially the air's acidity. So you can use their presence or absence as an indicator of air quality. They are actually two types of plants, algae and fungi, growing so closely together that they look like one single organism. They often are considered symbiotic organisms – mutually beneficial to each other.

Lichen fungi cannot live without their algae partners, while most of the algae can live by themselves. Lichens often grow in locations where most other plants cannot – bare rocks, tree trunks, bare soil. In some of these locations they play an important role helping soil formation. By interacting with the bare rocks to help break them down chemically and by trapping dust and organic matter from the air, lichens often start to create and enrich soil where other plants can eventually grow.

Every natural habitat from deserts to rain forests has lichens. They are able to survive extreme conditions of heat, cold and drought. However, few species of lichens can survive air pollution, particularly acid air pollution. Lichens come in a variety of sizes, shapes, colors and textures.

Lichens often are divided into three classifications – crusty, leaf-like or shrubby. Crusty lichens usually grow flat on rocks and tree trunks and may be embedded in these surfaces. Crusty rock lichens are colorful and range from oranges and yellows to greens, browns, grays and blacks.

Leaf-like lichens have lobed surfaces that are only partially attached to other surfaces. Shrubby lichens are branched and either stand upright or hang from other surfaces. Leaf-like and shrubby lichens are usually some shade of green. Lichens are often confused with moss, but real mosses are tiny plants with leaves and stems. Scientists study both the type of lichens present and the size of the lichens. Shrubby and leaf-like lichens can only survive in clean air.



Crusty Lichen

Lichens are relatively rare in large cities, and in areas of very heavy air pollution, there are no lichens of any type. The size of the lichens present also is important. Larger individual lichens generally mean better air quality. In 1971, an air quality map of the British Isles was made based on an evaluation of lichen presence and growth.

Shrubby Lichen

Lichens also are valuable for evaluating air quality in another way. Lichens accumulate metals and other elements from rainwater and dust. By analyzing lichens that live near emission sources for chemicals which indicate pollution, scientists can determine how far the pollution has spread.

MATERIALS:

- Small marking flags
- Masking tape
- A permanent marker
- The Lichen Grid (see page 20)
- A pencil
- Graph paper
- A clipboard
- A camera

PREPARATION:

1. Know the background information.
2. Make sure you have all of the materials.
3. Identify the location where the lichen are present.
4. Draw a map of the area.
5. Mark each flag to be able to identify it.

PROCEDURE:

1. Place the marked flags near the lichen.
2. Draw the location of the flags on the map.
3. Collect some of the lichen and trace them onto the grid.
4. Measure the lichen and record the size and type onto the same grid sheet.
5. Enter all of the data onto a master map (location, type of lichen and size).

RESULTS:

1. What kinds of lichens are found at the study site? Use the scale "Lichens as Pollution Indicators" to assess the air quality using the lichen type.
2. What size are the lichens? Use the chart "Measuring Air Quality Using Lichens Size" to assess air quality based on size.
3. Are the results the same using both methods?
4. Look at the site map. Describe where you found the biggest and smallest lichens and why.
5. Do you think air quality is affecting lichens at this site? Why or why not?

To learn more about the air in South Carolina, visit DHEC's Bureau of Air Quality at **www.scdhec.gov/baq**.

Measuring Air Quality Using Lichen Size

SIZE (square centimeters)	**AIR QUALITY**
10 – 12	Excellent
7 – 9	Good
4 – 6	Fair
0 – 3	Poor

Lichens as Pollution Indicators

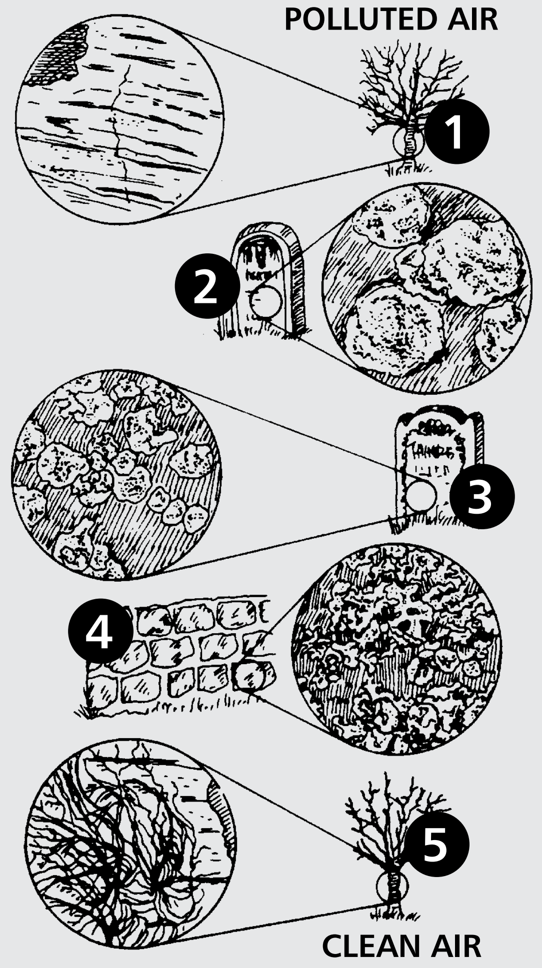
Plants called lichens are sensitive to air pollution, especially the air's acidity. So you can use their presence or absence to see how clean the air is. Shrubby and leaf-like lichens only survive in clean air. In the most polluted areas there are none at all. Look for lichens on walls, stones and trees, and use this scale to rate the air quality.

