Robert C. Williams
American Museum of Papermaking

Teachers’ Guide

Your Guide to the Science,
History, Art and Technology of Papermaking

www.ipst.gatech.edu/amp
This life-size statue, which stands in the center of the American Museum of Papermaking, is an adaptation of an illustration entitled "The Papermaker," which is believed to have first appeared in 1698 in the Book of Trades by Christopher Weigel.
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Robert C. Williams
American Museum of Papermaking

The Robert C. Williams American Museum of Papermaking is a cultural institution and educational resource serving Georgia since 1993. A small staff manages this unique museum and its collection that melds art, history, technology and industry from a historical, global perspective. The collection is made up of over 25,000 artifacts including manuscripts, rare books, prints, hand and industrial tools, and crafted and manufactured objects as well as paper samples. Our outreach programming - exhibits, lectures, workshops, tours and other programming - has been very successful and continues to establish larger and more diverse audiences for the museum. The Museum draws its membership and visitors from local regional, national and international communities.

The Robert C. Williams American Museum of Papermaking's mission is to: Collect, preserve, increase, and disseminate knowledge about papermaking - past, present and future.

Research
We are pleased to offer a new service to the public through our extensive archives. We can provide professional research services for most aspects of paper history and technology. We have many amazing things in our archives such as the patent for paper made of wood and ancient papermaking implements. Now the public can have access to this information via research. The first hour of research is free for members, after that it is $15 for each additional hour. The non-member rate is $30 for each hour of research.

Cost
Members are free. $3 donation suggested for non-members for non-guided tours. Guided tours for groups are $4.50 per individual. Guided tours for groups with papermaking workshop are conducted on Fridays at $6.50 per individual. One adult per 10 children is free and it is recommended that you bring one adult per 10 children as a minimum for adequate supervision.
For reservations call 404-894-6663 or email terri.williams@ipst.gatech.edu

Please call as far in advance as feasible to ensure you get the date you desire for your field trip. If you need to cancel your field trip please call us five business days before your scheduled arrival. We will be happy to re-schedule you at this time. If you do not give us notice a $25 cancellation fee will be charged. Payment is due at time of arrival.

Our address is:
500 Tenth Street NE,
Atlanta Georgia 30332-0620
Hours: Monday-Friday 9-5

Directions
From the Airport or I-85/I-75 Northbound, take I-75/I-85 North to Exit 250 (Williams Street/10th Street). Turn left at exit light on 10th Street, go about 3/4 of a mile. Just after you cross Hemphill Avenue, the parking entrance for the museum and IPST’s main location will be on your left. The building is located at the corner of 10th Street and Hemphill Avenue.

From I-85/I-75 Southbound, take I-75/I-85 south to Exit 250 (Techwood Drive/14th Street/10th Street). Continue on Techwood Drive until you reach 10th Street. (You will cross over 14th Street before you reach 10th Street.) Turn right at exit light on 10th Street, go about 3/4 of a mile. Just after you cross Hemphill Avenue, the parking entrance for the museum and IPST’s main location will be on your left. The building is located at the corner of 10th Street and Hemphill Avenue.

Visit our Web site at: www.ipst.edu/amp
Part I

The History and Social Studies of Papermaking Around the World
Pre-Paper

Pre-paper is material that was used for writing on before we had papermaking. There were all sorts of ingenious materials used for writing, the most common being papyrus and parchment. Papyrus was made mostly in Egypt and was made by slicing the papyrus plant down the middle lengthwise, placing the strips together in one direction and placing a second layer on top in the opposite direction. Then the papyrus strips were pounded together.

Parchment and vellum were most often used in Europe, and in fact many legal documents still used the animal skins until the late 1800s. First they would skin the sheep or cows and place the skin on a stretcher. Then they would rub lime into the skin to stabilize it as it dried. The skin would then be cut into rectangles or squares for their documents. Animal skins were also used to make pages and covers for books.

Popular writing materials in Thailand were palm leaves. They would cut the leaves into a long rectangular shape. Then they would take a sharp instrument and write in the leaf. Next they would rub soot into the writing. Books were made from palm leaves by cutting two holes in each leaf and stringing them together either by metal prongs or twine. Covers for these books were made by applying lacquer to the palm leaves and using paint to apply elaborate decorations.

The difference between paper and pre-paper, since they have both been made from a large variety of fibers over the years, is that paper is made with water and pre-paper has been pounded together to form the sheet.

Early Papermaking

The earliest known paper has been traced back to 200 BC in China. The paper was a prayer embedded into the adobe brick of a home, presumably to bless the home. Most early paper was used either for religious purposes, by the reigning government or the very wealthy for business transactions.

The first papers were made from recycled fishing nets, bamboo, mulberry bark or hemp. The papermaker would harvest the fibers and place them in water to soak for...
prolonged periods of time, sometimes 2 to 3 days. They would dig large pits and line them with stones or would use wooden vats for soaking the fibers. The fibers would then be stripped of their outer bark and the stalks would be re-soaked. The process would be repeated until most or all of the outer bark was gone, depending upon the quality of the paper they wanted. For instance, writing paper would be soaked for longer periods of time than Chinese Ceremonial money which was used for burning to the spirits at funerals. The papermaker would then pound the fibers into pulp. It is generally believed that the early papermakers would use wooden tools or rocks to pound the pulp. The papermolds were made in a rectangular frame shape from bamboo and the interior portion was a loosely woven material. The molds are known as wove molds because the paper takes on the texture of the fiber. The papermaker would pour a scoop of pulp on top of the mold and spread it out evenly using their hands to shake the mold. The molds with the wet paper were placed in the sunshine to dry. An average papermaker would probably have owned 25 to 30 molds. The pouring process would be repeated as the paper on the molds dried so they could be reused.

Papermaking moved to Korea circa 600 AD and though the basic process remained the same, several major advances were made. Some papermakers would harness animals to a large stone and as the animals walked around a circle, the stone crushed the fibers into pulp. They used a laid papermold which had a bamboo frame with a screen cover made from grass or mulberry bark strips tied together with horsehair and two deckle strips. The deckle strips were pieces of wood attached to the frame that offered support to the screen when it was too heavy from the wet pulp. Another advance involved placing the wet paper on wooden boards to dry. The paper became flatter by drying in this manner and the molds could be reused. The early Koreans were also responsible for two inventions that we still use today, the envelope and toilet paper.

Papermaking moved to Japan circa 610 AD at a time when the Japanese and Chinese had a friendly trading relationship and cultural exchanges were commonplace between the two cultures. The Japanese people had been writing on silk for their documents, books or scrolls, but this medium proved too expensive for wide spread use. After its introduction, paper quickly gained in popularity. In 770 AD Emperor Shotuko
ordered the first mass printing on paper. One legend says there was a small pox plague on at the time and the Emperor thought that by printing one million prayers on paper and encasing each in a little wooden pagoda this would help to protect his people. Another version of the legend claims that Japan had just finished a Civil War and the Emperor had the prayers delivered to the ten major temples in the country for healing. Woodblocks were probably used by the Priests to print the prayers.

Hand papermaking in Japan was and is a wintertime activity and a village industry not just a family industry. The early paper was made in a fashion similar to the Korean paper, however the Japanese papermakers developed it into a finer art.

Some of the paper was so thin and smooth that it was almost transparent and felt like silk. This was a far cry from the rough first Chinese paper that probably contained bits of unbeaten bark.

Papermaking traveled to the West on a journey very similar to the Silk Trade Road. It was not an easy journey and involved slavery, espionage and wars. From Japan papermaking traveled to Tibet, across the top of Africa and to India.

**Papermaking Travels to Europe**

Papermaking arrived in Europe in 1290 AD in Italy at the Fabriano Mills, a little less than 1500 years after its invention in China. The Europeans used cotton and linen as their fiber of choice, mostly from recycled clothing. Rag pickers would buy people's old clothing and sell it to the mills. At the mills the rag pickers would sort the clothing as to color, grade and condition. Buttons and hooks would be removed and the rags would be washed to remove all dirt. They used a rag knife to cut the rags into strips, wet them and rolled them up into balls. The rags would then ferment for a few weeks.
The papermakers would waste a lot of rags using this method because about 1/3rd of the rags would ferment too much and become rotten. However, the other 2/3rds would be soft for beating into pulp. Sometimes the papermakers would add lime to the rags to hurry up the fermentation but this caused the paper to be weaker.

In 1151 in Spain they invented the stamping mill for pulping the fibers instead of the ancient tradition of beating the fibers by hand. The stamping mill consisted of a waterwheel turning large wooden hammers. The strips of cloth would be placed into a trough and the hammers would pound them into pulp.

The major invention the Europeans added to hand papermaking was the changes in the papermold itself. The mold was now made from wood and metal, either brass or copper. The mold was in two parts; the bottom portion was a wooden rectangular frame with wooden strips running parallel to the sides at regular intervals. On top of the wood was a screen woven from the brass or copper, looking very similar to the fine mesh of a screen door. The top portion of the papermold was called a deckle. It was made from wood, looked like a picture frame, and fit around the edges and top of the mold. The papermaker would put both pieces together and dip them into a wooden vat filled with 95% water and 5% pulp. The papermaker would bring up a mold filled with pulp and would then shake the mold from side to side to evenly spread the pulp.

Then the papermaker would take the deckle off of the mold and couch the sheet, which means pressing the mold onto a sheet of wool, which would release the wet paper. The papermaker could then reuse the mold immediately. The deckle was an important part of the papermold and its use meant that even inexperienced papermakers could make a rectangular sheet of paper with even sides, because to wet pulp could not drip or slide off of the flat mold. The term deckle edge, which we use on expensive stationary and invitations, comes from this papermold.
Papermaking Comes to the United States

The First Settlers

Papermaking has played an important economic and social role in the history of the United States, from the Rittenhouse Mill in 1690 to the modern technology of today. Printers were the first to voice the need for papermaking in the Colonies. Supplies from Europe were available on an erratic and limited basis. At that time, in the late 1600s, William Penn was recruiting tradesmen in Europe to colonize his land in Pennsylvania. He sent flyers throughout Europe telling of religious freedom and economic prosperity. On one of his journeys to Holland he met William Rittenhouse, a papermaker, who was selling paper in Amsterdam. Rittenhouse was interested in the religious freedom promised and influenced by Penn decided to immigrate to North America.

William Rittenhouse and his family established the first colonial papermill in Germantown, Pennsylvania, an area slightly north of Philadelphia. Germantown was attractive to the family for a variety of reasons including serving as a potential source of rags for papermaking. The local blacksmith helped to build the heavy equipment necessary for a mill and there was a tannery where they obtained materials to make sizing. The location had the additional benefit of being downstream from a group of weavers and Rittenhouse obtained scraps of cotton and linen from the weavings for fibre.

The first papermill was built from logs, over the Wissahickan Creek. There are large boulders on the creek banks, which served as platforms to secure the mill. Rittenhouse chose the location because the water was clean and free of heavy mineral deposits.

Rittenhouse and his family continued the European tradition of papermaking. The majority of the fibers for pulp were rags from clothing and blankets. William’s wife Geertruid and daughter Elizabeth probably washed the rags, separated the cotton from the linen, and removed the bad spots and fasteners. Rags were sliced using a rag cutter; a large knife mounted on a stand, producing strips approximately 3 to 4” wide. These were then rolled up into balls with lime and left to rot for approximately 3 months. The rags were washed again and placed in a stamper.
A Stamper consisted of a long and narrow trough, with heavy wooden hammers, which were powered by a waterwheel to move up and down. As the wheel turned the hammers would beat the rags in the trough until they turned to pulp.

