

Make Your Own Paper

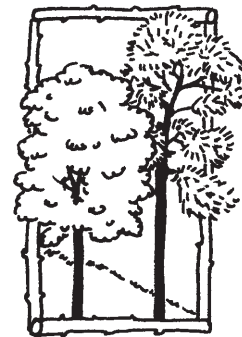
Paper is a simple material. It is essentially a mat held together by a fiber's roughness, and can be made from almost any fibrous material such as cotton, hemp, flax, wood, or recycled paper. And yet, this simple product has a tremendous effect on our lives. Imagine how different your day would be without paper!

The process for making paper was invented in China in the second century A.D., and all paper was made one sheet at a time until 1798. With the Industrial Revolution and the papermaking machine, papermaking became a major industry providing countless products, from books and newspapers to packaging and note pads. Some modern machines can make a sheet of paper 26 feet (8.8 m) wide and nearly 40 miles (64 km) long in just one hour! While the technology has changed dramatically over the centuries, the basic steps are simple enough for your students to do in class.

The process begins when trees, grown especially for papermaking, are harvested and transported to a paper mill. At the mill, large machines strip away bark and shred the logs into millions of chips the size of breakfast cereal. The wood chips travel on conveyors to gigantic "pulp cookers," where chemicals and steam are added. The mixture is heated and pressurized, breaking the chips into smaller and smaller pieces and finally forming a dilute water suspension of wood fibers called pulp. The pulp then passes through cleaners and screens and sometimes goes through a bleaching process that will give it the whiteness needed for the grade of paper being manufactured. Other chemicals like dyes, pigments, sizings, or resins are sometimes added to provide the paper or paperboard (thick paper for boxes) with the appropriate finish.

The pulp is then pumped through pipes to a paper machine where it is sprayed onto a wide, moving wire screen. After the water in the pulp drains through the holes, a damp mat of wood fibers remains: the paper. It is picked up from the end of the moving belt and dried over steam-heated rollers.

Commercial papermaking affects the environment in several ways. The energy needed for papermaking comes primarily from fossil fuels, which are nonrenewable. Burning those fuels can put carbon dioxide and other pollutants in the air. However, for public safety, there are state and federal guidelines that control emissions. Most of what you see coming out of the mill's smokestacks is steam, not pollutants. Many mills recycle the



Method

Students investigate the papermaking process by trying it themselves. While papermaking can be rather messy, it is well worth the effort.

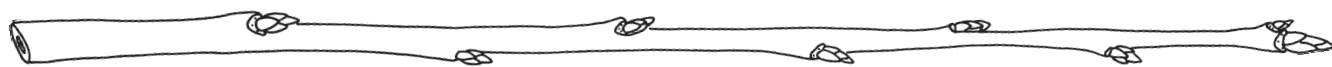
Key Concepts

Conservation technology enables humans to maintain and extend the productivity of vital resources.

By reducing waste and recycling materials, individuals and societies can extend the value and utility of resources and promote environmental quality.

Objectives

- make recycled paper from scrap paper
- describe the steps of the papermaking process and identify the elements and outputs of the process
- compare making paper by hand to the process used in factories



Subjects & WI Academic Standards

Science:

A.4, C.4, D.4, E.4, G.4, H.4
C.8, D.8, E.8, G.8

Social Studies:

B.4, B.8

English/Language Arts:

B.4, C.4
B.8, C.8

Environmental Education:

A.4, B.4, C.4
A.8, B.8, C.8

Materials

- scrap paper torn into 1" X 1" pieces (paper towels, construction paper, and toilet paper work well; avoid glossy finishes or paper with ink in it, like newsprint)
- a large bowl or tub
- a wooden frame about 5" X 7" or 8" X 10"
- nylon or wire window screening
- staples
- a plastic basin at least 2.5 gallons in capacity, that is larger than the frame
- liquid starch
- cloth dishtowels (felt, blotting paper, interfacing, or newspaper may be substituted)
- blender
- sponge
- household iron
- strainer
- towels for cleaning up water
- colored paper, pieces of colored thread, or dried flowers or herbs (optional)

waste paper they produce, and use wood waste to generate their own electricity for the process.