POLLUTED AIR

1. No lichens (possibly green algae)
2. Grey-green crusty lichens (tombstones)
3. Orange crusty lichens (tombstones)
4. Leaf-like lichens (walls and trees)
5. Shrubby lichens (trees)

CLEAN AIR

NOTE: Different lichen types can be found in the same area. To use this scale, decide which lichen type is most common in the study area.



The Lichen Grid

Project #2: Stick 'Em Up

BACKGROUND:

The air around us is invisible. It is made up of gases that cannot be seen. Many major air pollutants are also invisible gases. In some areas of the country, these air pollutants can build to levels where they can be seen. For example, in some California cities, smoky, yellowish clouds of primarily car exhaust build up to create SMOG.

Other easily visible air pollutants, called PARTICULATE MATTER, are made up of tiny particles of solids or droplets of liquids. Some of these particulates are naturally occurring and may pose less of a problem to human health than do man-made particulates. Some of the natural particulates include pollen, wind-blown dust or volcanic ash. Man-made particulates are generated by coal and oil-fired power plants, manufacturing plants, automobile and diesel fuels, and fireplaces and wood-burning stoves among others.

These AIRBORNE particulates – or particles carried through the air – can be harmful to plants, animals and humans. Buildings and statues can be discolored. Analysis and measurement of air pollutants can be done by various means, depending on the chemical and physical characteristics of the pollutant.

Particulate matter measurement uses gravimetric principles, which refers to measurement by weighing. Particles are trapped or collected on filters, and the filters are weighed to determine the volume of the pollutant. The weight of the filter with the collected pollutant minus the weight of a clean filter gives the amount of particulate matter in a given volume of air.

MATERIALS:

- Stick 'Em Up Collectors
- Scissors
- Clear tape
- String
- A hole punch
- A magnifying glass or microscope
- A marker
- Scales (in milligrams)
- A clipboard
- Graph paper
- A pencil
- A camera (optional)

PREPARATION:

1. Follow the directions and make the Stick 'Em Up Collectors (or create your own).

2. Weigh the collectors before they are used.

Stick 'Em Up Collector

Name: ____________________

Location: ____________________

Date: ____________________ Time: ____________________

3. Select different sites to hang the Stick 'Em Up Collectors. On each collector, record name, location, date and time it is hung or set in its location. Site selections may include inside your room, your kitchen, the garage, near the pets sleeping quarters, in the gym at school, bathrooms, outside near a tree, near the parking lot, on the recess field, etc. These should be placed where they can hang freely or set somewhere not touching other objects and where they will not be touched by other people. Be sure to let the custodial staff and your family know about this, too.

4. Draw a map of the area including the location of each collector (optional).

PROCEDURE:

1. Record the information on a chart including the "clean" weight of the collector and the location.

2. Place the collectors in their locations and leave them for at least eight days.

3. Take up the collectors and analyze them by weighing them and observing them through a microscope or magnifying glass.

4. Take pictures of some of the collectors in their location (optional).

RESULTS:

1. What is the weight of the collectors after the eight days? (Compare to the weight before they were used.)

2. What did you observe under the microscope or magnifying glass?

3. Did you have more particulate matter inside or outside? (Compare the results.)

REMEMBER: Always chart the information you collect throughout the project.

CONCLUSION:

1. Can we see air pollution? How do we know that air pollution exists?

2. Give examples of visible air pollution.

3. Discuss the concept of particulate matter.

4. Why do you think one location may have more particulate matter than another? What is in that area that may be the cause?

