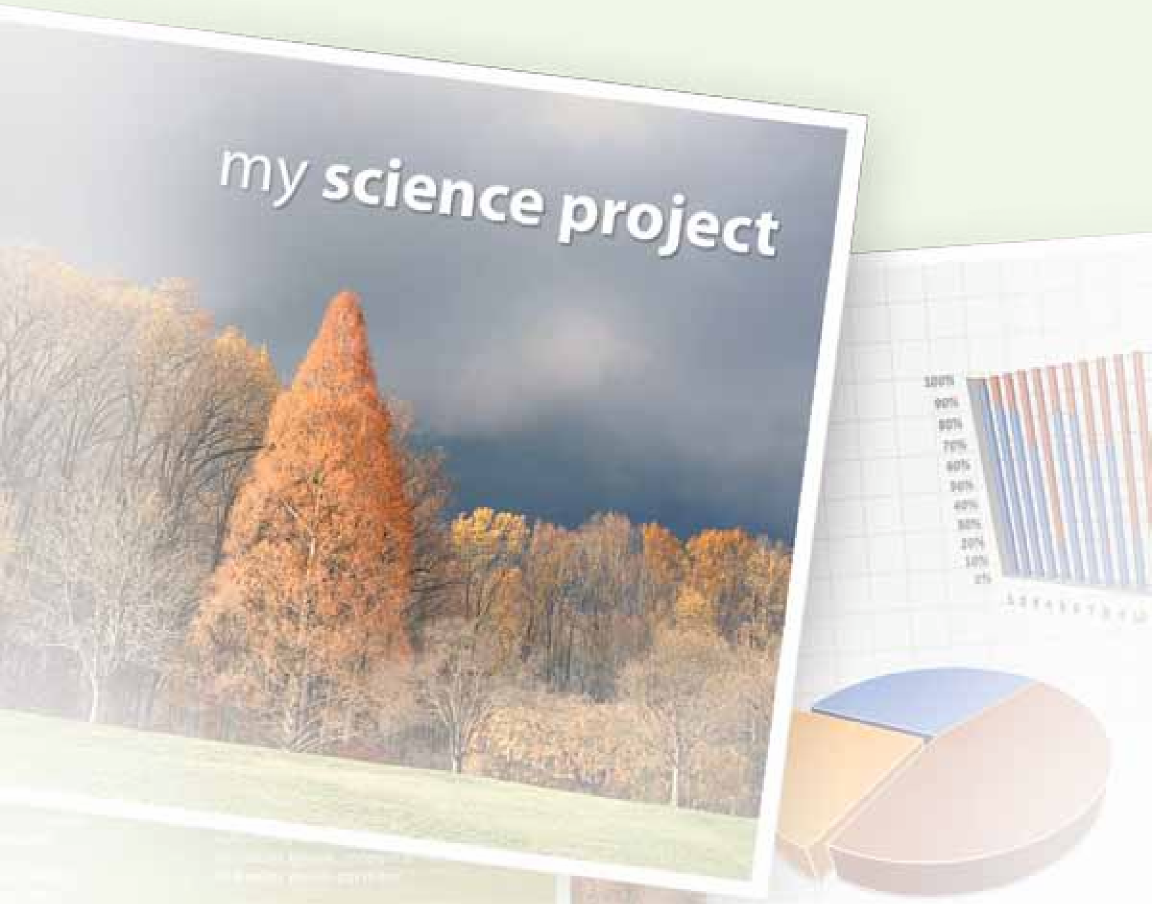
SCIENCE FAIR FUN

DESIGNING ENVIRONMENTAL SCIENCE PROJECTS FOR STUDENTS GRADES 6-8



Note for Teachers:

This booklet provides students in grades 6-8 with ideas and resources for developing environmental science fair projects about reducing, reusing, and recycling waste materials. Terms and topics in this booklet are addressed without in-depth definition or discussion, under the assumption that students have been exposed to these topics already through a classroom environmental science unit. However, this document does include a glossary (page 16) and a list of resources that provide more information (page 18). Words contained in the glossary appear in **bold text** throughout this document. Some experiments take more time to complete than others. Be sure to discuss your intended time frame when helping students decide on a project.