The waste water from papermaking can cause pollution problems. However, in the United States and Canada, the water discharged from mills is tightly monitored and controlled.

Additionally, the pulp-cooking process creates strong odors that can be smelled in the vicinity of the mill. Most mills have odor control systems to lessen this problem, although these sometimes fail.

Paper comes from trees, which are a renewable resource. Wisconsin forests produce 82% of the pulpwood used by the pulpmills in Wisconsin. Of the pulpwood produced in Wisconsin, 30.7% is aspen and 10% is red pine. The rest is a mixture of many other species. More than half of the fiber used for paper comes from residue left when lumber and other wood products are made and from paper which has been collected for recycling.

Paper is easily recycled, which helps reduce the amount of land space needed to store the 200 million tons of solid waste Americans generate each year. However, no matter how much paper we recycle, new trees still will be needed for paper products, because paper cannot be recycled indefinitely. Each time paper goes through the manufacturing process, the fibers deteriorate. After repeated recycling, the fiber is no longer suitable for papermaking.

Getting Ready

1. Decide how you will conduct the activity. If you are short on materials or adult supervision, you can demonstrate; but, ideally, you should try to find a way for the students to participate. Middle school students might use stations so some students can make paper while others do a different activity. For younger students, you might ask a parent or aide to help at stations, or have an activity for the rest of the class while you help small groups make paper.
2. The papermaking process is a wet one, so plan to use a work space that won't be harmed by moisture. You might want students to wear "wet gear"—an apron or smock, or old clothing.
3. Remove any plastic or staples from the scrap paper, and tear it into small pieces (1" or 2.5-cm squares). Soak the paper in hot water in the large container for at least 30 minutes or, if you can, overnight.
4. Buy or build a wooden frame, which you will prepare for papermaking. Tightly staple or tack nylon or wire window screening to the frame, making a "deckle," which is the surface on which you will layer the fibers.

Doing the Activity

1. Introduce the activity by asking students what they think paper is made of and how it is made.
2. Fill the blender halfway with warm water, then add a handful of the soaked paper. Blend at medium speed until you no longer see pieces of paper, and the pulp has a soupy consistency. You can blend in a piece of construction paper for color; or stir in short pieces of thread, dried flowers, or herbs for texture.
3. Pour the mixture into the large basin and then fill the basin with warm water, mixing thoroughly until the ingredients are evenly dispersed. Adding a few ounces of liquid starch will help make the paper firm.
4. Slide the deckle into the basin. Put some pulp onto the screen and, still holding the deckle underwater, gently move it back and forth to get an even layer of fibers on the screen.
5. Lift the deckle out of the mixture, keeping it flat. Allow it to drip until most of the water has drained off. You should have a uniform layer of pulp mixture on the deckle. Press the pulp gently with your hand to squeeze out excess moisture (rubber gloves will help). Soak up any excess water from the bottom of the screen with a sponge.
6. Place a clean dishtowel (or newspaper) on a flat surface and turn the screen paper-side-down on the cloth. Lift the screen gently, leaving the paper.
7. Quickly cover the paper with another cloth or piece of felt, and iron it at a medium-dry setting. When the paper is dry, pull the cloth gently from both ends, stretching it to loosen the paper from the cloth. Gently peel off the paper.
8. When you're finished making paper, collect the leftover pulp in a strainer and dispose of it in a wastebasket, or freeze it in a plastic bag for future use. Don't pour the pulp down the drain!
9. Discuss these questions:
 - ✦ What materials did we use in making paper?
 - ✦ What forms of energy did you need to make the paper? (electricity and students' own energy)
 - ✦ What types of wastes resulted from making paper? (dirty water, leftover pulp)
 - ✦ What did we do with the waste products?

Preparation Time

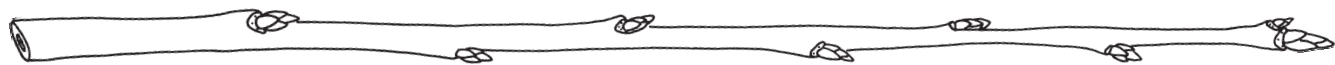
30 minutes, plus time to gather materials

Activity Time

2 50-minute class periods

Setting

classroom



✦ What were some problems with making paper? (cleaning up the mess)

✦ What would it be like in a paper mill, where tons of paper are being made a day? Why do you think

recycling paper is important? What about reducing the amount of paper you use?