The pulp was then mixed in a large wooden vat containing 10% pulp to 90% water. There was usually a fire under the vat to heat the water. The vatman was the owner of the mill or the most skilled worker. Papermaking would start about six in the morning. William would mix the pulp and water to the right consistency and then dip in the mold and deckle. He would then shake the mold, binding the cells of the fibers together to form a stronger sheet. The mold would be tipped at an angle to remove excess water. William would take off the deckle and hand the mold to the coucher, more than likely his son Claus.

Claus would turn the mold upside down and press the wet paper onto a sheet of felt. Another sheet of felt would be placed directly on top of the paper to build a stack approximately 2 feet high. The coucher had to be very skilled in stacking each sheet of wet paper exactly above the other, in order to press them evenly. The stack or post would be taken to the press where pressure was applied to gradually drain the water from the paper. A 2-foot high post of paper would become 6 inches high.

The paper was taken to the drying loft, the second story of the mill. Multiple windows opened into the loft, which were positioned to take the best advantage of the wind. Some of the papers were put on a wooden tool shaped like a T and positioned on ropes made of cows-hide hanging from the ceiling, others were placed on wooden drying racks. After the paper dried it was cut, wrapped and stacked for the market.

If the paper were for stationary or fine printing it was sized. Sizing was made from bits of skin and bone left over from the tannery, which were boiled into a gelatin mixture. Wooden tongs were used to dip the dried paper into the gelatin and then the paper would be re-hung in the drying loft. The sized paper was then hand polished by rubbing stones on the paper and stacked for the market. The three men working at the Rittenhouse Mill made about 4 reams of newspaper in a day. Their annual production would have been 1,200 to 1,500 reams of paper.

Between the years 1639 and 1728 there were 37 printers in business (23 in Boston, 9 in Philadelphia and 2 in New York). They had printed over 3,067 books, pamphlets and broadsides. There were also now 6 newspapers.
Although the need was growing for papermills to start one required not only land and money but also a willingness to go through a lot of red tape. A papermaker needed about $10,000 to start up and employed between 15 and 20 people. The bureaucracy came from two sources, the colonial and the European governments. The British in particular thought of the United States as their paper market. In 1728 the English Parliament investigated the Colonial papermills to see if they were infringing on their business but could only find two mills, one in Massachusetts and the other in Maine. Even though the English could not export enough paper to meet the demand of the Colonial market, there was a growing paranoia about competition.

In 1765 the Stamp Act was issued from England imposing a tax on every sheet of paper used for writing or printing. The idea was not to allow the Colonial paper to flood the market to the detriment of the English paper. However, collecting the tax was hard and brought in less revenue than it cost to enforce.

Papermaking was starting to spread around the colonies. The first Southern papermill was established in North Carolina by a group of German Morovians in 1767. The Colonial Congress met in Hillsborough North Carolina in September 1775. The Congress offered 250 pounds to the first person to establish a mill. Their condition was that the papermaker had to produce within the first two years 30 reams of brown paper, 30 reams of whited brown and 30 reams of white writing paper. The paper had to be an equivalent quality as that which was imported from England.¹

Feelings among the Colonists were now stronger for independence from England. The English were tightening their hold on trade and goods made in the Colonies. They issued the Townsend tariff schedules of 1767, which placed import duties on glass, paper, paperboard, lead, painter’s colors and tea. Several of the Colonies reacted by legislating non-importation acts, which included paper.

The need for paper became greater and greater. The shortage before the Revolutionary War caused newspapers to be printed with no margins, and sometimes to skip their weekly issues. According to John Maxson there were 30 to 50 family papermills in 1775.²

The Revolutionary War and The Spread of Papermaking

When the War finally started people became desperate for paper and would use anything they could get their hands on including recycled wallpaper, packing paper, backs of already used paper, and pages from books. “In July 1776 Henry Katz and Frederick Bicking, papermakers from the Philadelphia, petitioned the Pennsylvania Committee of Safety to allow papermakers to be excused from military duty, explaining that even supplies of cartridge paper (used to contain pre-measured charges of powder and shot) would soon be exhausted unless the mills could be kept in operation. On July 19, 1776, the Continental Congress approved a resolution ‘that the papermakers in Pennsylvania be detained from proceeding with the associators (a volunteer militia) to New Jersey’ and the Committee of Safety followed suit shortly after, on August 9’.”

After the Revolutionary War papermills started to proliferate and according to Jacques Pierre Brissot de Warville in 1794 he knew of 48 papermills in Pennsylvania and 15 in Delaware. John Maxson estimates that there were approximately 100 to 125 total in the United States.

In 1799, 22 year old Zenas Crane left Springfield Massachusetts to find a location for his papermill. Zenas had grown up in a papermaking family. His father was a partner in the Vose, Lewis and Crane Papermill in Milton Massachusetts, near Boston. He apprenticed at 16 with his brother who owned another papermill.

Crane's number one priority was to find a clear source of water with no contaminants and enough force to run the stamping wheel. He also needed to be relatively close to potential customers. Crane settled on Dalton Massachusetts on the Housatonic River with its clear water and a location near 2 newspapers - The Sun in Pittsfield and the Western Star in Stockbridge. It took him two years to find partners with the necessary funds to establish a mill. Interestingly, the mill was built on the land before the land was purchased from Martin Chamberlain for $194 on December 25, 1801.

The Crane Papermill had one vat that could produce 20 posts with 125 sheets in a post. Crane hired “an engineer at three dollars a week, a vatman and a coucher at three and a half each, without board; one additional workman and two girls at 75 cents a week each, and a lay-boy at 60 cents, all being boarded.”

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There is no record of what Crane received at the time as mill manager but several years later he was up to $9.00 per week.

In 1801 Zenas Crane, Henry Wisell and John Willard put an ad in the Pittsfield Sun:

"As the Subscribers have it in contemplation to erect a paper mill in Dalton the ensuing spring; and the business being very beneficial to the community at large, they flatter themselves that they shall meet due encouragement. And that every woman of her own family, at heart, will patronize them by saving her rags, and sending them to their Manufactory, or to the nearest Store Keeper; for which the Subscribers will give a generous price".5

In 1812 post riders would deliver mail to a centralized post office where individuals could come and pick up their mail. The nearest post office to Dalton was Pittsfield, a town approximately five miles away, a long distance in 1812. In order to make more sales the local newspapers started delivering the newspapers weekly along with the mail to the homes and farms. Zenas Crane persuaded the postriders to spread the news to save rags and take them to the village stores. The women could barter the rags for goods or credit and the stores sold the rags to Crane. One of the local peddlers came up with the bright idea that he would barter for the rags at the farms in exchange for his goods. He then sold the rags directly to the papermill.

By 1822 there were three papermills in Dalton, so the mill owners decided to split the rag trading to include a Northern and Southern route. The mills signed an agreement and promised not to infringe on each other’s routes.

By 1810, according to John Maxson, there were 218 papermills whose total production was worth $1,689,718. Even then they could not make enough paper to keep up with the demand, but the papermakers wanted protection from European imports and the ad valorem taxes were up to 27.5 to 37.5 percent. During the War of 1812 the imported paper was once again banned.

5 Artifact from the collection of the Crane Paper Museum.
The Machine Begins

The first papermachine was imported in 1817 for a mill in Brandywine Creek, Delaware. The machine would change the speed, and output of papermaking forever. Papermakers considered the paper machine a tool, as was the paper mold, and many of the same families adapted to the new style of production. By the mid to late 1800s the mills which had not changed to the machine could not compete in the market place and hand papermaking slowly died.

Thomas Gilpin, a papermaker, studied with the papermakers and paper machine inventors in Europe and had made drawings and extensive notes describing their inventions. He modified the Dickinson Cylinder machine design slightly and procured a US patent for the Gilpin machine. The Gilpin brothers are credited with the invention of the first American paper machine.

Growing Pains

The Civil War caused the next shortage of paper in the United States. The majority of papermills were located in the northern states. The south’s economy was mostly agricultural and they imported their paper from Europe and the northern states. When the Civil War started the South was cut off from their paper suppliers. Papermills became targets for both sides in order to handicap communication. Marietta Georgia had the largest mill in the South, running 24 hours a day to make paper before the mill was destroyed in the war. There was also a shortage of rags to make paper and experiments started in the South to make pulp from the cotton plant. The resulting paper did not possess the necessary strength needed for writing paper.
The northern states were also suffering from lack of rags. The Franklin Paper Mill in Connecticut held a government contract for making wrappers for cotton batting. The pulp for these was made from the “dust” from fine writing papermills. The higher quality dust was used for high-grade wrappers and the poorer quality dust was mixed with clay and made into wrappers for cotton batting.

The most successful experiments for alternate fibers were taking place in Europe with wood. A wood grinding machine was invented in Germany by Friedrich Gottlieb Keller in 1844 and twenty-two years later the first grinder was imported to the United States. The wood pulp was sold to the Smith Paper Company in Lee Massachusetts for 8 cents a pound. “The mechanical or wood-grinding process produces pulp by pressing short lengths of log, cleaned of the bark, against wetted revolving grindstones. By hydraulic pressure the blocks are forced against the stone sideways of the grain to tear out the fibers rather than pulverize them, so as to preserve the fibers length. At first a percentage of rag pulp was added to groundwood pulp to give tensile strength to the paper. Later, sulphite was used instead of the scarcer rag pulp”. 6

In 1869 CE Alfred Denison Remington made groundwood pulp newsprint. He sent two railroad cars full of the pulp to the New York Times who promptly rejected the paper as inferior. William Russell built two groundwood pulp mills in New Hampshire and Vermont. He too had a hard time trying to sell the newsprint. Russell’s salesmen filled the Boston Herald’s paper order of 500 reams of wood newsprint without telling. The paper was so successful that they refused to use the rag paper afterwards.

One of the more interesting alternate fibers was used at the Lick Paper Mill in San Jose California. The mill owners needed a local fiber and started experimenting with cactus. “The manufacture of paper of excellent quality from the species of cactus growing in great abundance in the Mojave Desert has recently been tested at the Lick Paper Mill in San Jose’ said the Sacramento Recorder Union in its issue of March 7, 1877.” 7 The article continues with the paper company planning to use the cactus extensively all along the West Coast. According to the mill owners the cactus made a strong paper and the supply was unlimited. Unfortunately, the cactus did not live up to the publicity and was replaced by wood shortly after.

6 Elliott, page 47
In 1878 Remington, from the Remington Paper Company of Watertown New York, bought the Lick Mill. He also enjoyed experimenting with fibers and was the first to import the sulfur process to produce pulp from wood fibers. California was badly in need of paper mills since the East Coast mills considered them too far away to export paper profitably.

The beautiful mahogany Lick Mill burned down in 1882 but was soon replaced by a new mill 175 feet wide. The new mill had its own blacksmith shop, machine shop and storehouse. The single mill workers lived in a two-story dorm and the married workers in mill houses. They had 40 men working in the mill both day and night.

The mill prospered selling newsprint for $160 per ton wholesale. The fibers used were cloth, wood (poplar, spruce, and hemlock), burlap or jute, chemical fibers, hemp, and straw (although this was being phased out). Their newest and eventually largest products were paper to wrap fruit in for shipping and druggists wrapping paper.

With papermaking becoming a larger industry in America, research and education became more important. Wood was the most popular fiber, triggering a new look at forestry practices. In 1895 Dr. Carl Alvin Schenck founded the first forestry school in the United States at the Biltmore Estates in North Carolina, home of the Vanderbilt family. In Europe forestry schools were wide spread and the students studied science and agriculture. When Schenck arrived from Germany he found the mountainous land to be worn out by crops with very few trees. He initiated good forestry practices and took on apprentices for help.