Note for Students:

This booklet contains ideas and suggestions for projects on reducing, reusing, and recycling **waste materials**. You should discuss your project with your teacher and ask for help, if needed, in constructing a **hypothesis**, defining **variables**, and determining what kind of equipment is available to you. Definitions for important waste terms used in this booklet can be found in the glossary on page 16. Also, you should note that some experiments take longer than others to yield results, so be sure that you will have enough time to complete the experiment. In addition, your science fair may have specific rules about how to conduct your experiment or how you should display your results. Be sure you understand and follow those rules.

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SCIENCE
FAIR
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GETTING STARTED

WHAT IS EPA?

The U.S. Environmental Protection Agency (EPA) protects human health and the environment. Over 18,000 people work at EPA, and more than half of them are engineers, scientists and **policy analysts**. Many of them were first introduced to science through science fair projects!

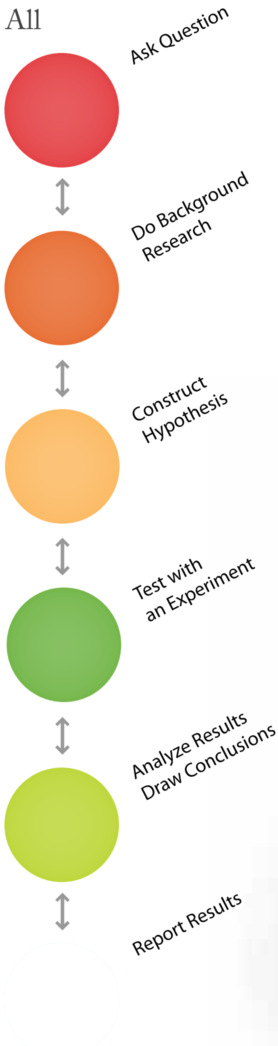
Science is fun—especially when you create a science fair project focusing on the **environment!** Science fair projects help you learn about the world around you, and they can also teach you and others how to improve the environment.

This booklet is a step-by-step guide to help you design an exciting science fair project that focuses on the 3Rs of waste management—reduce, reuse, and recycle. Use your science fair project to show how the 3Rs lead to **resource conservation**.

Check out the sample projects in this booklet, which also contains a list of useful resources to help make your project a winner!

THINK LIKE A SCIENTIST:
The Scientific Method

A good scientist learns about the world by using the scientific method. The scientific method tests a **hypothesis**, which is an educated guess based on **observations.** The six steps of the scientific method are outlined in the diagram to the right. All fields of science use the scientific method as a framework for making observations, gathering **data**, and drawing **conclusions**.



You should use the scientific method to help design your project. The step-by-step instructions on the following pages incorporate the elements of the scientific method. The sample projects on pages 10 through 14 provide ideas that will help you use the scientific method.

Be sure to find out whether your science fair is looking for true "experiments," or whether other types of research (such as **observation** or interviewing) are also acceptable.

STEP BY STEP

Did you ever notice something and wonder why it happens? Have you ever wanted to know how or why something works? Do you ask questions about what you observe in the world? If so, you may already have the foundation for a great science fair project! Below are step-by-step instructions that will help you turn your curiosity into a first-rate environmentally-themed science fair project.

CHOOSE A TOPIC

Choose a topic that explores resource conservation, including the 3Rs—reduce, reuse, and recycle. Choose a topic that interests you, that you want to investigate in more detail, and that you think might be interesting to others. Remember, your project should educate others as well as yourself.