✦ How is the new paper different from the old paper that you recycled?

Enrichments

Experiment with Papermaking

Students can use different types of materials to make paper, then compare the papers. Students might try newspaper, paper towels, typing paper, or cotton balls. Which paper is the strongest? Which is water-resistant? Which is best for writing? What other comparisons can students make? What kinds of uses can they think of for their new paper? What materials can they use that might otherwise be thrown away?

Recycle Your Homemade Paper

To demonstrate the principle that paper cannot be recycled forever but requires the infusion of new fiber, try recycling the homemade paper once or several times. Using a portion of the paper your students made as the pulp, make a batch of paper, and have students compare the first batch of paper with the second. Which is stronger? Which is more useful? Students can then take a portion of the second batch and use it to make a third, comparing the batches for texture and durability. Does this demonstration tell the students anything about how many times paper can be recycled? (In general, estimates say fiber cannot withstand recycling more than five or six times.)

Assessing Student Understanding

Ask younger students to write the directions for making paper on the piece of recycled paper that they made.

Ask older students to guide younger students in a papermaking activity. If possible, the class can make an instructional video on papermaking using a home video camera.



Copied with permission, American Forest Foundation, © 1993/1994/1995/1996/1997/1998, **Project Learning Tree Environmental Education Pre K - 8 Activity Guide**. The complete Activity Guide and High School Modules can be obtained by attending a PLT workshop. For more information call the National PLT office at (202) 463-2462 or the Wisconsin office at (608) 264-6280.

Extending the Learning

Visit with a Papermaker

Wisconsin is America's #1 papermaking state! If you live near a paper mill, invite a representative to help your class make paper. Ask him or her to bring samples of wood chips, pulp, and paper, if possible. After the visit, try the **Paper Makes Wisconsin Great!** activity "What Should I Be? What About a Papermaker?" In the activity, students investigate career possibilities in the papermaking industry by creating a poster about a specific career.

Close the loop!

Whenever possible, we should purchase items manufactured from recycled materials. Recycling our glass, plastic, paper, and aluminum is not good enough. If there isn't a market for products made from recycled materials, recycled resources will go to waste. Assign students the task of finding products made from recycled resources. Check to see if your school is buying paper made from recycled paper. Go to neighborhood stores and check the shelves for recycled products and recycled packaging. Ask students to check at home to see if their families are purchasing any products made from recyclables.



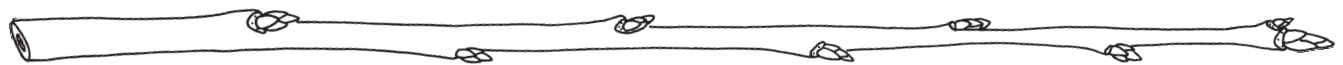
Hold the Paper, Please

Learn about school children in other countries who have little or no paper in their classrooms. What do you think they use for assignments and notes? Try to have one class period or one day that you don't use paper. Brainstorm with the students the day before. What will you use as paper substitutes? How will you do things differently? Did any of your ideas work? Could you permanently reduce the amount of paper you use?

Finding Out More!

Paper By Kids by Arnold Grummer. This book offers great ideas on making and using recycled paper. Find out how often paper can be recycled. It might surprise you to learn how paper companies are using the pulp that can't be recycled again. Here are some hints: kitty litter, fuel pellets, soil conditioners, and animal bedding.

300 Years of American Papermaking by Helena Wright (Smithsonian Institution, 1991).



Papermaking-related Websites

American Forest and Paper Association. This website features colorful, printable PDF files, including factsheets for kids focusing on paper and recycling.

www.afandpa.org

American Museum of Papermaking

www.ipst.edu/amp/

Forest Products Laboratory

www.fpl.fs.fed.us

Wisconsin Paper Council. This website has suggestions for simple ways to make paper.

www.wipapercouncil.org