5. List some sources of air pollution, both visible and invisible. Can a single source provide both visible and invisible air pollution?

EXTENSION ACTIVITY:

Make a traffic survey. Pick a location where you can observe a busy intersection from a safe distance. Separately record the number of trucks, cars, buses, vans and taxi cabs that pass through that intersection in a given hour. Try this over several days at different times of the day.

- **Ask:** What factors influence volume of traffic? (locations of highways, number of people in the community, shopping centers, businesses, special events, etc.)

- **Ask:** Did you see evidence of air pollution? (smells, smoke, wilted plants struggling to survive etc.)

- **Ask:** Do you think this is a problem? Why or why not? If so, what do you think should be done to correct it?

STICK 'EM UP COLLECTOR:

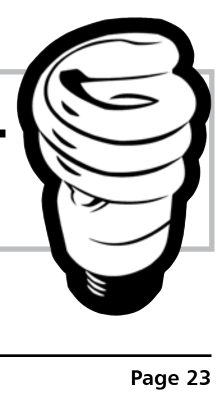
1. Copy the Stick 'Em Up sheet and make your particulate matter collector.

2. Cut out the four holes in the strip as marked. Using the hole punch, make a hole in the top and tie the string into a loop.

3. Cover one side of the strip with clear tape so that the holes are covered on one side. DO NOT TOUCH THE STICKY SIDE OF THE TAPE THAT IS SHOWING THROUGH THE HOLES.

Here's an IDEA ...

Choose a topic that will interest and challenge you.



Energy Efficiency

Project #3: Comparing Light Bulbs

MATERIALS:

- An incandescent bulb
- A compact fluorescent bulb (NOTE: The bulbs should produce equivalent lumens.)
- A thermometer
- A lamp

BACKGROUND:

There are many types of light bulbs available these days. Two that are used primarily at home are incandescent and fluorescent light bulbs. Which kind do you think produces the most heat? Do you think they give off the same kind of light?

PROCEDURE:

1. Have an adult place the fluorescent bulb in the lamp and turn it on. Observe the light that is produced.
2. Hold a thermometer 6 inches above the bulb for one minute and record the temperature. Turn off the lamp and let the bulb cool.
3. Have an adult remove the fluorescent bulb, place the incandescent bulb in the lamp and turn it on. Observe the light that is produced.
4. Hold a thermometer 6 inches above the bulb for one minute and record the temperature.

EXTENSION QUESTIONS:

1. Could you tell any difference in the kind of light the two bulbs produced?
2. Did one bulb produce more heat than the other?
3. Which bulb is more energy efficient?

Project #4: Energy for Life

MATERIALS:

- Two similar potted plants
- A brown paper bag
- Water

BACKGROUND:

Plants need several things to survive and grow. They need water, nutrients from the soil and carbon dioxide from animals. But what about sunlight?

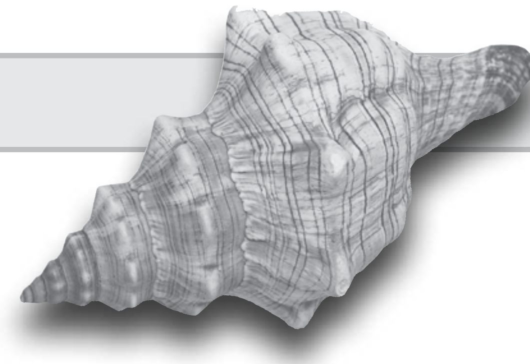
PROCEDURE:

1. Place two potted plants in a sunny place.
2. Cover one plant with a brown paper bag.
3. Give both plants the same amount of water.
4. Observe the plants for two weeks.

EXTENSION QUESTIONS:

1. Which plant looks healthier after two weeks?
2. How did the covered plant appear different from the uncovered one?
3. Did the covered plant need sunlight?

Ocean and Coastal Resources



Project #5: A Salty Sea

BACKGROUND:

Oceans cover about 71 percent of the earth's surface. Oceans contain salt water. There are some parts of the world, however, where the water is saltier than in other locations. The sun over the ocean causes the water to evaporate. Salt does not evaporate and is left behind, causing the remaining saltwater to be even saltier.