In 1898 Schenck issued his first course catalog to train students in private forest management. His tenure in the school lasted from 1898 to 1913. During that time he taught 350 students. Faculty from several Universities was brought in to teach subjects during their summer break. The course work would last one year with lectures in the morning and fieldwork in the afternoon. Schenck imported white pine seedlings from Germany but the school soon established a nursery and started experimenting with native trees. During his tenure Schenck invented the Biltmore stick which foresters use to gauge if a tree was ready to harvest. He also made the first census of trees in the United States.
States and developed a working plan for their management and development.

By the 1930s the dual wheel trucks and the bulldozers changed the harvesting methods, so a smaller strand of trees or even single trees could be harvested. Even so they could not keep up with the demand for paper. By 1930 newsprint was still hard to get so Congress permitted import of newsprint duty free and Canada wound up supplying 80% of the United States newsprint.

In 1929 the industry decided they needed a graduate school for paper science. The Institute of Paper Chemistry was started in Appleton Wisconsin to educate generations of students in the biology, chemistry, paper physics, and engineering involved in papermaking. The Institute researched new and better ways to make paper and produced hundreds of patents on papermaking. The graduate school is now located in Atlanta, Georgia with a new name, the Institute of Paper Science and Technology. The graduates are still studying the cutting edge of technology and graduate to eventually become the top management of the paper industry. The Institute is the home of the Robert C. Williams American Museum of Papermaking. The museum was founded by Dard Hunter who is responsible for the revival of hand papermaking in the United States. Hunter traveled around the world, studied how people made paper, collected artifacts and wrote books on his adventures.

Although science and technology changed the tools used for papermaking in a little over 300 years, certain elements have remained the same – the family ownership, the search for less expensive fibers, and continuous change to keep up with the market. The industry, until very recently, has remained a family industry. The mills were owned by generations of the same family, including some of the first mills such as The Crane Paper Company. The mill workers are often from generations of families from the same geographic areas.

Many business analysts predicted the end of paper when the computer technology became so embedded in our lives. The opposite has proven true with people using much more paper to print out all of the e-mails and faxes of today. The paper companies are always searching for new ways to reach their customers, whether they are the companies making filters or walls from paper or the customer purchasing stationery.

As George Bernard Shaw said “Let those who may complain that it was all on paper remember that only on paper has humanity yet achieved glory, beauty, truth, knowledge, virtue, and abiding love.”
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Now that you have read the History of Papermaking, here are a few lesson ideas....

Discuss with your class what they think is the most important event in papermaking history. Take a sampling of the answers and see how they might fit together. Now ask your students if they have ever seen a timeline. Ask them what timelines show and why they are useful. Suggest they make a timeline as a class or individually tracing the history of paper from prehistoric times to the present. A collection of important dates will follow this section.

Another way to get students involved in the history of papermaking and to introduce researching skills is to give them a topic and let them prepare a short paper or oral presentation on the given topic. To make it more fun suggest they dress like the person or peoples they wrote about. Here are some suggestions on research topics. Remember this is a short list; there are many more options out there!

**Pre-paper making societies**
- Native American pre-paper
- Cuneiform created by the Sumerians
- Papyrus and the Egyptians
- Tapa cloth in the South Pacific

**Important figures in paper history**
- Empress Shotoku (sometimes referred as Emperor)
- Emperor Fredrick II
- Johann Gutenberg
- Nicholas-Louis Robert
- William Rittenhouse
- Mathias Koops
- Dard Hunter
The Paper Artifact Box!

Objectives

Students will:
1. Analyze artifacts to determine their possible use by (a) specific cultures(s).
2. Formulate questions regarding artifacts and the culture that developed them. Identify areas of further study and/or research regarding the artifacts.

Materials Needed:
1. Artifact box provided by the Robert C. Williams International Museum of Papermaking
2. Paper and writing utensils for group brainstorming

Procedure

Teacher Presentation - Introduction
“Do you know what an artifact is? Tell me.” (Request definitions)
“This box is full of artifacts, but the description page has been lost. However, we only have this box for a few days, and I want to make the best of it. You have all proven yourselves to be wonderful at deductions: figuring out what things are or what they mean or what happened based on clues and bits of information. We need to use these skills today.”
“I know that everything in this box has to do with the history of papermaking, starting in ancient China to the present in America. Other than that, I don’t know what these things are or what they were used for. But you do because today you are archeologists and historians. You will need your expert powers of deduction!”
“Each person will work with a partner. You will need a paper and pencil; one person will be the scribe. You will receive/ select (teacher’s choice) one of the artifacts from this box and set to work to deduce the following:
What you think the item is.
What it was used for.
Who used the item.
How it was used (be prepared to demonstrate).
Why this item was important to the culture/ time.

“You will have 20 minutes to discuss the artifact and write down your ‘findings.’ Then we will gather together and one of you will present your findings to the group.”

**Time to Explore!**
The teacher then assists each pair in selecting an item from the box. Have the pairs settle in parts of the room where they can discuss and explore the artifact freely. Encourage them to be creative! When they seem stumped, ask them to think about the shape, the texture, the color, and the unusual markings. Have them determine which is the top and which is the bottom. How should the item be held? Can they compare it to anything we use today? How so?

**Now we all become teachers!**
Gather everyone together for a sharing session. One at a time, have a representative from each group “show and tell” everything they determined about their particular artifact. Encourage the rest of the class to ask questions of the presenters as well as of themselves. (E.g. how does my artifact relate to the one being presented?)

**Oops! Here is the explanation sheet!**
After everyone has presented his/her discoveries, the teacher should suddenly remember where the descriptor sheet is. She should highlight the individual artifacts and read its identity and use from the sheet, asking the class to see how close the “experts” came to reality. They will often be amazed at how close they actually came to the truth, and they will almost always laugh when they are way off.
Follow Up
Have students conduct research on their artifacts. Find other resources with pictures or descriptions of the artifacts and the culture from the correct time period.

1. Draw pictures of the people from the country and time period using the artifact.
2. Pretend you are an archeologist who has made this find for the first time.
3. Write a newspaper article that describes what an important find this is for the whole world. How did this item change life for those who used it as well as our lives today?
4. Prepare an imaginary interview with the inventor of this object. Find out what inspired the inventor to create it.
5. Write an advertisement for this item that would entice people from its time period to buy it and use it.

QCCs for Lessons 1

Social Studies
5th grade: 4,9,10,11
6th grade:
3,4,5,6,7,8,10,11,13,14,19,
20,21,23,24,25,26,28,28,
39,40,42

Science
5th grade: 1,2,4
6th grade: 1,4
7th grade: 1,2

Art
5th grade: 17,19
6th grade: 17,18
7th grade: 3,20
Taking a Closer Look at Paper

It's time to take a closer look at paper now. You now have some samples of different kinds of paper. You will take these samples and look at them with a microscope. Do they look different when they are wet from when they are dry? What do you think paper is made of? Now you are set to explore these questions!

Instructions for Students:

1. Put each sample in a compartment in your paper tray. Tear off a corner of the first sample of paper.
2. Rub the torn edge of the first sample between your thumb and finger several times.
3. Now observe the torn edge. Observe the rest of the paper sample. First look with just your eyes, then with the hand lens, then with the microscope. Look for patterns in the paper fibers, the things that look like thread. If you have any questions about microscope safety of use, please ask your teacher.
4. Get a small piece of tape and put the sticky side over the torn edge of the paper sample. Press it very gently. Then gently peel the tape off the paper. Look the tape with the hand lens and then with the microscope. If it is hard to see the fibers on the tape put a piece of black construction paper underneath the tape. Record your observations of the tape and dry paper sample.
5. Using the plastic dropper, place one drop of water near the middle of the paper strip. You may need to gently rub the water in if it does not absorb. Slide the wet section under the microscope lens and observe.
6. Gently pull on the dry ends of the paper. Observe any changes in the wet middle section. Record these observations. Repeat steps for other samples.

Materials Needed:

- 1 hand lens
- 1 microscope
- 1 plastic dropper
- 1 piece of notebook paper, newsprint, paper towel, copy paper, magazine paper, and toilet tissue
- 1 plastic screw-top jar of water, about 8 oz.
- 1 paper tray
- 1 piece of black construction paper
- 1 roll of transparent tape

The Technology of Paper

Lesson 2

the robert c. williams american museum of papermaking
Discussion Questions:
1. How does the paper look under magnification? What did you observe about the torn paper? The tape after you pressed it to the paper?
2. In what ways were the paper samples alike? How are they different?
3. In what ways was the wet part of the paper different from the dry parts?
4. Based on the observations you just made, how is paper affected by water. Give examples.
5. Again, based on your observations, what do you think would happen if paper soaked for a longer period in water?
6. Finally, Study your observations and guess what paper is made from. See if others came to the same conclusion.

QCCs for Lesson 2

Science 5th grade: 1,3,4
6th grade: 1,2,3,5
Taking an Even Closer Look at Paper

When we look at things what we see is little packets of light bouncing off of the surface, but sometime we might want to look at things that are smaller than those little packets of lights, which are called photons. We might use something called a scanning electron microscope, SEM for short, to view these items. The SEM shoots a beam of very tiny subatomic particles at the surface and when they bounce back they make a picture!

The first pictures we are going to look at are of printer paper, like this page is printed on or like you use at home in the computer. See the fibers? That is the wood fiber that most paper is made of. See the little round objects? Those are bits of Calcium Carbonate; it makes the paper more opaque. Do you remember what opaque means?

The next set of pictures we are going to look at is currency, the money we use. See the long fibers? That is cotton and linen. See the little pieces of fiber that come out all over? Those are called fibrils. This is where the pulp has been beaten so much the fibers are very separate. Note how smooth this paper appears compared to our next example.
Can you guess what this paper is? See how it is rippled? This is toilet paper. When they make toilet paper they scrape a razor down the length to give it the ripples, which is called crepeing, this makes it soft. This is also wood pulp.

The last example is called coated paper. This is what magazines and business cards are made of. Can you see any fibers? No, there is either a clay or calcium carbonate coating over the entire surface, which makes it water resistant and shiny.
The Properties of Paper (Part 1)

Lesson 3

Tear-Resistance Test

One way to learn more about the properties of a product is to test it. In this lesson, you will perform a tear-resistance test on the six paper samples. Before you do, there are some questions to think about. What do we mean by the “quality” of a product? How do we compare the quality of different products? And how can you be sure the test you are doing is fair?

Instructions for students:

Today you will use a tear-resistance test to explore one property of paper: how resistant to tearing it is. Try to predict how you think each paper will perform in the test.

1. Put a strip of transparent tape down each long side of the strip of paper.
2. Using the ruler, make a 3-cm (1 1/4-in) tear down the middle of the strip. This will create two tabs, a left and a right.
3. Bend the paper clip into a hook.
4. Using your ruler and a pen, make a mark in the right tab about 2 cm (3/4 in) from the end. Then, use the end of the paper clip to poke a hole through the mark on the tape. Use your finger as a brace as you poke the clip through. Then remove the paper clip hook.
5. Using masking tape, secure the top of the left tab of the sample to the table of desk edge.
6. Hang the paper clip hook through the hole as shown below. Bed the tab down gently so the hook dangles freely.

Materials needed:

- 2 strips each of notebook paper, newsprint, paper towel, copy paper, magazine paper, toilet tissue, and grocery bag
- 35 washers
- 1 large paper clip
- 1 pen
- 1 ruler
- Masking tape
- 1 roll of transparent tape
7. Add washers gently, one at a time, until the paper begins to tear again. Record in your notebook the number of washers you added.

8. Do two trials for each sample and then average your results.

**Discussion Questions:**

1. Which paper was the most resistant to tearing? The least?

2. Were you surprised by the results? Why or why not? How did the results compare with your predictions?

3. On the basis of what you have observed about each paper sample, what properties of the strongest paper do you think contributed to its strength? What properties contributed to its weakness?

4. Think about the uses of each paper type you tested. On the basis of their uses, which samples need to resist tearing? For which ones is tear-resistance less important?