GATHER BACKGROUND INFORMATION

GIVE YOUR PROJECT A TITLE

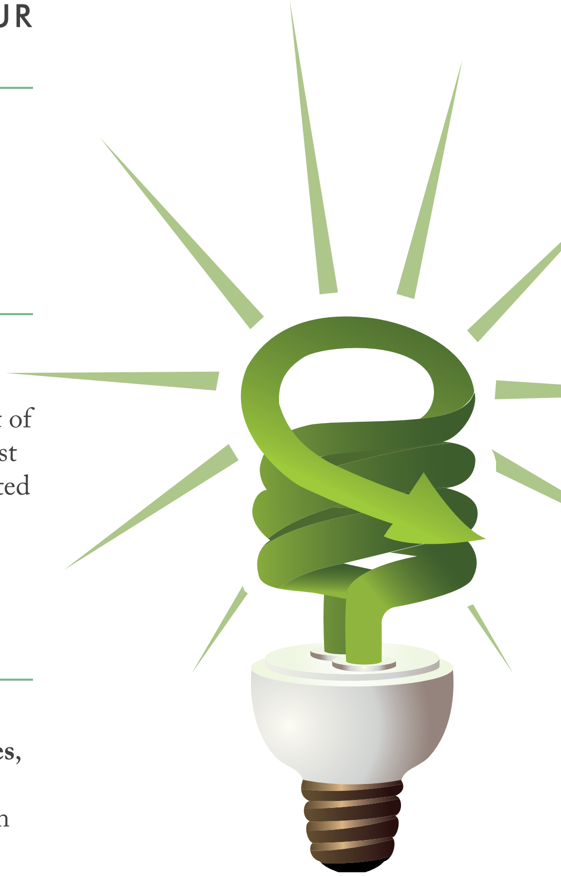
Choose a title that describes what you are investigating. Make it catchy, yet descriptive.

STATE THE PURPOSE OF YOUR PROJECT

Ask yourself: "What do I want to find out? Why am I designing this project?" Write a statement that answers these questions.

DEVELOP A HYPOTHESIS

Make a list of answers to the questions you have. This can be a list of statements describing how or why you think the subject of your experiment works. The **hypothesis** must be stated in a way that will allow it to be tested by an experiment.



DESIGN AN EXPERIMENT TO TEST YOUR HYPOTHESIS

Make a step-by-step list of what you will do to test the **hypothesis**. Define your **variables**, the conditions that you control or in which you can observe changes. The list is called an experimental method or procedure.

OBTAIN MATERIALS AND EQUIPMENT

Make a list of items you need to perform the experiment. Try to use everyday, household items. If you need special equipment, ask your teacher for assistance. Local colleges or businesses might be able to loan materials to you.

PERFORM THE EXPERIMENT AND RECORD DATA

Conduct the experiment and record all measurements made, such as quantity, length, or time.

RECORD OBSERVATIONS

Record all your **observations** while conducting your experiment. Observations can be written descriptions of what you noticed during an experiment or the problems encountered. You can also photograph or make a video of your experiment to create a visual record of what you observe. Keep careful notes of everything you do and everything that happens. Observations are valuable when drawing **conclusions** and are useful for identifying experimental errors.

PERFORM CALCULATIONS

Perform any calculations that are necessary to turn the **data** from your experiment into numbers you can use to draw **conclusions**. These numbers may also help you make tables or graphs summarizing your **data**.

SUMMARIZE RESULTS

Look at your experimental **data** and **observations** to summarize what happened. This summary could be a table of numerical **data**, graphs, or a written statement of what occurred during your experiment.