MATERIALS:

- Table salt
- A tea kettle
- Water
- A glass or plastic plate
- A world map

PROCEDURE:

1. Combine 2 cups of water with table salt (2 tablespoons) and place in the tea kettle. Taste a drop of this mixture. With the help of an adult, bring the water in the kettle to a boil.
2. Have the adult hold the plate over the escaping steam and allow a few drops to accumulate. Be careful not to come in contact with the steam – IT CAN BE VERY HOT! Pull the plate away and allow the drops to cool, then taste a drop. Is it as salty as the original mixture?
3. Boil the remaining water left in the kettle for five minutes. Allow the water to completely cool and taste it again. Does this taste saltier or less salty than the original mixture? Does it taste saltier or less salty than the drops on the plate?

EXTENSION QUESTIONS:

1. Look at the map of the world. Where are the warmest oceans? The coolest?
2. When water is heated, what happens?
3. What does evaporation mean?
4. Which seas and oceans might be the saltiest? Why?

Here are more suggestions ...

1. Look for important concepts, definitions, and equations that will explain how and why your experimental results turn out the way they do. Also research why your topic is important in today's society.
2. Do not get discouraged if your research seems too difficult to understand. Start with the basics and work upward. Sometimes you have to read an article a few times before you even begin to understand it.
3. Push yourself to the limit of your understanding, and do not be afraid to tackle concepts you have never seen before (it is normal for much of your background research to look alien to you the first time you see it). One of the reasons people do a science project is to learn new information and challenge themselves.
4. Go in-depth with your research. Try learning advanced concepts and be as detailed as possible. The more you know, the more the judges will be impressed.

Waste Reduction and Recycling

Project #6: Soap Box Opera

MATERIALS:

- Different-sized laundry detergent boxes
- A scale
- A calculator

BACKGROUND:

Usually, it is more economical to buy larger rather than smaller sizes of products. Purchasing larger quantities is known as "buying in bulk." For example, a 5-ounce box might only cost $5, making the cost $1 per ounce whereas a 10-ounce box might cost $8 or 80 cents per ounce. Buying in bulk might have advantages other than cost savings.

Examine the ratio of carton material to the product quantity. Does buying in larger quantities also require less packaging material per unit measure of the product? Could people lessen their impact on the environment by buying in bulk?

PREPARATION:

Purchase several different-sized boxes of laundry detergent. Pour the contents of each into separate containers – one container for each box.

PROCEDURE:

1. Before pouring the detergent into the containers, weigh the containers while they are empty and record the weights of the containers. Weigh the detergent in the separate containers and record the numbers. Take the total weight and subtract the weight of the container. This number will be the weight of just the detergent.

2. Weigh the empty boxes that the detergent came in. Record these numbers.

3. Divide the weight of the empty box by the weight of the detergent. This will tell how much packaging is needed for the amount of detergent. Is less packaging needed per ounce of detergent in larger boxes than smaller boxes?

WEIGHT OF CONTAINER	WEIGHT OF CONTAINER & DETERGENT	WEIGHT OF CONTAINER & DETERGENT - WEIGHT OF CONTAINER = WEIGHT OF DETERGENT	WEIGHT OF DETERGENT BOX	WEIGHT OF DETERGENT BOX ÷ WEIGHT OF DETERGENT

Project #7: Natural or Man-made Fibers

BACKGROUND:

Some fibers are made from natural materials like cotton, while others are made from man-made or “synthetic” materials like polyester. Which type of fiber do you think will decompose faster – natural fibers or synthetic fibers?

MATERIALS:

- A 100 percent cotton T-shirt
- An old nylon stocking
- An old wool sock
- An old acrylic or polyester sweater
- A plot of soil
- Water
- A glass jar with lid

PROCEDURE:

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

EXTENSION QUESTIONS:

1. Which fibers deteriorated the most?
2. Which environment made the materials deteriorate more quickly?
3. Can you find out why?

Project #8: Test Your Strength

BACKGROUND:

Some people question whether products made from recycled materials can perform their job as well as products made from entirely new materials. Plastic, paper products, aluminum cans and some clothing are all commonly available with both new and recycled content.

MATERIALS:

You will need products made from “virgin” (new) materials and recycled content materials such as writing paper, pencils, folders and clothing.

PREPARATION:

Purchase similar items made from recycled content and “virgin” (new) materials.

PROCEDURE:

Compare the strength and performance of the “virgin” (new) products to ones made with different percentages of recycled content.

PRODUCT	TESTS PERFORMED	PERFORMANCE

EXTENSION QUESTIONS:

1. Does manufacturing a product with recycled materials alter its performance?
2. Which materials were stronger or more durable?
3. In what ways did the recycled materials perform better or worse than the products made from new materials?

Project #9: The Water Table

OBJECTIVE:

In this activity, you will create a model of the water table and conduct an experiment to see how water is stored in the ground and how water runoff and pollution move through soil.