5. In what ways do you think paper tests can be helpful? To whom?
**Opacity, Water-Drop, and Ink-Mark Test**

Can you design a test for the smoothness of paper? Which sample do you think will be the most smooth? The least? After you find out, you will compare the smoothness test with the tear-resistance test. In this lesson, you will also conduct tests for opacity, water absorbency, and ink absorbency. What do we mean when we say a test is “subjective”?

**Student Instructions:**

1. **Opacity Test**
   The degree to which a paper prevents you from seeing through it is called its opacity. Printers call it the “show-through” of paper. Paper that is very opaque is hard to see through. The higher the opacity, the lower the show-through. To compare the opacity of the paper samples, follow the steps below.

   1. Place the first paper sample over the question below. The words will show through some papers more than others. If you cannot see the words through the page, the paper has high opacity. If you can easily read the words, the paper has low opacity. Record your results.

   2. Repeat step 1 for the other five paper samples.

   3. On the basis of how well you read the print through each paper sample, rate the samples from “1” for low opacity (high show-through) to as much as “6” for high opacity (low show-through).

**MATERIALS NEEDED:**

- 1 piece each of notebook paper, newsprint, paper towel, copy paper, magazine paper, and toilet paper
- 1 plastic screw-top jar of water, 240 ml (8 oz)
- 1 plastic dropper
- 1 piece of blotter paper
- 1 clock with second hand
- 1 microscope
- 1 hand lens
- 1 rolling ball pen
- 1 ruler
- 1 roll of transparent tape

*How well can you read me through the paper?*
II. Water-Drop Test

The rate at which paper absorbs water can determine how the paper is used. To compare water-absorption rates, you can time how long it takes for a drop of water to be totally absorbed by different types of paper. To do this, follow the steps below:

1. Place each paper sample on the blotter paper. Fill the dropper with water.
2. As one of you places a drop of water onto the first sample, the other needs to watch the clock. Record how long it takes the water to be absorbed by the paper and soak through to the blotter paper.
3. If the water is not absorbed after 1 minute repeat step 2 on the remaining samples. Check the other samples periodically.
4. If any water drops have not been absorbed or have not soaked through after 10 minutes, try comparing the degrees of wetness on the underside of those samples.
5. On the basis of how much water was absorbed, rate each sample from “1” for low absorption (not all water was absorbed) to “6” for high absorption (all water was absorbed fast).

III. Ink-Mark Test

How ink reacts with paper is important to printers, writers, and artists. Generally, we want to be able to write on paper with ink, but we want the paper to resist absorbing a lot of ink. To test a paper’s resistance to absorbing ink, follow the steps below:
Procedure

1. Hold the tip of the pen on the first paper sample at about a 45-degree angle. Hold it there for 10 seconds. Did the ink make a small mark, or did the ink spread out on the paper?

2. Use your ruler to measure the width of the mark. Is it a uniform circle, or does it appear feathery? Use the hand lens and microscope to take a closer look at the ink mark.

Repeat steps 1 and 2 for the remaining paper samples.

On the basis of how small and uniform the ink mark is, rate the samples from “1” for the least uniform and largest mark to “6” for the most uniform and smallest mark.
Caliper Measurements and Tensile Strength

Caliper Measurements

Background:
Caliper is the thickness of a single sheet of paper. Paper that is used in printing and writing should have uniform caliper. The caliper of each page of your book should be the same as the rest. The caliper of each sheet in a package of writing paper should be the same as the rest. If you were in a paper mill laboratory you would use an instrument called a micrometer to measure caliper. You can measure more accurately with a micrometer than with a ruler. Both of these measuring tools can be applied to samples of different kinds of paper.

Instructions for Students:
1. To find the caliper of paper, measure the thickness of a stack of the paper with a ruler. Calculate the caliper by dividing the thickness of the stack by the number of sheets in the stack. For example, if you have 100 pieces of paper and the stack is .75 inches, you divide .75 by 100, which gives you .0075 inches for every piece of paper.
2. Place the first stack of paper on a flat, level surface.
3. Use the ruler to measure the thickness (height) of the paper stack. Your eyes should be level with the tip of the stack when you read the numbers on the ruler.
4. Record your measurement.
5. Count the number of sheets in the stack.
6. Take similar measurements and record the data for the other paper samples. When you measure the hardback book cover, measure only the top cover.
7. Calculate the caliper for each kind of paper. To do this, divide the measurement of the stack thickness by the number of sheets you counted. Record your results.

Materials Needed per Group:
- Facial tissue
- Newsprint
- Typing paper
Questions:
1. According to your calculations, which paper had the largest caliper? The smallest?
2. Compare the value for caliper of the notebook paper which you obtained with some values obtained by your classmates. Is your value close to theirs?

Tensile Strength

Background:
Papermakers use precise methods to test the strength of paper. They measure the tensile strength of paper by determining how much stress the paper can withstand without tearing apart. The intended use of a paper indicates the tensile strength it must have. For example, wrapping paper must have higher tensile strength than paper towels.

Instructions for Students:
Precise equipment for measuring the tensile strength of paper is very expensive and usually found only in paper mills and testing labs. In this activity, you will use your hands to judge whether various types of paper have high or low tensile strength.

1. Hold the long side of one of the paper samples between your hands and tug on it, moving your hands back and forth. Gradually pull harder and harder.
2. Repeat holding the sample by its short side.
3. Describe the results.
4. Repeat steps 1 through 3 for the other paper samples.

Materials Needed:
- Facial Tissue
- Napkin
- Notebook paper
- Paper towel
- Brown grocery sack (cut a 20cm by 25cm sheet from the sack)
**Questions:**

1. Which samples could you pull apart?
2. For each sample tell which direction, length or width, pulled apart more easily.
3. Was there a difference in the sound each sample made as you tugged it? Describe the sound each sample made.
4. Can you relate noise to the strength of the paper? Rank your samples from high to low according to tensile strength.

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**QCCs for Lesson 5**

**Caliper Test**

Science 5th grade: 1, 2, 4
6th grade: 1, 3

**Tug of War**

Science 5th grade: 1, 4, 6
6th grade: 1, 3, 8
7th grade: 1, 2
Lessons in Papermaking

Classroom Lessons With Dipping Your Hands into Pulp
HOW TO MAKE RECYCLED PULP

The Chinese used recycled fishing nets, ropes, and mulberry trees to make the first paper. Centuries later, Europeans used cotton and linen rags. In 1800, Mathias Koops received the first patent for making paper out of wood pulp.

Today, about 80% of recovered paper can be recycled to make new paper. Recovered paper describes the paper itself, and the stuff that comes along with it. Food, plastic, staples, and glue are just a few things that might be found on paper that cannot be recycled with it. This makes sorting very important!

You can make recycled pulp for hand papermaking out of old newspapers, homework, paper towels, construction paper, and more! Gather your materials and follow the instructions listed below.

**MATERIALS NEEDED:**
- Paper to be recycled
- A blender
- A vat - any large plastic container will do!
- Water

**Procedure**

1. Gather paper for re-pulping. Tear these sheets into approximately one-inch pieces.

2. Place a small handful of the torn sheets into a blender half full with water.

3. Blend for about one minute, giving the blender a break every few seconds. Use the pulse setting for best results. The blender breaks the paper down into fibers called pulp! Repeat these steps until you have enough pulp for papermaking. Remember that when it comes to pulp, a little goes a long way!

**TIP:** Unused pulp can be stored for later use in plastic Baggies, containers, glass jars - anything you can seal. Pulp will be good for 2-3 weeks in the refrigerator. If you are making a lot of pulp, you may want to run the unused portions through a sieve to drain the water. Just pour in the pulp, squeeze out the excess water, and form it into a ball. Store your “pulp ball” in a cool dry place. The dried pulp will dissolve in water when you are ready to use it again. You can also use this method for discarding old pulp.
HOW TO MAKE YOUR OWN PAPER MOLD

Paper molds are basically made up of a frame and a screen. In the East, this screen is made of bamboo sewn together with horsehair. Western molds have a screen made of wire or brass. The screen allows water to flow through, leaving behind a sheet of paper. Once the paper is formed, it is removed, or couched (kooched!) from the mold.

Nathan Sellers of Pennsylvania was a famous paper mold maker. He joined the American Revolution in 1776, but was soon discharged by special order of the Continental Congress. They sent him home to make paper molds for paper gunpowder wrappers and written orders.

Follow the instructions listed below to make your own paper mold.

**MATERIALS NEEDED:**
- Two wooden picture frames of the same size
- Net curtaining, a tightly woven window screen, or any material that will act as a sieve
- A heavy duty staple gun

**Procedure**

1. Simply stretch the net curtaining over one of the wooden picture frames and staple it along the sides, Save the second frame to use as a deckle!

**TIP:** Use an indoor/outdoor sealer on the paper mold to protect the wood from warping. This way, you can use it over and over again!
HOW TO MAKE YOUR OWN HANDMADE PAPER

Now that you have recycled pulp and a paper mold, just gather the materials listed below and get going!

<table>
<thead>
<tr>
<th>MATERIALS NEEDED</th>
<th>A paper mold</th>
<th>An iron &amp; ironing board</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recycled pulp</td>
<td>Newspaper and sponges</td>
<td>Blotters - cut a few inches</td>
</tr>
<tr>
<td>A vat</td>
<td>A rolling pin</td>
<td>larger than your paper mold</td>
</tr>
</tbody>
</table>

**TIP:** You can buy blotter paper from any art supply store, or improvise with heavy paper towels, or woolen blankets. Anything that will absorb a lot of water will work well!

**Procedure**

1. Place a handful of pulp into the vat, which should be half full with water, and mix well. Remember, the vat can be any large plastic container, or even the kitchen sink.

2. Hold the deckle over the paper mold and dip them into the vat. The deckle will keep pulp from flowing over the sides of the paper mold. Swirl them around for a few seconds to get enough pulp on the screen, then lift the mold and deckle straight out of the water. Let the water drain through the screen.

3. Remove the deckle and set it aside.

4. Place a blotter sheet on top of a stack of newspapers. The newspapers will absorb a lot of the water, and can then be recycled. Couch your paper onto the blotter by flipping it over so the paper faces the blotter.

5. Sponge off the excess water by pressing down into the back of the mold. Then list the mold off the blotter. Your paper should stick to the blotter!

6. Place another blotter sheet on top of the new paper and use the rolling pin to squeeze out the excess water.

7. Place the blotters with the paper in-between on the ironing board and run the hot iron over the paper. The heat will dry the paper in minutes!

**TIP:** Iron alternative: Squeeze out as much water as you can with the rolling pin, then peel the damp paper off the blotter paper. The damp paper will stick to a window and the sun will do the rest! This method is recommended for younger papermakers.
Making your paper Beautiful...

When you make your recycled pulp pay attention to the color and texture of the materials you recycled, it will make a big difference in your final product. Think about using the colorful junk mail that you get every day to add to your paper.

Recycled paper isn’t the only way to add some color to your paper. Natural dyes such as indigo and berry juices can make wonderful colors. You can also use specially made pigments from art stores that are guaranteed to have beautiful results.

Another way to add pizzazz to your paper is through additions. You can add leaves, seaweed, pine needles, almost anything you want to give your paper a character all your own. You can buy glitter, pressed flowers, and other fancy additions at art supply stores. Remember to buy metallic glitter, not plastic, so it won’t melt to your iron.

QCCs for Lesson 6

Science  
5th grade: 3,4  
6th grade: 2,3,6  
7th grade: 1,2  

Social Studies  
5th grade: 13  
6th grade: 13,14
This section is a sampling of some fine art creations you can make with paper. Don’t let the simplicity of the design fool you. There are lovely creations if made with care and proper materials. These designs come from Asia, the birthplace of paper. Paper is an important cultural element in these countries and is used in many different crafts.