DRAW CONCLUSIONS

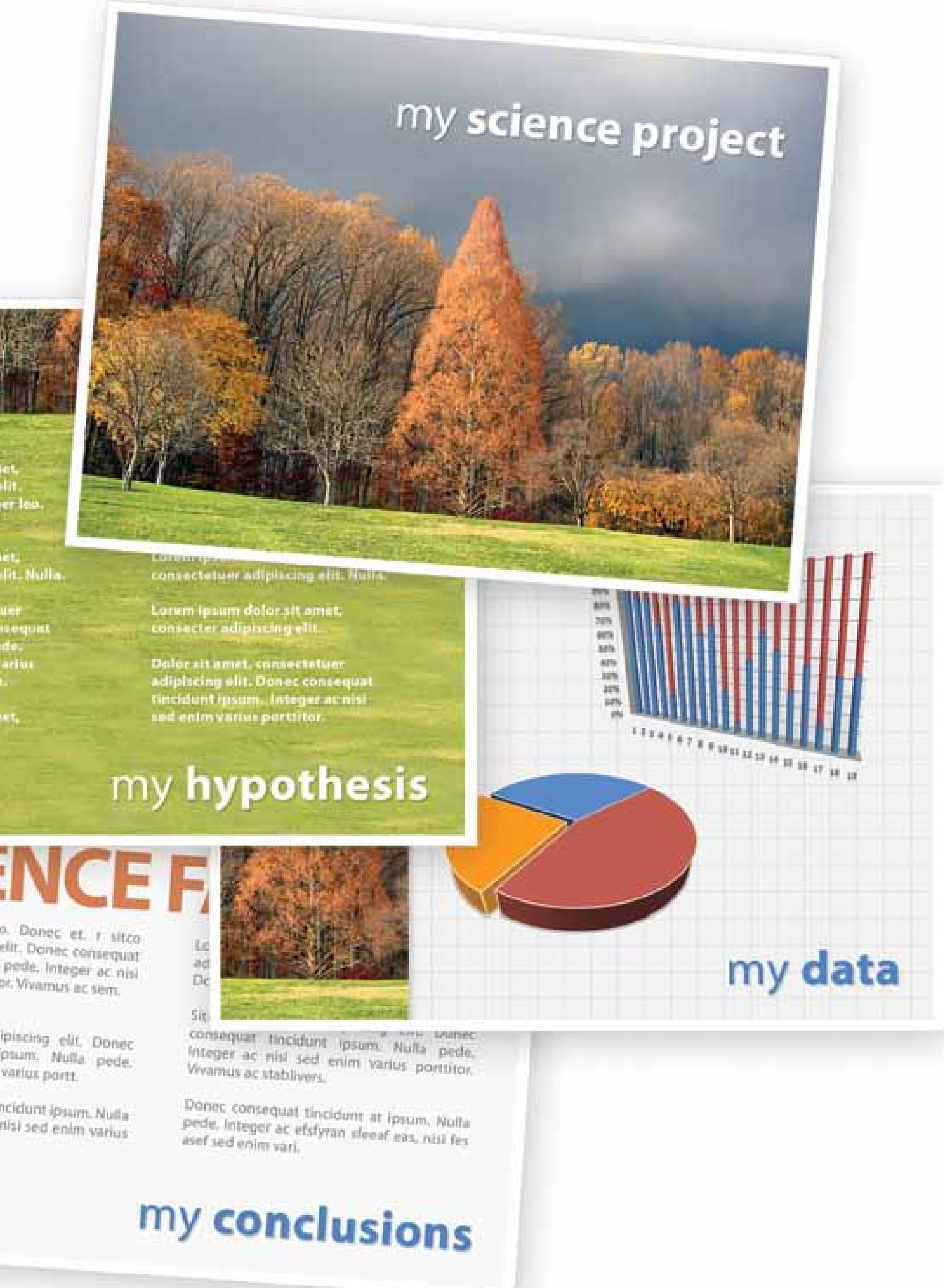
Use your results to determine whether your **hypothesis** is correct. Now is the time to review your experiment and determine what you learned.

DOCUMENT YOUR FINDINGS IN A REPORT, DISPLAY, AND PRESENTATION

Record your experiment and the results in a report, a display, and, if required, a presentation. Your report should thoroughly document your project from start to finish. If you can choose the report format, it should include a title; background or introduction and purpose; **hypothesis**; materials and methods; **data** and results; **conclusions**; acknowledgement of people who helped; and **bibliography**.

You might want to prepare a poster or 3-sided display to give your audience an overview of your project. You can use charts, diagrams or illustrations to explain the information. Bring a computer with a slide show or video of your experiment and the results. Your display should include a descriptive title; photos, charts, or other visual aids to describe the project and the results; the **hypothesis**; and a project report near the display.