BACKGROUND:

Precipitation falls into water or on land where it "runs off" of hard – or impervious – surfaces such as rock or concrete, or infiltrates soft, or pervious, surfaces such as soil or sand. If water moves downward, it can replenish water contained in the underground rock and sediment. This supply of water is referred to as GROUNDWATER.

Groundwater is water that has percolated into the ground and is held under the surface. Rain seeps through the top layers easily. The earth near the surface is loaded with tiny air spaces. Even rocks have cracks and pores through which water can find its way. But when water reaches clay or impervious rock, it will not sink any farther.

As more water seeps or percolates into the ground, it begins to collect above the bedrock or dense soil. When the ground has as much water as it can hold, it is saturated. Water that seeps into the ground fills the tiny crevices and the water level rises toward the surface as the spaces in the ground fill up. The uppermost level is called the WATER TABLE. The area of dry ground above the water table is called the ZONE OF AERATION. After heavy rains, the table is nearer the surface, and in dry weather it drops again.

MATERIALS:

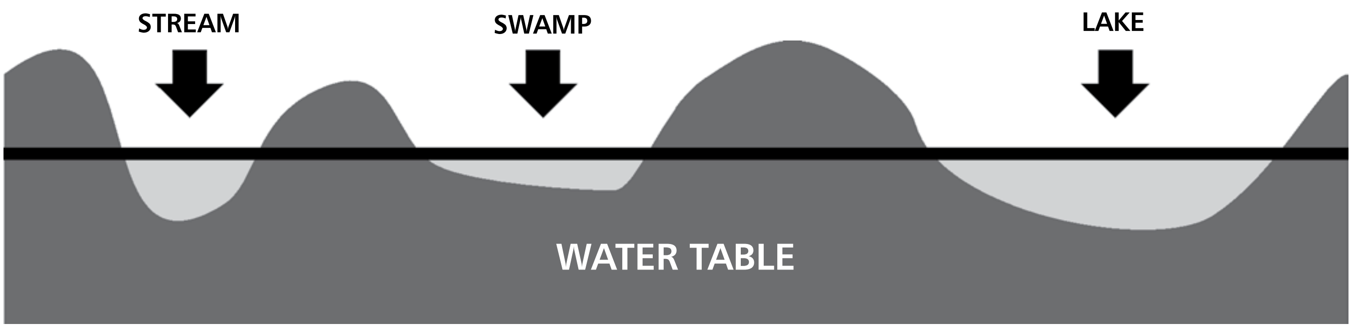
Refer to the illustration of the water table model below.

- A wide-mouth glass jar (or a 2-liter plastic soda bottle with the top cut off)
- A beaker, measuring cup or any cup for pouring water
- A crayon (dark colors works best to mark on plastic) or a permanent marker
- A mixture of sand and gravel (several cups)
- Water (several cups)

PREPARATION:

1. Fill a clear container (soda bottle or jar) three-fourths full of sand and gravel mix. Next, pour water down the side of the jar until the water level rises about half way up the side of the jar. This water level should represent the level of the water table. Use a crayon or marker to mark the present level. Point out that if more water is added, the water table will rise.

2. Using your crayon or marker, press down on the sand in one spot down to the water table to show that wherever the land surface dips below the water table, groundwater flows out to the surface. This forms springs, swamps or lakes. Explain that during dry weather periods, the water table level goes down and some streams and swamps may dry up as well. You may want to draw the water table illustration below on the board as an example.



EXTENSION ACTIVITY:

The following activity will demonstrate how water moves through different types of soil. You will also measure volume accurately, identify three types of soil by texture and make visual observations about water movement through the soil.

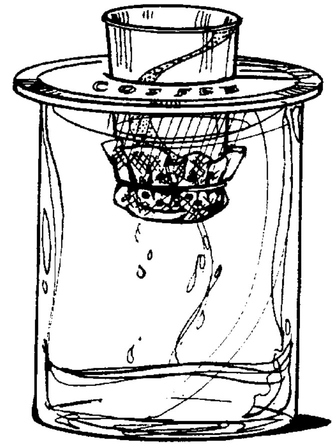
NOTE: This activity should be preceded by a discussion of types of soils, and how water is absorbed into the soil and moves, with time, around the soil particles.