**Glow Lamp**

In China they used these beautiful decorated lamps to light their houses until electricity became popular. These lamps are still beautiful today! Be sure to let a grown up light the candle.

**Materials Needed:**

- Colored paper
- Tissue paper
- Scissors
- Glue
- Glass Jar
- Candle

**Procedures**

1. Get some black or dark paper. Fold it accordion style as many times as you like. Remember, the more you fold it the more decorative the paper will be.

2. Then cut out small triangles on both sides of your paper.
Procedures (continued)

Open it up.
3. Glue the tissue paper onto the dark paper, covering all the holes. You can use colored tissue paper or color white tissue paper to make a stained class design.

4. Put the small lighted candle into the jar

5. Wrap the paper around the jar.

6. Your lamp is done!
Tanabata Matsuri Tassel

Do you know what Tanabata Matsuri is? It is the star festival in Japan celebrated in summer to show success. Make this pretty tassel to show your success in handicrafts!

**Materials Needed:**
- Origami Paper squares
- String
- Scissors
- Beads or Macaroni

**Procedures**

1. Fold a square in half from corner to corner. Open it and fold it the opposite way.

2. Turn the paper over.

3. Fold the square in half from side to side. Open it and fold it the opposite way.

4. Turn your paper over again.

5. Push the sides toward the center to form a bell. (Two triangles)
Procedures (continued)

6. Cut the tip off

7. Tie the bead or macaroni to the end of the string

8. Thread the paper bell onto the string. Rest the bell on the macaroni

9. Keep tying the beads or macaroni and adding the bells till your tassel is done.
Japanese Paper Doll
These little dolls are intriguingly easy to make. Remember the nicer the paper you use, the nicer your doll will look.

**Materials Needed:**
- Different patterned decorative paper
- Scissors
- Markers or Crayons
- Glue
- Wooden Coffee Stirrers or Toothpicks

**Procedures**
1. Cut two rectangles of exactly the same size of two different kinds of paper.
2. Put the two rectangles on top of each other. Fold a little over on the top.
3. Turn your rectangles over
Procedures (continued)

4. At the midpoint, where the rectangles are folded, fold over the left corner, then the right.

5. Fold over the right half of the rectangles, then turn out the right bottom corner.

6. Fold over the left half of the rectangles, then turn out the left bottom corner.

7. Make a belt out of folded paper and wrap it around your doll. Fasten it with glue in the back.

8. Draw a simple head on a piece of white paper or cardboard. Glue it on the back of a toothpick or coffee stirrer.

9. Carefully work the head into the collar of the kimono. Snip a tiny whole in the neck if you need to.

Well done!
**Chinese Envelope**

Use this envelope design from China for any special occasion.

**Materials Needed:**
- Pretty paper
- Scissors
- String

**Procedures**

1. Cut your paper into a square.
2. Take the bottom corner a little more than half way up and fold it flat.
3. Bring the side corners to the middle.
4. Fold the top corner down.
5. Tie your new envelope shut with your string.

**QCCs for Lesson 7**

Art  5th grade: 1,2,3,4,5,6,17
     6th grade: 1,2,3,5,7,6,12,17
     7th grade: 3,20

Social Studies  6th grade: 5
Robert C. Williams
American Museum of Papermaking

A Student’s Guide to the World of Papermaking

500 10th Street NW, Atlanta, GA 30332-0620
www.ipst.edu/amp
Have You Ever Stopped to Think About Paper?

Paper is something we use everyday, but what do we really know about it? Why is it important to our lives?

Imagine that you didn’t have any paper. List five types of paper that you would miss most.

1. __________________________
2. __________________________
3. __________________________
4. __________________________
5. __________________________

Before paper was invented, people had to use other materials to fill the needs that paper fills for us today.

Can You Imagine...
Reading a book made out of leaves?
Carrying clay tablets to school?
Purchasing pieces of fine silk to write on?

That is what people did before the invention of paper in 200 BC.
Go to the Reading Selection to find out how paper became so important to our lives!

Fun Facts!

In Paper History

- The Chinese made the first paper out of recycled fishing nets.
- The Koreans invented the envelope in the 600’s.
- Toilet paper was in use in China in 875.
- The first paper mill in America was built in 1690 in Pennsylvania.
- Nicholas Louis-Robert developed the paper machine in 1798.
- In 1855, some paper was made of the linen wrappings of mummies!
- Local people on Mount Everest use trash left by climbers to make recycled paper!

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www.ipst.edu/amp
**THE PAPER TRAIL**

What do you do when you want to remember something? You write it down! Paper is one of the materials we depend on to help us communicate our thoughts and ideas. But what do we really know about it?

**The Invention of Paper**

Recently, a fragment of paper with a prayer written on it was discovered in a clay brick in China. This paper was found to be 2200 years old! Thanks to that discovery we know that paper was invented sometime in the year 200 BCE.

The papermakers soaked the fibers in a pit lined with stones for approximately 3 months. The fibers, usually recycled fishing nets, hemp or bamboo, were placed in the pit with layers of lime and then beat them until the fibers came apart and became pulp. Next they made a mold of loosely woven cloth stretched over a bamboo frame. The pulp, mixed with water, was poured onto the paper mold and drained through the cloth screen. The pulp on the screen was left to dry in the sun, forming a sheet of paper!

**The News Spread**

The news of this exciting new invention took more than 700 years to spread to Korea and Japan. Papermaking was a closely guarded secret! As papermaking spread, people worked to improve on the original methods. The Japanese were the first to put their pulp into a large vat of water and dip their molds into it, just like many hand papermakers do today.

In 751 CE, an Arab army defeated the people living in Central China. Many papermakers were taken prisoner and put to work making paper. The Arabs were great traders doing business in many different countries. As the Arabs traded goods, they also spread the news of papermaking. The skill spread first to Damascus, then to Egypt, and finally to Europe.

Paper arrived in Spain first, then to Italy, France, and Germany and throughout Europe. Still, the secrets of papermaking were closely guarded! Ulman Stromer opened the first paper mill in Germany in 1390 with a staff of papermakers from Italy. He demanded that everyone working in the paper mill take an oath of loyalty, and promise not to divulge the secrets of papermaking. His Italian workers refused, but soon changed their minds. Why? He confined them in a tower!
The European papermakers made paper out of cotton and linen rags from people's recycled clothing. In time, the demand for rags increased, and a shortage of rags was created.

**Rags Wanted**

The first paper mill in America was built in Pennsylvania in 1690, more than 80 years before the United States became an independent country! As the shortage of rags for papermaking continued, England limited the amount of paper that could be made in the American colonies. During the Revolutionary War, the British completely stopped exporting paper. How did the paper shortage affect George Washington's armies? Without paper, they could not issue written orders. Soldiers needed paper to wrap powder and bullets for their muskets. Not only did they need rags, but also skilled papermakers. In time, every papermaker in the Revolutionary Army was discharged to make paper.

The shortage of rags remained a problem well into the 1800s. In 1855, Sir Issiah Deck came up with a very unusual solution to this problem. He and his partners learned that there was a large supply of mummies in Egypt, each wrapped in many yards of fine linen. Mummy cases included not only people, but also the mummified remains of sacred cats, bulls and crocodiles.

He began importing these mummies and stripping off their linen bandages to make pulp. One mummy could yield as much as 30 pounds of linen! But the mummy solution had one catch - because the linen had never been disinfected, it carried disease and caused an epidemic of cholera to break out among some paper workers. This, along with many people's horror at the practice of using mummies in this way, put an end to mummies as a source of fiber for papermaking.

**Wasps Show the Way**

The use of wood for pulp remained a missing link in the papermaking process for a very long time. Many scientists worked to find an alternative to cotton and linen. In 1719, A French scientist named Rene'de Reaumur noticed that the nests of wasps were made of a sort of paper. He observed that wasps would buzz around until they found soft, rotting wood.
They would use their legs to scrape at this wood, leaving behind wood shavings. They chewed these shavings and mixed them with a glue-like chemical in their saliva. This created a fine pulp, which dried into layers of paper.

Dr. Jacob Christian Schaffer's quest for materials for papermaking started with Reaumur’s wasps nests, and lead to cabbage stalks, potatoes, grass, tulips and even old roof shingles! He published six volumes of experiments using plant and vegetable fibers to make paper between 1765 and 1771.

By 1800, an English scientist named Mathis Koops had created a book written on paper made of wood and straw!

Before an efficient machine for making paper was invented, papermakers had a very hard life. They labored for more than 12 hours a day in dark, wet rooms, their faces exposed to vats of steam, their arms continuously stuck in pulpy water, their backs bent as they stood over piles of paper. According to some accounts, the lives of papermakers were so difficult that many were hard drinking, tough, unpleasant people to be around!

**The Paper Machine**

In 1798, Nicholas-Louis Robert, a manager in the Didot paper mill in France, decided he was fed up with quarrelsome, short-tempered workers in the mill. His employer, Leger Didot, transferred Robert to a quiet flour mill so he could have more time to work on his papermaking machine. His invention, though crude and simple, was the prototype for today's modern paper machine.

In 1801, Leger Didot moved to England, where he sold his idea for a new, improved version of Robert’s papermaking machine to Henry and Sealy Fourdrinier. The Fourdrinier brothers wrote their patent wrong and did not make any money. Bryan Donkin, an engineer, further improved the machine with drying cylinders and began selling it in 1865.

The period during and after the Civil War is often called the “Paper Era.” People were experimenting with the possible uses of paper. In 1853, the first paper collars and cuffs were worn in New York City.

Marietta Georgia Papermill
By 1863, paper was used for many items, such as aprons, hats, curtains, carpet and roofing materials. By this time, however, hand papermaking was almost extinct.

In the 1920’s, Dard Hunter worked to revive the art of making paper by hand. He traveled the world studying how people in other countries made paper. Today, artists all over the world make their own paper by hand. Many paper mills still operate this way, making unique papers that we all enjoy.

Many paper mills use modern versions of the Fourdrinier machine. But now they are the size of two football fields and can go as fast as 60 miles per hour! Scientists and engineers work everyday to improve the technology of papermaking to conserve energy and resources. Next time you pick up a paper cup, read a newspaper, or play a game of cards, imagine where that pieces of paper started: from a pulpy liquid of wood and recycled fibers to the products we depend on everyday.

A Renewable Resource

Today, the most common materials for papermaking are wood and recycled paper. Trees are grown on a tree farm, where they are cared for by foresters. Tree farms provide more than a renewable resource for papermaking. They are also home to many birds and small animals. Being a renewable resource means trees will grow and regenerate naturally under the care and supervision of an experienced forester.

**Cellulose Fibers**

Trees are harvested and sent to a paper mill by truck or railroad car. There they are cut, trimmed and placed in a dedarker drum. This barrel-shaped machine removes the bark from the trees by turning them over and spraying them with water. The bark will be recovered and used for fuel. The logs are then feed into the chipper, which uses spinning blades to cut the wood into approximately one-inch pieces suitable for pulping. The resulting wood chips are sent to the digester where they are pressure-cooked with a mixture of water and chemicals in a process called chemical pulping. Chemical pulping separates cellulose, the fiber necessary for making paper, from lignin.

**TREE TRIVIA**

Did you know?

- Each year, the U.S. forest community plants some 1.5 billion seedlings. That’s an average of more than 4 million new trees planted every day!
- More than 5 new trees are planted each year for every man, woman and child in America, and millions more regrow naturally from seeds and sprouts.
- There are more trees in America today than there were 70 years ago.
- About 33% of the U.S. land area, 737 million acres, is forest land.