Some science fairs require oral presentations. In preparing your presentation, ask yourself, “What is most interesting about my project, what will people want to know about, and how can I best communicate this information?” Use an outline or note cards to help you in your presentation. Be sure to check the rules for the presentation. You will probably need to introduce yourself and your topic, state what your investigation attempted to discover or prove, describe your procedure, results and conclusions, and acknowledge anyone who helped you. Practice your presentation before delivering it.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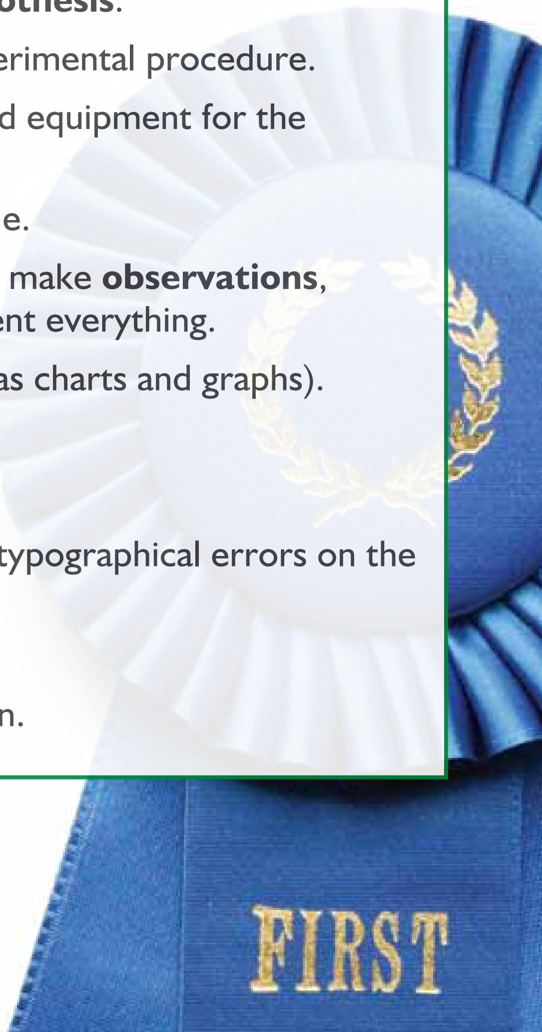
What Makes a Good Science Fair Project?

Use this checklist to help you walk through the steps to a good science fair project.

- ☐ Select a topic.
- ☐ Conduct background research and prepare a **bibliography**.
- ☐ Formulate a testable **hypothesis**.
- ☐ Write a step-by-step experimental procedure.
- ☐ Develop a list of items and equipment for the experiment.
- ☐ Prepare a project schedule.
- ☐ Conduct the experiment, make **observations**, collect **data**, and document everything.
- ☐ Prepare visual aids (such as charts and graphs).
- ☐ Develop a report outline.
- ☐ Design a clear display.
- ☐ Ensure that there are no typographical errors on the report or display.
- ☐ Prepare for the judges.
- ☐ Practice your presentation.



What the Judges Look For

Good science fair judges do more than simply select winners; they also encourage students to enjoy science. Judges are not trying to stump you; they want to reward students who worked hard, learned a lot, and did a great job. Below is a list of criteria that judges often use. If your project meets these criteria, you're likely to do well!

- ☐ Does the idea for the project show originality?
- ☐ Is the idea clearly expressed?
- ☐ Did the student do enough background research?
- ☐ Are the **variables** clearly defined?
- ☐ Did the student complete the experiment?
- ☐ Did the student repeat the experiment to confirm the results?
- ☐ Are the **data** accurate and correctly interpreted?
- ☐ Are there enough **data** to support the conclusions?
- ☐ Is the experiment clearly documented?
- ☐ Is the report complete?
- ☐ Does the display effectively describe the experiment and the results?
- ☐ Is the display attractive and interesting?
- ☐ Was the student able to explain the experiment and results?
- ☐ Did the student complete the project with little or no assistance?

Have confidence in your work and yourself. Answer questions thoroughly and don't be afraid to say you don't know an answer.

Remember—being a winner isn't simply about getting an award. It's about being proud of the time, work, and energy you put into your project.

SAMPLE PROJECTS

These sample projects focus on the 3Rs of waste management: reduce, reuse, and recycle. Use or modify these projects to create your own environmental science fair experiment.

Don't forget to develop your **hypothesis** (see page 4). Remember, the **hypothesis** must be stated so that you can test it in your project. Some of the sample projects are true "experiments." We've marked these projects with a *. Others allow you to formulate and test a **hypothesis**, but are not experiments.

Some kinds of experiments take more time than others to complete. Make sure you allow enough time to research the topic, plan and perform the experiment, and prepare the presentation for the science fair.