MATERIALS:

- Three large polystyrene cups
- Three plastic coffee can lids
- Three squares of cheesecloth
- Rubber bands
- Water
- A thumbtack
- A watch or clock
- Sand
- Clay
- Gravel
- A pencil
- Four 250-ml beakers or cut-off soda bottles
- Scissors
- A measuring cup

PROCEDURE:

1. Using a thumbtack, punch several holes in the bottom and around the lower part of each cup.
2. Place a square of cheesecloth over the bottom of each cup so it covers all the holes, and secure it tightly with a rubber band.
3. Using scissors, cut a hole in the plastic coffee can lid so that the cup just fits inside. Place each cup in a lid, and place each lid over a beaker. (See the illustration for the demonstration set up.) Label the cups A, B and C.



4. Fill Cup A half full of dry sand, Cup B half full of clay, and Cup C half full of a mixture of sand, gravel and clay.
5. Make a chart similar to the one below for recording your observations.
6. Pour 100 ml of water into the middle or center of each cup. Record the time when the water was first poured into each cup.
7. Record the time when the water first drips from each cup. Note the appearance of the water.
8. Allow the water to drip for 25 minutes. At the end of this time, remove the cups from the beakers. Measure and record the amount of water in each beaker.

QUESTIONS:

1. Which soil sample is the most permeable?
2. Which soil is the least permeable?
3. How does the addition of gravel affect the permeability of clay?
4. How does soil type affect the movement of groundwater?
5. Can soil protect groundwater? Which one? How?

CUP	TIME IN WATER	TIME OUT OF WATER	OBSERVATIONS
A			
B			
C			

Project #10: Taking the Swamp Out of Swamp Water

OBJECTIVE:

This project demonstrates the procedures that municipal water plants use to purify water for drinking.

BACKGROUND:

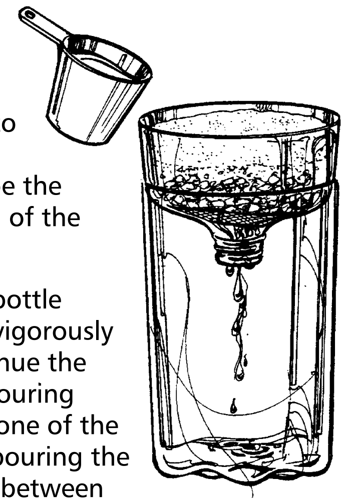
Water in lakes, rivers and swamps often contains impurities that make it look and smell bad; it also may contain bacteria and other microbiological organisms that can cause disease. In most places, surface water should not be drunk until it has been cleaned. This project shows how water treatment plants turn polluted water into drinking water.

This project illustrates the four basic processes involved in purifying water for human consumption. Water treatment plants typically clean water by taking it through the following processes: (1) AERATION; (2) COAGULATION and SEDIMENTATION; (3) FILTRATION; and (4) DISINFECTION. Demonstration projects for the first four processes are included below.

MATERIALS:

- Five liters of "swamp water." (Use muddy water from a pond or creek or "custom mixed" swamp water made by adding a handful of dirt or mud to each liter of water.)
- A 2-liter plastic soft drink bottle (The bottle should include its cap or cork that fits tightly into the neck.)
- Two 2-liter plastic soft drink bottles – one with the top removed and one with the bottom removed
- A 1.5-liter (or larger) beaker or another soft drink bottle bottom
- 20 grams (g) or 2 tablespoons of alum (potassium aluminum sulfate; available in drug stores or spice aisle of most supermarkets)
- Fine sand (about 800 milliliters [ml] in volume)
- Coarse sand (about 800 ml in volume)
- Small pebbles (about 400 ml in volume) NOTE: Washed natural color aquarium rocks will work.
- A 500 ml (or larger) beaker or jar
- A coffee filter or 5 centimeters (cm) by 5 cm piece of flexible nylon or fine mesh screen
- A rubber band
- A tablespoon
- A clock with a second hand (or a stopwatch)

PROCEDURE:



1. Pour about 1.5 liters of "swamp water" into a 2-liter bottle. Have your audience describe the appearance and smell of the water.
2. Place the cap on the bottle and shake the water vigorously for 30 seconds. Continue the aeration process by pouring the water into either one of the cut-off bottles, then pouring the water back and forth between the cut-off bottles 10 times. Describe any changes you observe. Pour the aerated water into a bottle with its top cut off. AERATION is the addition of air to water. It allows gases trapped in the water to escape and adds oxygen to the water.
3. With the tablespoon, add 20 g of alum crystals (potassium aluminum sulfate) to the swamp water. Slowly stir the mixture for 5 minutes. COAGULATION is the process by which dirt and other suspended solid particles are chemically "stuck together" so that they can be removed from water.
4. Allow the water to stand undisturbed in the cylinder. Observe the water at 5-minute intervals for a total of 20 minutes and write your observations with respect to changes in the water's appearance. SEDIMENTATION is the process that occurs when gravity pulls the particles of floc (clumps of alum and sediment) to the bottom of the cylinder.
5. Construct a filter from the bottle with its bottom cut off as follows:
   a. Attach the coffee filter to the outside neck of the bottle with a rubber band. Turn the bottle upside down and pour a layer of pebbles into the bottle. The filter will prevent the pebbles from falling out of the neck.

