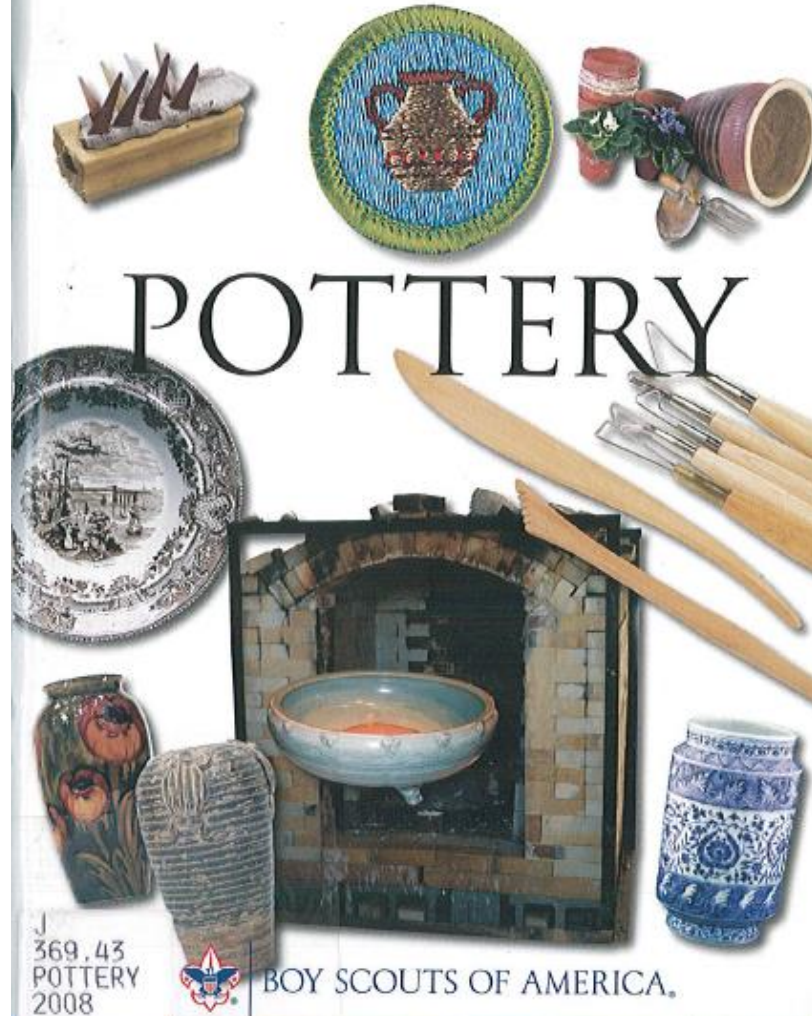


MERIT BADGE SERIES



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POTTERY
2008



BOY SCOUTS OF AMERICA.

Requirements

1. Explain to your counselor the precautions that must be followed for the safe use and operation of a potter's tools, equipment, and other materials.
2. Do the following:
 - a. Explain the properties and ingredients of a good clay body for the following:
 - (1) Making sculpture
 - (2) Throwing on the wheel
 - b. Tell how three different kinds of potter's wheels work.
3. Make two drawings of pottery forms, each on an 8½-by-11-inch sheet of paper. One must be a historical pottery style. The other must be of your own design.



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4. Explain the meaning of the following pottery terms: bat, wedging, throwing, leather hard, bone dry, greenware, bisque, terra-cotta, grog, slip, score, earthenware, stoneware, porcelain, pyrometric cone, and glaze.
5. Do the following. Each piece is to be painted, glazed, or otherwise decorated by you:
 - a. Make a slab pot, a coil pot, and a pinch pot.
 - b. Make a human or animal figurine or decorative sculpture.
 - c. Throw a functional form on a potter's wheel.
 - d. Help to fire a kiln.
6. Explain the scope of the ceramic industry in the United States. Tell some things made other than craft pottery.
7. With your parent's permission and your counselor's approval, do ONE of the following:
 - a. Visit the kiln yard at a local college or other craft school. Learn how the different kinds of kilns work, including low fire electric, gas or propane high fire, wood or salt/soda, and raku.
 - b. Visit a museum, art exhibit, art gallery, artists' co-op, or artist's studio that features pottery. After your visit, share with your counselor what you have learned.
 - c. Using resources from the library, magazines, the Internet (with your parent's permission), and other outlets, learn about the historical and cultural importance of pottery. Share what you discover with your counselor.
8. Find out about career opportunities in pottery. Pick one and find out the education, training, and experience required for this profession. Discuss this with your counselor, and explain why this profession might interest you.