GOOD THINGS IN SMALL PACKAGES

Did you ever notice that many of the products you buy are packaged in boxes much bigger than the product itself? Other
...re wrapped in plastic, placed inside
then sealed with cellophane.
:kaging just means more waste to
d. Design a project that determines
ackaging waste can be reduced by
ıg people to change their buying
eate a **hypothesis** that asks whether
io of a product's size to the size of
roduct's packaging increases as the
f the product increases. Look at
oducts that come in several sizes,
ıch as laundry detergent or cereal.
leasure the area of the packaging
or example, in square inches) and
ıart that against the weight or
olume of the contents. Do small
roducts have the same product-
ze to packaging-size ratio as large
oducts? You may also want to ask
nall products have the same cost-
ratio as large products.

NEW VERSUS RECYCLED

Some people question whether products made from recycled materials can perform their jobs as well as products made from entirely new **("virgin") materials**. Plastics, paper products, aluminum cans, and some clothing are all commonly available with both new and recycled content. Choose a product, such as writing paper, and compare the performance of the **virgin** product to products made with recycled content. You may want to measure performance using criteria such as strength or durability.

SPREAD THE WORD ABOUT RECYCLING

With the approval and cooperation of your school administrators, set up recycling bins and trash cans near the cafeteria doors or in other safe, convenient locations. For a period of time— perhaps a week— weigh the amount of recyclables and trash collected. Follow this with an outreach campaign for a waste-free lunch. Put up posters and hand out flyers with information on how students can contribute to improving the environment by reducing, reusing, and recycling materials typically thrown away after lunch. After the conclusion of the outreach campaign, set up the trash and recycling bins again. Weigh the contents of both bins to see whether the outreach campaign had any effect on the amount of trash and recyclables. Did the amounts increase or decrease? Do a survey to see what element of the outreach campaign affected the students' habits.

TAKING CHARGE

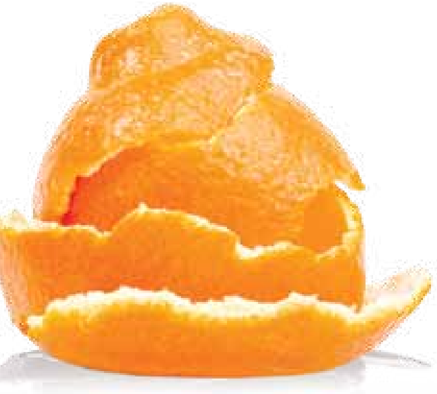
Lots of everyday items require batteries: cell phones; portable CD, DVD, and music players; watches; cameras; and computers. Some batteries contain heavy metals that can harm the environment if not recycled or disposed of properly. Are there better alternatives to these batteries? Develop a **hypothesis** about the effectiveness versus environmental risk of different types of batteries, such as rechargeable alkaline, nickel cadmium (NiCd), and rechargeable nickel metal hydride (NiMH). How long do they last? How do their costs compare? What environmental risks do they pose?

EFFECT OF CONVENIENCE ON RECYCLING RATES

Although people may want to recycle, sometimes it is difficult. Conduct an experiment to see whether convenience affects recycling rates. Learn about the factors that increase or decrease recycling participation and design a way to test one of those factors. For example, with the approval and cooperation of your school administrators, place a recycling bin that accepts multiple types of materials (This type of recycling is often called **co-mingled** recycling.) next to a trash can. In another part of the school, set up the trash can next to separate bins for paper, aluminum, steel and other metals, and glass. See whether this affects how much is recycled. Conduct a survey to see whether students think separating recyclables into different bins is less convenient than **co-mingling recyclable** materials, and ask them whether it affects how much they recycle.

* CREATING THE PERFECT COMPOST

Composting can be a good way for gardeners to reuse food scraps and yard trimmings while making their gardens healthier. In order to work properly, a **compost** pile needs the right balance of air, moisture, carbon, and nitrogen. Build several different **compost** piles containing different amounts of air, moisture, carbon, and nitrogen. For example, a carbon-rich pile would mostly contain dried leaves and wood chips. A nitrogen-rich pile would contain grass clippings and fruit and vegetable peels. Make sure that your **compost** pile has good air circulation and a balance of ingredients to control the experiment. Note that indoor composting takes two to five weeks to be ready, and outdoor composting takes at least two months. You will also need to allow time to grow plants



in the **compost** piles in order to determine which type of **compost** is most effective. Once you've created your **compost** and measured the plant growth it produced, ask whether the composition of the **compost** affected plant growth. How?