b. Pour the coarse sand on top of the pebbles.

c. Pour the fine sand on top of the coarse sand.

d. Clean the filter by slowly and carefully pouring through 5 liters (or more) of clean tap water. Try not to disturb the top layer of sand as you pour the water.

6. After a large amount of sediment has settled on the bottom of the bottle of swamp water, carefully – without disturbing the sediment – pour the top two-thirds of the swamp water through the filter. Collect the filtered water in the beaker. Pour the remaining (one-third bottle) of swamp water back into the collection container. Compare the treated and untreated water. Has the treatment changed the appearance and smell of the water? FILTRATION through a sand and pebble filter removes most of the impurities remaining in water after coagulation and sedimentation have taken place.

ATTENTION!

Advise your audience that the final step at the treatment plant is to add disinfectants to the water to purify it (that is to kill any organisms that may be harmful). Because the disinfectants are caustic and must be handled carefully, it is not presented in this experiment. The water that was just filtered is therefore UNFIT TO DRINK and can cause adverse effects! IT IS NOT SAFE TO DRINK!

EXTENSION ACTIVITIES:

1. Plan a field trip to a local water treatment plant. Find out how (or whether) the plant removes bacteria, lead or other heavy metals such as nitrates, sulfides or calcium from the water.

2. Contact a state or local agency that tests water for contaminants. Have the agency test samples of tap water and the swamp water that you treated.

3. Add garlic powder to the swamp water and filter it out using deodorizing charcoal and filter paper (coffee filters).

Ideas for More Projects

ENERGY

- Which type of material makes the best insulation?

HEALTH

- Is there a relationship between eating breakfast and performance at school?
- Which fruit drinks have the best nutrition?
- Which brand of cereal has the most raisins?
- What is the pH of various shampoos, lotions and sunscreen products?

PLANTS AND GARDENING

- What type of soil is best for water retention?
- Can potatoes be grown without soil?
- Does the type of water affect the growth of plants?

RECYCLING AND WASTE MANAGEMENT

- What happens to newspaper in a landfill?
- What types of materials decompose the fastest or slowest?
- What is the environmental impact of some household chemicals and/or pesticides?

WATER

- What is in drinking water?
- Does the amount of water affect the size of the wave?
- Where is the current of a stream fastest?
- How does depth affect water pressure?
- What makes a good filter for drinking water?

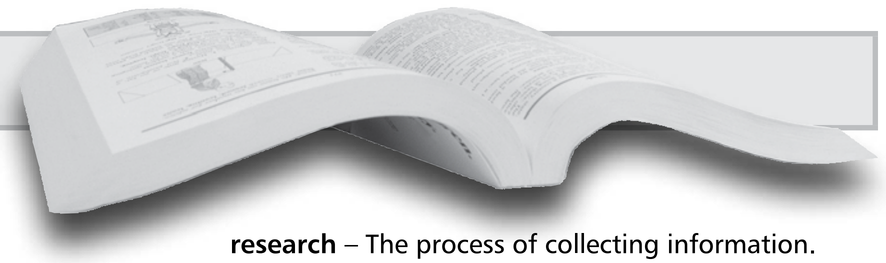
WEATHER

- How can we prevent the weathering of sidewalks and driveways?
- Does soil in South Carolina show the effects of acid rain?
- What causes dew?

OTHER

- Which diaper is the most absorbent?
- Are home-made cleaners as effective as store-bought ones?
- Do different brands of gasoline make a difference in gas mileage?
- Does color affect the behavior of people?

Glossary



abstract – A brief summary of the experiment.

conclusion – The summary of the results of the project experimentation including a statement of how the results relate to the hypothesis.

hypothesis – An idea about a solution to a problem that is based on knowledge and research.

project experimentation – Doing experiments designed to test the hypothesis.

problem – A scientific question to be solved.

