

Students learn about the papermaking process by trying it themselves. Students will find out that they can make their own paper and that their product is practical, as well as beautiful.

MAKE YOUR OWN PAPER



SUBJECTS

Science, English Language Arts, Social Studies, Visual Arts

PLT CONCEPTS

1.4, 2.5, 2.7

STEM SKILLS

Creativity, Nature-based Design

DIFFERENTIATED INSTRUCTION

Hands-on Learning, Student Voice

MATERIALS

Scrap paper torn into 1" x 1" (2.5 cm x 2.5 cm) pieces (paper towels, construction paper, and toilet paper work well); a large bowl; a wooden frame 5" x 7" (13 cm x 18 cm) or 8" x 10" (20 cm x 25 cm); nylon or wire screen; a stapler; a plastic basin at least 2.5 gallons (9.5 liters) in capacity and larger than the frame; cloth dishtowels, blender; sponge; strainer. Optional: Colored paper, liquid starch, rubber gloves, pieces of colored thread, or dried flowers.

TIME CONSIDERATIONS

Preparation: 30 minutes, plus time to gather materials
Activity: Two 50-minute periods

OBJECTIVES

Students will

- **Describe the steps of the papermaking process.**
- **Identify the inputs and outputs of the papermaking process.**

BACKGROUND

Paper is a simple material, essentially a mat held together by the roughness of fibers. It can be made from almost any fibrous material, such as cotton, hemp, flax, wood, or recycled paper. Despite its simplicity, paper has a tremendous effect on our lives. Imagine how different your day would be without paper!

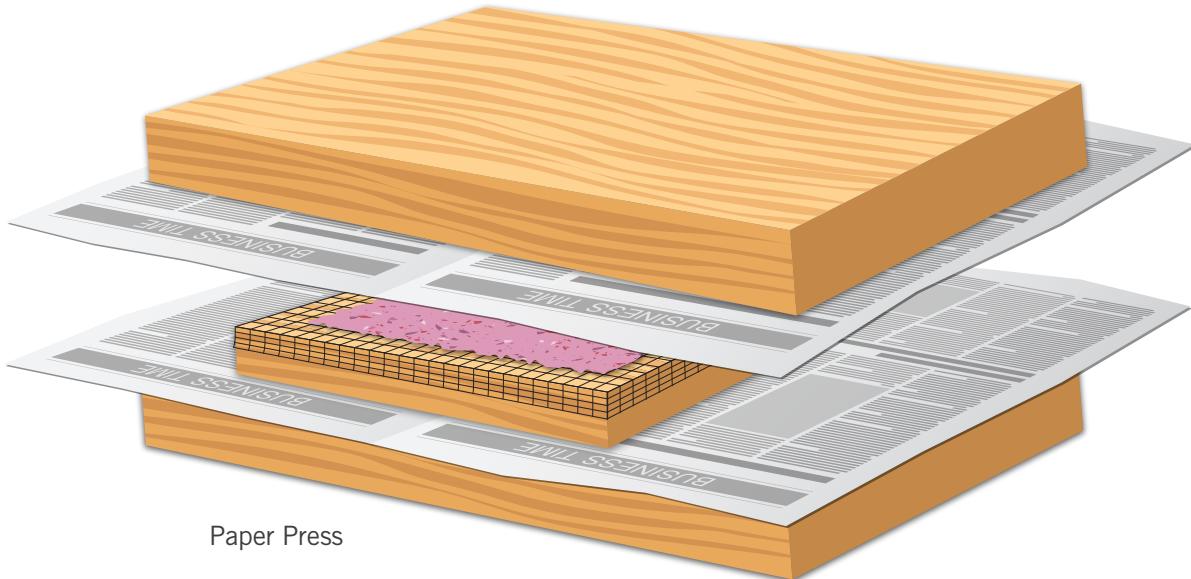
We use paper for countless things, including books, stationery, copiers and printers, tissues and sanitary products, bags, containers, food packaging, gift wrap, wallpaper, disposable dishes, lampshades, and artistic media. Industrial uses include gaskets, liquid and gas filters, insulation, and friction devices.

The process for making paper was invented in China in the second century A.D. Until 1798, all paper was made one sheet at a time. During the Industrial Revolution, mechanical advances helped papermaking become a growing industry that provided countless products. 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 that you can try them yourself.

FOREST FACT



Papermaking begins with trees. About one-third of the paper used in the United States is made from trees that are thinned (harvested from a forest) to give other trees room to grow or from trees that were grown especially for papermaking. About one-third is made from the wood chips and sawdust created from milling lumber from logs. And one-third is made from recycled paper.



During the papermaking process, large mill machines strip away bark and shred logs into millions of chips the size of breakfast cereal. The wood chips travel on conveyors to gigantic 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 passes through screen cleaners and sometimes is bleached to whiten it. Dyes, pigments, or resins are sometimes added to give the paper or paperboard (thick paper used to make boxes) the appropriate finish.

The pulp is 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; this is the paper. It is picked up from the end of the moving belt and dried over steam-heated rollers.