ECONOMICS OF RECYCLING

More than 4,000 communities across the country have adopted "**pay-as-you-throw**" (PAYT) programs where residents pay fees based on the amount of trash they throw away. This encourages residents to recycle more and throw away less. Conduct a PAYT experiment at your school. Measure the amount of waste thrown away in your cafeteria over a period of time (perhaps a week). Then, with the approval and cooperation of your school administrators, hand out the same amount of fake money to each student and charge them based on the amount of trash they throw away from their lunch. For example, throwing away a paper bag might cost a student $10, throwing away a plastic bag might cost $20, and throwing away an aluminum can might cost $50. Keep this up for a few days and see if the students begin to bring in lunches that are less wasteful (and therefore less costly). Keep track of the amount of waste discarded to see if the "fee" reduces the amount of waste thrown away each day. Vary the fee to see whether higher fees change the amount of waste discarded.

DECOMPOSITION OF EVERYDAY GARBAGE

Find out how waste decomposes and the factors that affect decomposition. Read about landfills and composting and how their properties affect the decomposition process. Plan an experiment to see if **biodegradable** objects kept in the dark (as in a landfill or in compost) will decompose faster when exposed to air (composting) or when not exposed to air (landfilling). Form a hypothesis using an if/then statement, such as: if air affects how fast biodegradable objects decompose, then I will see a difference between objects exposed to air and objects not exposed to air. Test to see if your hypothesis is correct. First, gather two pieces of bread, two apple slices, two pieces of cardboard, and other pairs of biodegradable items. Record all the features of each item. Then get two shoeboxes and fill one with dirt. Place one of each pair of items in the dirt-filled box. Place the remaining items in individual sealable plastic bags so that no air can enter; put some dirt in each bag; and place the bags in the second box. Then place the boxes in a dark space where there is no light. Observe the rate of decomposition every two days for a month. Prove or disprove your hypothesis by noting which items decomposed faster. Think about how or why exposure to air might affect decomposition, and identify properties that affect decomposition of biodegradable materials.

REDUCE

REUSE

RECYCLE

WRAPPING UP

A science project can be a great way to learn about your **environment** and teach others the benefits of the 3Rs of waste management—reduce, reuse, and recycle. At the end of your science fair, think back over your experience. What did you learn? How could you improve your project? Start planning for an even better science fair project next year!

GLOSSARY

Bibliography. A list of books and articles used by someone when writing or researching a written work.

Biodegradable. Materials that are decomposed by bacteria into their original organic components within a reasonably short period of time. Most organic materials (such as paper, grass clippings, food scraps), are biodegradable under the right conditions.

Conclusion. A reasoned deduction or inference.

Conservation. Preserving and renewing, when possible, human and natural resources. The use, protection, and improvement of natural resources according to principles that will ensure their highest economic or social benefits.

Co-mingled materials. Recyclables (e.g., paper, aluminum, glass) that are collected mixed together, rather than separate from one another.

Compost. A crumbly, earthy, sweet-smelling mixture of decomposing organic matter (such as grass clippings, leaves, food scraps) that is often used to improve the texture, water-retaining capacity, and aeration of soil.

Data. Information, often in the form of facts or figures obtained from experiments or surveys, used to make calculations or draw conclusions.

Decompose. To biologically break down into basic components, given the right conditions of air and moisture. Refers to organic materials such as food and other plant and animal matter.

Environment. All the external factors influencing the life and activities of people, plants, and animals.

Hypothesis. A statement that proposes an explanation to a phenomenon or event and that can be tested by an experiment.

Landfill. Disposal sites for non-hazardous wastes spread in layers, compacted to the smallest practical volume, and covered by soil or similar material at the end of each operating day.

Observation. Viewing or noting a fact or occurrence for scientific or other purpose.