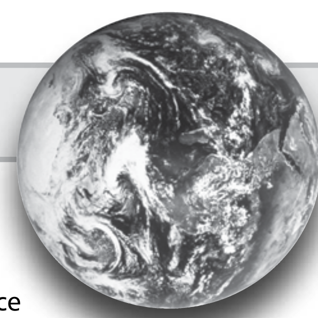
procedure – The process of deciding what needs to be done to find the answer to the problem. For example, what steps need to be taken, what material is needed.

research – The process of collecting information.

scientific method – The tool that scientists use to answer questions. The process of thinking through solutions to a problem and testing possibilities to find the solution. The scientific method has the following steps: research; identifying the problem; hypothesis; project experimentation; and reaching a conclusion.

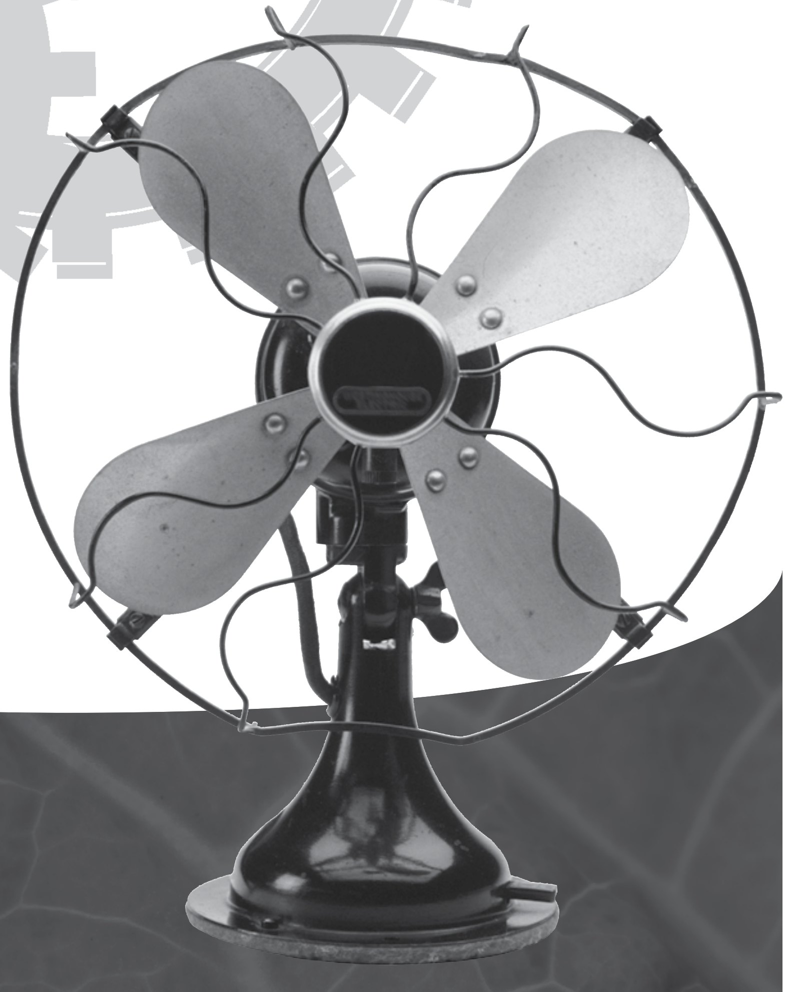
variable – Something that has an effect on an experiment. An **independent variable** is a manipulated variable in an experiment that causes a change in the **dependent variable**. A dependent variable is the variable being observed in an experiment that changes in response to the independent variable.

Helpful Web Sites



- "Discovery Education: Science Fair Central," **http://school.discoveryeducation.com/sciencefaircentral/**
- Dragonfly TV: Science Fair, **http://pbskids.org/dragonflytv/scifair/**
- "Free Science Fair Projects," **www.freesciencefairproject.com/**
- "Free Science Fair Project Ideas, Answers & Tools for Serious Students," **www.sciencebuddies.org**
- "Santee Cooper Kids," **https://www.santeecooper.com/portal/page/portal/SanteeCooperKids**
- "Science Fair Adventure," **www.sciencefairadventure.com**
- "Science Fair Fun: Designing Environmental Science Projects, **www.epa.gov/wastes/education/pdfs/sciencefair.pdf**
- "Science Fair Project Ideas," **http://sciencefairprojects-ideas.com/**
- "Super Science Fair Projects, Ideas, Topics and Experiments," **www.super-science-fair-projects.com**
- "Science Fair Projects Made Easy," **www.yoursciencefairprojects.com**
- "Science Fair Projects World," **www.sciencefair-projects.org**

science fair PROJECT guidebook



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