Cellulose is found in the cell walls of plants, and is held together by lignin, a natural “glue.” Mechanical pulping is a process of pulping where lignin is left in with the cellulose fibers. Newsprint is one type of paper made from mechanical pulp. How can you tell? Lignin causes paper to turn yellow over time. Mechanical pulp paper will turn yellow faster than chemical pulp paper due to the presence of lignin.

**From Pulp to Paper**

The pulp is now ready to be made into paper! At this stage, the pulp is 99.5% water. The pulp is sent to the headbox of the paper machine where it is held before being poured or sprayed onto the forming board. The forming board is made up of a plastic screen and moves very quickly. The forming board allows the water to drain through; leaving behind a complex web of fibers called paper. The forming board leads to the press section, where the paper is pressed flat and half of the water is squeezed out and recycled. Now the pulp begins to look like a sheet of paper. The paper passes through a series of large metal rolls heated with steam called drying cylinders. Once the paper is dry, calendar rolls iron it to make it smoother with a uniform thickness. The paper is then wound into a paper reel. A reel may be as wide as 30 feet, and weigh up to 25 tons!

**PAPER JAM!**

Can you find these words in the Paper Jam? Remember that they could be upside down, diagonal and backward!

- PAPER
- REEL
- LIGNIN
- WOOD
- DIGESTER
- CHIPPER
- CELLULOSE
- HEADBOX
- PULP
- SLURRY

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The Robert C. Williams American Museum of Papermaking

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Recycling

Today, people are worried about running out of space in our landfills. When wastepaper is put into garbage bags, it usually ends up sitting in a landfill. Landfills simply do not have the sunlight, water and air necessary to disintegrate the waste. Scientists digging deep inside landfills have found newspapers and even hot dogs that were 20 years old and still in good shape! In 1995, about 30% of the trash we dumped in landfills were paper, a total of almost 51,380,000-tons each year. You alone can produce more than two pounds of wastepaper everyday!

But what really happens to a piece of paper after you put it in the recycle bin?

Recycling paper simply means taking old paper and making it into new paper. In 1994, 40% of fiber for papermaking was recovered. Recovered means it was removed from the waste stream and recycled. By the year 2000 we recycled 50% of all paper used in the United States.

Steps to Recycling Paper

First, paper is collected from your recycle bin and taken to a warehouse. There, the paper is sorted according to type and placed in large bundles called bales. You can help by pre-sorting your papers. For example, separate newspapers from magazines, and office papers!

The bales are sent to a paper mill to be re-pulped. The recovered paper is placed in a large vat called a pulper with a mixture of water and chemicals, chopped into small pieces, then heated to help break the paper back down into cellulose fibers.

The pulp is then screened and cleaned to remove contaminants that cannot be recycled with paper, such as food, staples, adhesives and paper clips.

Ink is removed from recycled pulp through a process called Flotation Deinking (de-inking). Once contaminants are removed, the pulp is mixed with water, air and sticky chemical soaps that create air bubbles. Ink sticks to the bubbles and float to the top where they are removed.

The pulp is then sent to the headbox of the paper machine to be made into new paper!

WORD RECYCLING
Unscramble the recycling terms below

EINDGNKI

EPUDPRLE
**How much paper do YOU use in a day?**

Want to find out? Start a list of everything you use that is made out of paper for one day, from the moment you wake up in the morning until you go to sleep at night.

Compare your list with the lists of your classmates, then answer the questions below.

1. List 4 different types of paper you used in one day on the lines provided

   ______________________________________

   ______________________________________

   ______________________________________

   ______________________________________

2. Paste and label a sample of each type of paper you listed in the boxes.

   ______________________________________

   ______________________________________

   ______________________________________

   ______________________________________

3. What type of paper did you use the most?

   ______________________________________

4. What type of paper did you use the least?

   ______________________________________

5. What types of paper did you recycle?

   ______________________________________

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**Use this list of products as a guide to finding out how much paper YOU use in a day!**

- Paper towels
- Toilet paper
- Baby wipes
- Playing cards
- Lollipops sticks
- Tickets to the movies
- Seedling containers
- Carry out food trays
- Paper dolls
- Paper airplanes
- Coloring books
- Money
- Diapers
- Bandages
- Pizza boxes
- Post-it notes
- Construction paper
- Stamps
- Tags
- Calendars
- Boxes
- Magazines
- Books
- Newspapers
- Masking tape
- Counter top laminates
- Vacuum cleaner filters
- Wrapping paper
3rd grade social studies

Strand: Geography

12. Topic: Map and Globe Skills
   *Standard:* Determines the purpose of a map by examining title and content.

   *Standard:* Recognizes how human actions and physical environments affect one another.

15. Topic: Map and Globe Skills
   *Standard:* Explains the purpose of a map scale; and calculates distance between points using map scale.

18. Topic: Location
   *Standard:* Names the Earth’s seven continents, four hemispheres, and four oceans.

Strand: Core Social Study Skills

24. Topic: Information Processing
   *Standard:* Gathers information through reading, listening, observing and surveying.

25. Topic: Information Processing
   *Standard:* Uses various print and non-print reference sources to locate information.

28. Topic: Information Processing
   *Standard:* Arranges events, facts, and ideas in sequence.

32. Topic: Information Processing
   *Standard:* Distinguishes between fact/opinion and fiction/non-fiction.

42. Topic: Civic Participation
   *Standard:* Shows respect toward others
3RD GRADE SOCIAL STUDIES

43. Topic: Civic Participation
   Standard: Observes set rules of procedures

46. Topic: Time and Chronology
   Standard: Relates cause and effect relationship among events and dates.

47. Topic: Time and Chronology
   Standard: Relates the past to the present in the study of change and continuity in human affairs.

49. Topic: Time and Chronology:
   Standard: Arranges in chronological order, a series of experiences.

53. Topic: Map and Globes
   Standard: Uses cardinal and intermediate directions on a map or globe.

57. Topic: Maps and Globes
   Standard: Uses length of familiar units of measure to determine distance on maps.

58. Topic: Maps and Globes
   Standard: Explains that a map scale compares a map distance with a real distance on the earth.

4TH GRADE SOCIAL STUDIES

4. Topic: Specialization and Interdependence
   Standard: Demonstrates how unequal distribution of limited resources leads to specialization among individuals and regions of the United States.

6. Topic: Regions
   Standard: Identifies physical regions within the United States and describes major physical features of each region.

7. Topic: Map and Globe Skills
   Standard: Distinguishes between political and physical maps; devises maps to show when states were admitted to the union.

30. Topic: Information Processing
    Standards: Locates and utilizes information from a variety of sources, e.g books, newspapers, atlases, glossaries, photographs, laser-disks, computer software and others.

32. Topic: Information Processing
   Standard: Arranges time-related events into chronological order, using timelines when feasible.
38. **Topic:** Information Processing  
   **Standard:** Makes predictions and comparisons based on factual information.

40. **Topic:** Problem Solving  
   **Standard:** Identifies and states a problem related to topic under study.

43. **Topic:** Problem Solving  
   **Standard:** Chooses a solution to a problem after supplying evidence.

44. **Topic:** Civic Participation  
   **Standard:** Follow established rules.

46. **Topic:** Civic Participation  
   **Standard:** Works in a group, following set rules of procedure to complete an assigned task.

52. **Topic:** Time and Chronology  
   **Standard:** Uses indefinite time concepts, such as long ago, before and after.

53. **Topic:** Time and Chronology:  
   **Standard:** Relates sequence and chronology in personal experiences.

54. **Topic:** Map and Globes:  
   **Standard:** Examines a map's context and title to determine it's purpose.

56. **Topic:** Maps and Globes  
   **Standard:** Compares maps and make inferences from them.

58. **Topic:** Map and Globes  
   **Standard:** Combines scale and direction to locate features on a map/globe.

60. **Topic:** Map and Globes  
   **Standard:** Explains that a map scale compares a map distance with a real distance on the earth.
5TH GRADE SOCIAL STUDIES

4. **Topic:** Contemporary United States  
   **Standard:** Explains how people in the United States participate in basic economic interdependence  
   - producing  
   - consuming  
   - exchanging  
   - investing, and  
   - specializing

9. **Topic:** Characteristics of Regions  
   **Standard:** Relates how natural resources and physical features influence human activity in each region of the United States.

10. **Topic:** Physical Characteristics Human, Environment Interactions Region  
    **Standard:** Examines how the natural resources and physical features influence human activity in each region of the United States.

11. **Topic:** Physical characteristics of Regions  
    **Standard:** Analyzes ecological problems arising in regions of the Unites States from the Industrial period to the present and evaluates proposed solutions.

6TH GRADE SOCIAL STUDIES

3. **Topic:** Cultural Geography  
   **Standard:** Identifies various ethnic groups in Americas, Europe, and Oceania, and describes their impact on the development of the regions (e.g., linguistic patterns and cultural contributions).

4. **Topic:** Cultural Geography  
   **Standard:** Explains how natural resources and physical features influence human activity in the Americas, Europe, and Oceania, and how human actions modify the physical environment.

5. **Topic:** Cultural Geography  
   **Standard:** Assesses cultural expressions of art, music, and literature.
6. **Topic:** Cultural Geography  
   **Standard:** Explains how social institutions (religion, government, and economics) influence the attitudes and behaviors of people.

8. **Topic:** History  
   **Standard:** Outlines the important historical developments of the Americas, Europe, and Oceania, and demonstrates how geographic factors influenced events and conditions.

10. **Topic:** Economics  
   **Standard:** Explains how people in all economic systems engage in basic economic activities: producing, exchanging, consuming, saving, and investing.

11. **Topic:** Economics  
   **Standard:** Identifies natural, human, capital, and entrepreneurial resources in the Americas, Europe, and Oceania.

13. **Topic:** Economics  
   **Standard:** Describes how major technological advancements have contributed to the standard of living of the Americas, Europe, and Oceania.

14. **Topic:** Economics  
   **Standard:** Identifies the three basic questions asked by all societies: What will be produced? How will it be produced? For whom will it be produced?

19. **Topic:** Information Processing  
   **Standard:** Analyzes artifacts.

20. **Topic:** Information Processing  
   **Standard:** Analyzes interpretations of the same event from multiple types of sources.

21. **Topic:** Information Processing  
   **Standard:** Makes predictions and comparisons based on factual information.

23. **Topic:** Information Processing  
   **Standard:** Formulates questions related to topic.

24. **Topic:** Information Processing  
   **Standard:** Determines adequacy, relevancy and consistency of information for justifying conclusions or generalizations.

25. **Topic:** Problem Solving  
   **Standard:** Identifies and defines a problem.
26. **Topic:** Problem Solving  
   **Standard:** Formulates possible alternatives or solutions to a given problem.

28. **Topic:** Problem Solving  
   **Standard:** Chooses a reasonable solution from among the various alternatives.

29. **Topic:** Problem Solving  
   **Standard:** Identifies areas for further study.

30. **Topic:** Civic Participation  
   **Standard:** Follows established rules.

31. **Topic:** Civic Participation  
   **Standard:** Shows respect toward others.

32. **Topic:** Civic Participation  
   **Standard:** Works within a group, following set rules of procedure to complete an assigned task.

42. **Topic:** Time and Chronology  
   **Standard:** Place events in chronological order; make timelines with sequencing dates.

### 7th Grade Social Studies

1. **Topic:** Physical Geography  
   **Standard:** Locates the countries of Asia, the Middle East and Africa on a world map.

2. **Topic:** Physical Geography  
   **Standard:** Using maps and globes, defines and locates climactic zones, physical features, and the physical processes that shape these features, in the Middle East, Asia, and Africa

3. **Topic:** Cultural Geography  
   **Standard:** Explains how natural resources and physical features influence human activity in the Middle East, Asia and Africa and how human actions modify the physical environment.