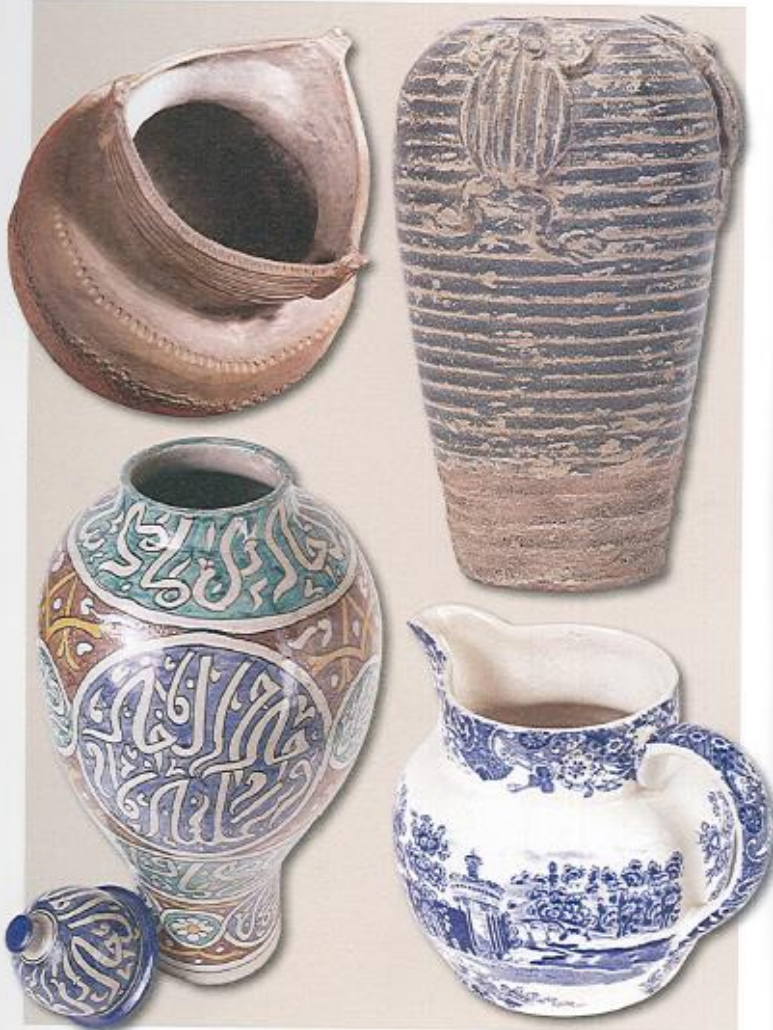




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Introduction

Consider this *Pottery* merit badge pamphlet an introduction to pottery making, a potter's tool in its own right to help you understand the process and learn some of the language. The greater part of your new knowledge will come with experience—the skill and understanding you will gain from actually creating pottery. You will be involved in hands-on production of a work of art, from start to finish.

The resources listed in the back of this pamphlet are good materials to help you learn. The local library is a good place to look for information. Many libraries have magazines about pottery making and ceramics with illustrated articles about techniques and design, tips for professionals and beginners, and advertisements from manufacturers and dealers of clay and supplies.

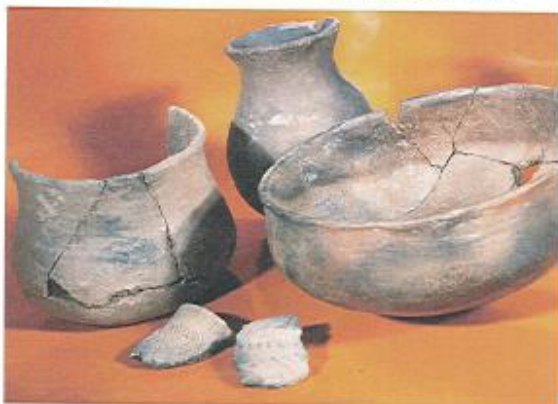
Before you discover the fun of sinking your hands into a lump of clay, here is a little background about and history of pottery.



Pottery has a language of its own. All the words you see in **boldface** appear in a glossary at the back of this pamphlet.

What Is Pottery?