Pay-as-you-throw (PAYT). Systems under which residents pay for municipal waste management and disposal services by weight or volume collected, rather than general taxes or a fixed fee.

Policy analyst. A person who analyzes alternative courses of action or procedure, using quantitative or qualitative methods, to determine which will achieve a given set of goals.

Recyclable. Material that still has useful physical or chemical properties after serving its original purpose and can be reused or remanufactured to make new products. Plastic, paper, glass, steel and aluminum cans, and used oil are examples of recyclable materials.

Trash (Solid waste). Items that are discarded because they no longer work and are uneconomical or impossible to reuse, repair, or recycle.

Resource. Natural substances that are a source of wealth and support life, such as minerals, fossil fuels, timber, or water.

Variables. The things that affect an experiment. The **independent variable** is the variable you purposely change. The **dependent variable** changes in response to the independent variable. The **controlled variable** remains constant.

Virgin materials. Previously unprocessed materials. A tree that is cut down and shredded to make paper is an example of virgin material.

Waste materials. See **Trash.**

RESOURCES

The following resources are available free of charge from EPA. You can download the files at the URLs listed below or order hard copies or a CD with camera-ready files of these materials using the contact information on the opposite page.

The Quest for Less: A Teacher's Guide to Reducing, Reusing, and Recycling EPA530-R-05-005
http://epa.gov/wastes/education/quest/index.htm

Activities and resources for teaching reduce, reuse and recycle to students in grades 1-8.

The Make a Difference Middle School Kit EPA530-E-03-001
http://epa.gov/wastes/education/mad.htm

A resource kit that inspires youth to reduce, reuse, and recycle to "make a difference" at home, at school, and in their communities. In the interest of waste prevention, only one Make a Difference kit per classroom is available. Some pieces in the kit are available for distribution to your students. Order the kit and those pieces at http://epa.gov/wastes/education/ordermad-ms.htm. The kit includes:

Be Waste Aware - Waste Reduction Resources and Tools for Students EPA530-F-03-056
http://epa.gov/wastes/education/pdfs/resource.pdf

A Collection of Solid Waste Resources on CD-ROM EPA530-C-05-001
http://epa.gov/wastes/inforesources/pubs/cdoswpub.htm

"Greenscaping" Your Lawn and Garden EPA530-03-002
http://epa.gov/wastes/education/pdfs/home-gs.pdf

Let's Go Green Shopping EPA530-K-04-003
http://epa.gov/wastes/education/pdfs/shopping.pdf

The Life Cycle of a CD or DVD EPA530-H-03-002
http://epa.gov/wastes/education/pdfs/finalposter.pdf

The Life Cycle of a Cell Phone EPA530-H-04-002
http://epa.gov/wastes/education/pdfs/life-cell.pdf

The Life Cycle of a Soccer Ball EPA530-H-05-001
http://epa.gov/wastes/education/pdfs/life-soccer.pdf

Make a Difference in Your School: A How-to Guide for Engaging Students in Resource Conservation and Waste Reduction EPA530-K-06-003
http://epa.gov/wastes/education/pdfs/mad-guide.pdf

The New Wave in Electronics: eCycling EPA530-F-04-020
http://epa.gov/wastes/education/pdfs/consumer.pdf

Pack a Waste Free Lunch EPA530-H-05-002
http://epa.gov/wastes/education/pdfs/lunch.pdf

Science Fair Fun EPA530-K-10-002
http://epa.gov/wastes/education/pdfs/sciencefair.pdf

Service Learning: Education Beyond the Classroom EPA530-K-02-001
http://epa.gov/wastes/education/pdfs/svclearn.pdf

Tools to Reduce Waste in Schools EPA530-K-07-002
http://epa.gov/wastes/education/pdfs/toolkit/tools.pdf

You Can Make a Difference: Learn About Careers in Waste Management EPA530-F-02-011
http://epa.gov/wastes/education/pdfs/career02.pdf

To Order Hard Copy Publications or the CD

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By Phone:	Call 1-800-490-9198. (Speak to an operator Monday through Friday, 7:30 AM - 5:30 PM, ET.) Leave an order 24 hours a day.

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