19. **Topic:** Information Processing  
   **Standard:** Analyzes artifacts

23. **Topic:** Information Processing  
   **Standard:** Formulates questions related to topic

25. **Topic:** Problem Solving  
   **Standard:** Identifies and defines a problem
26. **Topic: Problem Solving**  
   **Standard:** Formulates possible alternatives or solutions to a given problem

28. **Topic: Problem Solving**  
   **Standard:** Chooses a reasonable solution from among the various alternatives

30. **Topic: Civic Participation**  
   **Standard:** Follows established rules

31. **Topic: Civic Participation**  
   **Standard:** Show respect for others

32. **Topic: Civic Participation**  
   **Standard:** Works within a group, following set rules of procedure to complete an assigned task

34. **Topic: Civic Participation**  
   **Standard:** Formulates and defends position on an issue

35. **Topic: Civic Participation**  
   **Standard:** States reasons for an advocated position.

41. **Topic: Time and Chronology**  
   **Standard:** Place events in chronological order; make time-lines with sequencing dates.

**3rd Grade Science**

   **Standard:** Asks questions, classifies objects and events, communicates with others, makes inferences and predictions, uses estimation and measurement, uses evidence to construct explanations, makes sketches and diagrams to explain ideas, and organizes data into tables and charts to interpret and formulate simple hypotheses.

3. **Topic: Safety**  
   **Standard:** Identifies and practices accepted safety procedures in manipulating science materials and equipment.

4. **Topic: Activities/Tools**
**Standard:** Actively engages in the learning process via hands-on/minds-on science activities and experiences Uses appropriate tools to collect and analyze data and solve problems

**4TH GRADE SCIENCE**

1. **Topic:** Inquiry, Process Skills, and Problem Solving  
   **Standard:** Asks questions, makes inferences and predictions, uses estimation and measurements, uses evidence to construct explanations, makes sketches and diagrams to explain ideas, organizes data into tables and charts for interpretation, reads and interprets various types of graphs formulates simple hypotheses, identifies and controls a limited number of variables, and designs a simple experiment.

2. **Topic:** Reference Skills  
   **Standard:** Uses encyclopedia, science reference magazines, books and other media to obtain information related to science concepts.

3. **Topic:** Safety  
   **Standard:** Identifies and practices accepted safety procedures in manipulating science materials and equipment.

4. **Topic:** Activities/Tools  
   **Standard:** Actively engages in the learning process via hands-on/minds-on science activities and experiences. Uses appropriate tools to collect and analyze data and solve problems.

23. **Topic:** Ecology: Cycles of Matter and Glow of Energy  
   **Standard:** Describes relationships in living communities, changes that occur, and the impact of these changes. Constructs a model or diagram of a food chain/food web. Describes the impact of an interruption in the chain.

   **Standard:** Identifies how matter and energy do or do not cycle in an ecosystem. Describes how matter cycles in an ecosystem.

   **Standard:** Discusses the importance of recycling and identifies examples of recycled products. Identifies and collects examples of
materials that can be reused or recycled and those that cannot. Shows examples of products and materials that are biodegradable and those that are non-biodegradable.

5th Grade Science

1. **Topic:** Science Inquiry, Process Skills, and Problem Solving  
   **Standard:** Asks questions, makes and keeps records of observations, classifies objects and events, communicates with others, makes inferences and predictions, uses estimation and measurement, uses evidence to construct explanations, makes sketches and diagrams to explain ideas, organizes data into tables and charts for interpretation, reads and interprets various types of graphs, formulates simple hypotheses, identifies and controls a limited number of variables, and designs a simple experiment.

3. **Topic:** Safety  
   **Standard:** Identifies and practices accepted safety procedures in manipulating science materials and equipment.

4. **Topic:** Activities/Tools  
   **Standard:** Actively engages in the learning process via hands-on/minds-on science activities and experiences. Uses appropriate tools to collect and analyze data and solve problems.

5. **Topic:** Structure of Matter  
   **Standard:** Describes atomic structure of and relationship between atoms, elements, molecules and compounds. Uses models to identify electrons, protons, and neutrons as basic structural components of atoms. Shows relation of atoms and elements to molecules and compounds (models, diagrams, and formulas).

6. **Topic:** Structure of Matter  
   **Standard:** Investigates characteristics of length, mass, volume, density, alkalinity/acidity and temperature. Uses balance scales, thermometers, rulers, litmus paper and containers to compare characteristics of various objects.

7. **Topic:** Structure of Matter  
   **Standard:** Recognizes that elements can be organized in a systematic way (introduction to the periodic chart).

8. **Topic:** Structure of Matter  
   **Standard:** Differentiates between and describes physical and chemical
changes in matter. Identifies and demonstrates examples of physical and chemical changes.

6TH GRADE SCIENCE

1. **Topic:** Scientific Inquiry Process  
   **Standard:** Uses process skills of observing, classifying, communicating, measuring, predicting, inferring, identifying, and manipulating variables; recording analyzing and operationally defining, formulating models, experimenting, constructing hypotheses and drawing conclusions.

2. **Topic:** Safety Skills  
   **Standard:** Understands and applies laboratory safety rules and practices.

3. **Topic:** Standard International (SI) Measurements (Metric System)  
   **Standard:** Defines and identifies standards of measurement. Names the prefixes used in the SI system Identifies SI units and symbols for length, volume, mass, density, time, and temperature Converts measurements among related SI units. Uses appropriate tools for determining mass volume, temperature, density, and length.

5. **Topic:** Structure of Matter  
   **Standard:** Explains the properties and phases of matter, using as an example the composition and properties of water. Distinguishes between atoms and molecules and among elements, mixtures, and compounds. Describes the structure of elements. Describes the periodic table of elements and uses it to find information about an element. Distinguishes physical and chemical properties and physical chemical changes. Recognizes and writes common chemical symbols, chemical formulas, and chemical equations.

6. **Topic:** Structure of Matter  
   **Standard:** Analyzes the relationship of matter and energy. Describes how the molecular motion changes in each phase of matter.
Discusses the nature of freezing, condensing, boiling, and evaporating.

8. *Topic:* Motion, Forces, and Energy  
*Standard:* Describes how energy and work are related.  
- Distinguishes between kinetic and potential energy  
- Describes different forms of energy (e.g., mechanical, electrical, chemical, radiant, nuclear, etc.).  
- Describes how energy and power are related.

9. *Topic:* Motion, Forces, and Energy  
*Standard:* Defines speed as a rate.  
- Distinguishes between mass and weight.

11. *Topic:* Motion, Forces, and Energy  
*Standard:* Describes how particles of a fluid exert pressure.  
- States Archimedes' principle  
- States Bernoulli's principle and describes a way Bernoulli’s principle is applied  
- Explains how a hydraulic device operates.

12. *Topic:* Motion, Forces, and Energy  
*Standard:* Explains how machines make work easier.  
- Describes six different kinds of machines.  
- Recognizes the simple machines that make up a compound machine.  
- Describes the relationship between work, power, and time.

*Standard:* Investigates the characteristics, movements, and measurements of heat energy. Shows how heat causes matter to expand and contract.

18. *Topic:* Energy and Its Transformation  
*Standard:* Investigates the relationship between light and color.  
- Describes the differences among opaque, transparent, and translucent materials.

**7th Grade Science**

1. *Topic:* Scientific Inquiry Process  
*Standard:* Uses process skills of observing, classifying, communicating, measuring, predicting, inferring, identifying, and manipulating variables. Also uses recording, analyzing, and operationally
defining, formulating models, experimenting, constructing hypotheses and drawing conclusions.

2. **Topic:** Safety Skills  
   **Standard:** Understands and applies laboratory safety rules and practices.

### 3rd Grade Fine Arts

#### Stand: Visual Arts

15. **Topic:** Critical Analysis and Aesthetic Understanding  
   **Standard:** Distinguishes between original artwork and reproductions.

16. **Topic:** Critical Analysis and Aesthetic Understanding.  
   **Standard:** Discusses the purposes and function of art in today's world.

17. **Topic:** Critical Analysis and Aesthetic Understanding.  
   **Standard:** Examines other individual's reasons for preferences in artworks.

18. **Topic:** Historical and Cultural Context  
   **Standard:** Associates artworks of a particular style with the culture from which the work was produced.

19. **Topic:** Historical and Cultural Context  
   **Standard:** Examines other individual's reasons for preferences in artworks.

20. **Topic:** Historical and Cultural Context  
   **Standard:** Places selected art reproductions in chronological order based on information (clues) within the artworks.

21. **Topic:** Historical and Cultural Context  
   **Standard:** Examines other individual's reasons for preferences in artworks.

### 4th Grade Fine Arts

1. **Topic:** Artistic Skills and Knowledge: Creating, Performing, Producing  
   **Standard:** Creates artworks using the following properties of colors (e.g. hue, intensity, and value.

5. **Topic:** Artistic Skills and Knowledge: Creating, Performing, Producing  
   **Standard:** Emphasizes specific elements of art and principles of design and selects materials and techniques appropriate to creating an artwork based on own idea and self-direction.

6. **Topic:** Artistic Skills and Knowledge: Creating, Performing, Producing.  
   **Standard:** Produces artworks in a variety of subject matter and in the areas
QCC Listing for Education Materials

of drawing, painting, sculpture, printmaking, pottery, fiber arts, and mixed media.

   Standard: Develops and applies criteria for judging personal decisions about artworks.

20. Topic: Historical and Cultural Context
   Standard: Matches a description of a culture with an artwork representative of the same culture.

   Standard: Explains how art reflects the relationship between artists and their culture, (e.g., geographic, political, religious, and economic.)

5th Grade Fine Arts

2. Topic: Artistic Skills and Knowledge: Creating, Performing, Producing
   Standard: Plans, organizes, and creates artworks using: form, color expressing emotion, linear perspective, proportion, and contrast.

3. Topic: Artistic Skills and Knowledge: Creating, Performing, Producing
   Standard: Creates artworks in the areas of drawing, painting, sculpture, printmaking, pottery, fiber arts, mixed media, and digital images.

4. Topic: Artistic Skills and Knowledge: Creating, Performing, Producing
   Standard: Creates a separate work of art that imitates nature (Realism), is concerned with design and composition (Structuralism/Formalism), expresses a feeling or emotion (Emotionalism/Expressionism).

5. Topic: Artistic Skills and Knowledge: Creating, Performing, Producing
   Standard: Demonstrates proper care and safe use of art materials and tools.

8. Topic: Critical Analysis and Aesthetic Understanding
   Standard: Define characteristics of form as open or closed.

11. Topic: Critical Analysis and Aesthetic Understanding
    Standard: Illustrates how elements of art and principles of design are used in combination to create contrast in artwork.

15. Topic: Critical Analysis and Aesthetic Understanding
**Standard:** Develops, judges, and communicates personal decisions about artwork.

16. **Topic:** Critical Analysis and Aesthetic Understanding  
**Standard:** Supports a personal position on the “big” questions about art (e.g., Why do people create art? Why are certain objects considered art and others are not considered art? How do we justify judgments about what is art? Must art be beautiful? Does art have to be functional? If it is in an art museum, does that make it art?).

17. **Topic:** Historical and Cultural Context  
**Standard:** Interprets artworks from selected periods of art based on historical facts, theories, and other information compiled by historians.

19. **Topic:** Historical and Cultural Context  
**Standard:** Explains how particular technological advances change the way an artist works, such as the invention of steel and the architect; the computer and digital artist, architect and graphic designer; the camera and the photographer.

**6th Grade Fine Arts**

1. **Topic:** Artistic Skills and Knowledge: Creating, Performing, Producing  
**Standard:** Plans and creates artworks using the principles of design to organize the elements of art for creating a composition.

2. **Topic:** Artistic Skills and Knowledge: Creating, Performing, Producing  
**Standard:** Creates artworks to depict a mood, emphasize the effects of light as reflected off surfaces and within the atmosphere, or demonstrate proportion.