Sustainable practices can help to reduce the environmental impacts of commercial papermaking. These include:

- Sustainably managing forests to ensure the long-term health of trees.
- Using wood waste in mills to generate the electricity to run the mills, thus lessening the use of fossil fuels that emit carbon dioxide and other pollutants.
- Using smokestack systems to reduce both air pollution and odors created by the pulp-cooking process.
- Recycling the wastepaper produced in mills and using recycled paper in addition to new wood fiber.
- Monitoring mill wastewater to ensure that it does not pollute waterways.

For more about sustainable practices related to papermaking, see the activity What's in a Label? (in Grades 6-8).

It is easy to recycle paper, which helps reduce waste. However, paper cannot be recycled indefinitely. Each time paper goes through the manufacturing process, the fibers deteriorate. After undergoing repeated recycling, the fibers are no longer suitable for papermaking. So new trees are still needed for paper products, which is why sustainable forest management is so important.

GETTING READY

- Decide how you will conduct the activity. While you can demonstrate, ideally the students should participate. You might set up a papermaking station that you supervise and have students rotate through it. While you are helping the papermaking group, the rest of the group can do an alternative activity.
- Papermaking is a wet process, so use a workspace that won't be damaged by moisture. You might want students to wear "wet gear"—an apron, smock, or old clothing.
- Remove any plastic or staples from the scrap paper and tear it into small pieces (1-inch or 2.5-cm squares). Soak the paper in hot water in the large bowl for at least 30 minutes before you use it.
- Tightly staple or tack nylon or wire screening to the wooden frame, making a "deckle," which is the surface on which you will layer the fibers. Visit YouTube for helpful papermaking deckle tutorials.

DOING THE ACTIVITY

- 1 Ask students what they think paper is made of and how it is made. Ask what questions they have about paper, listing them where everyone can see. Ask them how they might find the answers to their questions. Suggest that one way is to make paper themselves.
- 2 Fill a blender halfway with warm water, then add a handful of soaked paper scraps. 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 fill it with warm water, mixing thoroughly. Adding a few ounces of liquid starch will help make the paper firm.
- 4  **HANDS-ON LEARNING** Allow students to help you 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  **HANDS-ON LEARNING** Allow students to help you lift the deckle out of the mixture, keeping it flat. Allow it to drip until most of the water has drained off, leaving a uniform layer of pulp mixture on the deckle. Press the pulp gently with your hand to squeeze out excess moisture (wearing rubber gloves helps). Soak up any excess water from the bottom of the screen with a sponge.
- 6 Place a cloth (or other absorbent material) on a flat surface and turn the deckle paper-side-down. Lift the deckle gently, tapping the screen to release the paper onto the surface.



TAKE IT OUTSIDE



Papermaking works well in outdoor settings, where it is easier to conduct wet and messy projects. Encourage students to look outside for small leaves, flower petals, or seed pods to add to their paper.

- 7** Let the paper dry naturally overnight. Gently peel the paper off the surface when it is dry.
- 8** When you're finished making paper, collect the leftover pulp in a strainer and recycle it, or freeze it in a plastic bag for future use. Don't pour the pulp down the drain!
- 9**  **STUDENT VOICE** Revisit students' initial questions about paper from Step 1. Ask them what they learned by actually making paper, and what questions they still have about paper or the papermaking process.

VARIATION: GRADES 3–5

- 1** Have students create paintings using paper pulp. Start by making different colors of pulp from construction paper scraps. Pour the pulp into small paper cups, pinching the rims of the cups to make pouring spouts.
- 2** Invite students to choose one color for the background, pouring a half cup of pulp onto the deckle screen. They should then carefully drip thin layers of other colors on top of the background to create a piece of artwork.
- 3** Have students research other ways that people use paper in addition to writing and art projects, such as cleaning, construction, packaging, or clothing. Students might also look for other fibers besides wood fiber that are used to make paper. Have them share the findings with the group in an oral, written, or visual report.



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ACADEMIC STANDARDS

SCIENCE	ENGLISH LANGUAGE ARTS	SOCIAL STUDIES
<p>Practices</p> <ul style="list-style-type: none">• Asking questions and defining problems <p>Concepts</p> <ul style="list-style-type: none">• Natural resources• Engineering design• Cause and effect	<p>Practices</p> <ul style="list-style-type: none">• Speaking and listening: comprehension and collaboration	<p>Practices</p> <ul style="list-style-type: none">• Applying disciplinary concepts <p>Concepts</p> <ul style="list-style-type: none">• Economics: exchange and markets

ASSESSMENT

Ask students to

- Write about or visually organize the steps of the papermaking process and the materials needed.
- Tell or write a story about how paper is made.

ENRICHMENT

- Use different types of materials to make paper and compare the results. Students might try using newspaper, paper towels, or cotton balls. Which paper is the strongest? Most water-resistant? Best for writing? What other comparisons can you make about them? What other materials could you recycle to make paper instead of throwing them away?
- Create a book or bulletin board showing different kinds of manufactured paper, noting the characteristics, benefits, and limitations of each. Include samples of newsprint, gift wrap, parchment, wallpaper, packaging, food cartons, greeting cards, and so on.
- Make paper for thank-you cards, invitations, and stationery. Use homemade paper to write a poem (as in the Poet-Tree activity [in Grades 3-5]) for a gift or special occasion.
- If you live near a paper mill, plan a visit or invite a representative to talk to your class and help with the papermaking activity. Ask them to show samples of wood chips, pulp, and paper.