3. **Topic:** Artistic Skills and Knowledge: Creating, Performing, Producing  
**Standard:** Uses art materials and techniques.

5. **Topic:** Artistic Skills and Knowledge: Creating, Performing, Producing  
**Standard:** Creates a series of artworks that is concerned with design and composition (Structuralism/Formalism).

6. **Topic:** Artistic Skills and Knowledge: Creating, Performing, Producing  
**Standard:** Demonstrates proper care and safe use of art materials and tools.

7. **Topic:** Connections
Standard: Applies concepts and ideas from another discipline and its topics as sources of ideas for own artworks.

9. Topic: Critical Analysis and Aesthetic Understanding
   Standard: Judges an artwork based on how successfully it expresses aspects of the society in which it was produced.

10. Topic: Critical Analysis and Aesthetic Understanding
    Standard: Examines selected artworks based on questions related to art theories such as:
                 Does the intent of the artwork seem to be to imitate? (Realism)
                 Is the artwork primarily concerned with design or composition? (Structuralism/Formalism).
                 Is the work trying to express a feeling or emotion? (Expressionism/Emotionalism).

12. Topic: Critical Analysis and Aesthetic Understanding
    Standard: Identifies the interrelationships between elements of art and the principles of design in artworks and the environment.

14. Topic: Critical Analysis and Aesthetic Understanding
    Standard: Recognizes how artists use selected subject matter, including symbols or ideas, to communicate a message.

15. Topic: Critical Analysis and Aesthetic Understanding
    Standard: Describes the expressive quality (feeling/mood) of artworks.

17. Topic: Historical and Cultural Context
    Standard: Locates, reads, and summarizes major points from historical accounts of artists and/or artworks indigenous to a specific culture.

18. Topic: Historical and Cultural Context
    Standard: Traces the development of selected art professions from past to present societies, such as painting, architecture, photography, printmaking, and graphic designing.

7th Grade Fine Art

3. Topic: Artistic Skills and Knowledge: Creating, Performing, Producing
   Standard: Uses art materials and tools

20. Topic: Historical and Cultural Context
    Standard: Compares and contrasts styles of selected artworks from Asia, the Middle East and Africa.
Inventory Checklist for Papermaking Workshop

✔ One 5-7 gallon plastic tub
✔ Molds and Deckles
✔ Pulp (either from linters or recycled)
✔ Shop Vac. (Wet/Dry)
✔ At least two couching sheets per participant
✔ Three rolling pins
✔ Three ironing boards
✔ Three (old) irons
✔ Nets to strain pulp
✔ Buckets (2-3)
✔ Normal typewriter paper and coloring supplies (depending on age of students)
✔ Convenient water source (or strong arms)
✔ Powerstrips and extension cords
“Hi Everyone, my name is __________” Today we are going to learn a little about papermaking. Who in here uses paper? {Pause for answer after questions} What do you use it for? Great. Does anyone know what paper is made of? That's right! Its usually made of trees. Is money paper? It sure is, but this paper is made of cotton and linen. Just like clothes. Who wants to make some paper? Alright let's get started. Everyone push up your sleeves and take off any watches or jewelry you have. Don't worry if the pulp gets on you, it will brush off when it dries.

This is called the vat. Who knows what the stuff floating around is? Its pulp. We are using cotton pulp today to make our paper. The first thing you do to make paper is dump a big handful of pulp into your vat. Then you stir it round and round and round with your hands. This is called “charging the vat”. Next, you take your mold and deckle and squeeze them together tight. Make sure your thumbs are on the wood, not the screen. Dip your mold and deckle into the vat, all the way to the bottom and bring it straight out of the water.

{walk around with the mold with the pulp on top and see how recognizable this product is to paper, ask the kids what it looks like}

Now, I am going to take the deckle off the top and take it to the vacuum, where ______ is going to help you.

After that take it to ________ and put a couching sheet on top. Can you say couch (koosh)? Carefully push the screen onto the couching sheet. It should come off. Turn the couching sheet paper side down and roll the remaining water out of the paper.

Now, we only have one big rule today and here it is. Hold up the hand you write with, now hold up the other one, put the other one behind your back. This is how you iron very carefully, with one hand behind your back so that you don't burn yourself or anyone else. Carefully iron your paper with the couching sheet still on. Then when it almost dry, peel the paper off the couching sheet and very gently iron your paper till its dry. There will be a grown up here to help you.

Its important to remember that your new paper is very delicate. That is why I have given you two pieces of typing paper each. Color on these sheets of paper and put your name on the outside so its like a folder. Everyone’s new paper will look the same and if you try to color on your new paper before its all the way dry it might tear.

All right, teachers if you can bring your students up in groups of five and escort them back as they finish we'll get started.”
To make pulp from linters:

- Get nice and sturdy paint buckets from a supplier.
- Tear the linter into 3 inch chunks and let sit in a bucket full of water.
- Next day, use a mud mixer attached to a drill to begin beating the pulp.
- Be careful and start slowly or you will be covered in pulp.
- The pulp is sufficiently beaten when it is dropped into clear water and looks cloudy rather than lumpy.

One linter makes one bucket, this bucket should last through four 30 person classrooms.

Cotton pulp can be stored no longer than overnight without refrigeration. It is a plant and will rot with the lack of additives.

Provide every student with two regular pieces of typing paper. This helps occupy them while the other students are making paper and also protects their paper when they are through.

Encourage everyone, even adults, to put their hands in the pulp.

Have a teacher or volunteer bring the students up in groups of five and get them seated again when done.

When purchasing a shop-vac, it is worth the money to invest in a quiet vacuum.

Remember to add pulp after every five or so students.

Students need to be reminded over and over again that their paper is fragile and cannot stand rough ironing or coloring.
Hints and Suggestions for a Successful Papermaking Workshop

Remember this is a wet activity. You will need towels, paper towels or sponges. A mop is also handy, if you are doing the workshop in a room that has carpeting, remember to lay down some sort of plastic drop cloth or mat, especially over any electrical outlet.

If you mess up your paper in any way, or make it on the wrong side of the mold, just turn it back over into the vat. This is called “kissing the vat”.

Additions:

- Only use metal glitter in your paper, as plastic will melt.
- Test dried flowers before using them by soaking them to see if their color bleeds.
- It is easy to dye handmade paper by putting water and colored construction paper into a blender.
- Experiment with different grasses and pine needles.
- If an item is too large to suspend in the pulp, it can be “sandwiched” between two pieces of just pulled paper.

Hand Papermaking Glossary

**Beating**: Process of macerating materials into pulp using either hand or mechanized methods.

**Casting**: Making a dimensional surface or copy of a form by applying prepared wet pulp, then letting dry.

**Cotton Linters**: Cotton fibers too short for thread-spinning, but useful for making paper. This is what you have been provided.

**Couching**: Method of removing a newly formed sheet of paper from a papermaking screen onto a felt, couching sheet, in order to be dried.

**Couching sheet or felt**: reusable blotter sheet for couching new sheets from papermaking screens.
Hand Papermaking Glossary

**Deckle:** Sits on top of the mold and determines the sheet’s shape and size. The removable top part of a hand mold. Fits around the papermaking screen and keeps the wet pulp from running off the screen when lifted out of the vat.

**Fiber:** Material used to make paper, a cellulose fiber produced by a plant.

**Hand Mold:** In papermaking, a frame with screen mesh stretched across it. Used with the deckle to form the sheet of wet pulp.

**Pulp:** The material used for papermaking in their fibrous, disintegrated, wet state.

**Pressing:** In papermaking, submitting newly formed sheets to pressure in order to squeeze out excess water. We are going to do this with the iron.

**Recycle:** In papermaking, blending existing torn pieces of paper with water to disperse the fibers into wet pulp. The pulp is then used to make a new sheet of paper.

**Slurry:** Water with fibers or pulp in it.

**Vat:** The container which holds the slurry (pulp and water), must be large enough to accommodate the mold and the papermakers’ hands.

**Watermark:** An image seen in a sheet of when held up to the light. Usually a logo or other image placed by the papermaker while the sheet is in its wet state.

Resources for the Hand Papermaker - Books of Papermaking Art and Education


Robert C. Williams. American Museum of Papermaking
http://www.ipst.gatech.edu/amp

Affiliates

Crane’s Store online
http://service.bfast.com/bfast/click?bfmid=37920249&siteid=39154851&bfpage=home

Teaching Resources

TAPPI Paper University http://www.tappi.org/paperu/welcome.htm

Members Pages

The Menil Collection http://www.neosoft.com/~menil/default.html

Associations

American Forest & Paper Association http://www.afandpa.org/
Dard Hunter Studios http://www.dardhunter.com/
The Friends of Dard Hunter http://www.friendsofdardhunter.org/
The International Association of Hand Papermakers and Paper Artists http://www.design.dk/org/iapma/
International Association of Paper Historians http://www.paperhistory.org/
JapanFest Atlanta http://www.japanfest.org/index.new.php
Papermakers of Victoria http://home.vicnet.net.au/~papervic/
Paper Online http://www.paperonline.org/
The Roycrofters http://www.roycroft.com/
San Diego Book Arts http://www.sandiegobookarts.com/
Technical Association of the Pulp and Paper Industry
http://www.tappi.org/

Other Interesting Web Sites

Scull Shoals
http://www.scullshoals.org/

Georgia Forestry Association
http://www.gfagrow.org/default.asp

Carriage House
http://www.papermakinghistory.org/index.html

Museums & historic Papermills – directory around the world
http://www.asv.at/difr/mus.html

Columbia Center for Book and Paper Arts
http://www.colum.edu/centers/bpa/

PanAsia Paper Museum

Paper Airplane Museum

Paper Museums

Awagami Factory http://www.awagami.or.jp


Crane Museum of Papermaking http://www.crane.com/about/museum

Gomez Mill House http://www.gomez.com

Hansol Paper Museum http://www.papermuseum.co.kr
Resources for the Hand Papermaker - Web Sites

**Historic Rittenhouse Town** http://www.rittenhousetown.org

**Japan Paper Museum, Kochi**
http://www.isei.or.jp/Paper_Museum/Paper_Museum.html

**Museum Rijswijk presents the Holland Paper Biennial**
http://www.museumryswyk.nl/

**Paper and Watermark Museum, Fabriano, Italy** http://www.museodellacarta.com/


**THE ‘MUSEO CARTACEO’, or ‘Paper Museum’**
http://www.britac.ac.uk/arp/pozzo/

**Papermaking and Book Arts Schools**

**Corcoran College of Art and Design** http://www.corcoran.edu

**Dieu Donne Papermill** http://www.dieudonne.org

**Penland School of Crafts** http://www.penland.org

**SUNY Buffalo Printmaking** http://128.205.120.196/printmaking/index.html

**The University of Alabama Book Arts Program** http://www.bookarts.ua.edu/

**The University of Iowa Center for the Book** http://www.uiowa.edu/~ctrbook/

**Paper History**

**The Whatmans and Wove Paper**
http://www.wovepaper.freeserve.co.uk/what_s_new.html

**Wookey Paper Mill** http://www.wookey.co.uk/papermil.htm
Bibliography of Papermaking

Hand Papermaking Magazine http://www.handpapermaking.org

Papermaking Suppliers

Twinrocker Papermaking http://www.twinrocker.com

Papermaking Supplies eBay Store http://www.ebaystores.com/papermakingsupplies

Hand Papermakers

Joan Giordano http://www.joangiordano.com

Kyoko Ibe http://www.kyobeibe.com

Steve Miller http://www.bookarts.ua.edu/miller01

Susan Olsen http://www.thepaper-isapainting.com

Lynn Sures http://www.lynnasures.com

Watermarks
Thomas L. Gravell Watermark Archive http://www.gravell.com