Pottery can be defined simply as any item that is formed from clay then hardened by heat, and a bit more specifically as the baked-clay wares of the entire ceramic industry. As an art form, pottery is one of the oldest and most widespread in the world. In fact, archaeologists have uncovered pottery objects that have been on Earth almost as long as the human race, which places them among the oldest human-made artifacts ever found.



As you explore the world of pottery, you will discover that pottery making is as much science as it is art. The process is fun and challenging, and the end product can be as useful as it is beautiful. With your first pieces of pottery, be prepared to gain a greater sense of self-confidence and accomplishment.

There are three broad categories of pottery: **earthenware**, **stoneware**, and **porcelain**. Within each category are many different styles of pottery, each one unique, according to the type of clay used, the kind of **glaze** or decoration applied, and the **kiln** temperature at which it is **fired**. We have only enough space in this pamphlet to cover some of the most famous and most popular styles of pottery, and expand on the three main categories.

The Ceramic Industry

The term *ceramic* refers to any human-made solid produced from nonmetallic mineral substances—such as clay—by **firing** in a kiln. The ceramic industry provides much more than just dinnerware and decorative articles. Many manufacturing industries use or produce clay products including brick, sewer pipe, floor and wall tile, electrical porcelain, glass, abrasives, engine components, superconductors, rocket nose cones, and cements used in the construction of concrete roads, bridges, buildings, and dams.



The word *ceramic* has been traced back to an early Greek term, *keramos*, which means “pottery” or “potter’s clay.” *Keramos* is related to an ancient root word that means “to burn.” The Greeks used the term to mean “burned stuff” or “burned earth” when referring to articles they produced through the action of fire upon materials they dug from the earth.

Ceramics and Our Environment. Ceramics play an important role in our environment by helping to decrease pollution. The catalytic converters in cars and trucks, which are made of ceramics, help change harmful exhaust fumes into ordinary carbon dioxide and water. Ceramic engine components are lightweight and heat- and wear-resistant, which results in significant fuel savings, more efficient combustion and, ultimately, cleaner air.

Absorbent ceramics also are used in oil-spill cleanup equipment to help restore our environment after such a disaster.

Ceramics are even used to make musical instruments—ocarinas, whistles, flutes, and whistling jars.

Ceramics in Medicine. Ceramics are increasingly being used in medicine and dentistry. Special ceramic materials are being used for repairing and replacing human hips, knees, teeth, and even heart valves. Ceramic materials that are used in the human body, from replacement parts to coatings on metal replacements, can stimulate bone growth, promote tissue formation, and help protect the immune system. Modern ceramic materials are also used in ultrasound and X-ray computed tomography (CT) systems.



Ceramics play a significant role in NASA's space shuttle program. The shuttle has a protective shield made up of about 34,000 lightweight, reusable ceramic tiles that protect the astronauts and the shuttle's aluminum frame from the extreme temperatures generated as they pass through Earth's atmosphere.



The History of Pottery

No one knows for sure *how* the process of making pottery was invented, but for many years archaeologists throughout the world have been uncovering pieces of pottery from as far back as prehistoric times. Since the clay base of pottery does not react to chemicals and does not corrode like metal, cloth, or wood, these artifacts often are preserved nearly unchanged, while other items of the same age are at least partially destroyed. For this reason, pottery is used extensively by archaeologists to determine how ancient peoples lived their daily lives.

The First Ceramics

Archaeologists in the Czech Republic have uncovered human-made ceramics that they believe date to at least 24,000 B.C. These artifacts are in the form of slabs, balls, and animal- and human-shaped figures, and are made of animal fat, bone, bone ash, and a claylike material. It is not clear what these articles were used for, but they might have been used for ritualistic or religious purposes.



Scientists date this Chinese vessel, Western Han dynasty, to the second century B.C.

The earliest clay vessels were sun-dried, not fired. They probably were used to store only grain and other dry foods, because filling them with water would have caused the clay to absorb the liquid and soften. Not long after these first crude clay vessels were made, people learned how to use fire to make them stronger, harder, and more watertight.

Many scientists believe the discovery that fire could change clay into a useful, beautiful, and more durable vessel occurred independently among different cultures throughout the prehistoric world. This eventually led to the development of structural clay products, including brick and tile.

Many scientists believe that the oldest known functional pottery came from Neolithic cultures in Japan and Turkey. They believe dirt-brown pot fragments, or shards, unearthed from a cave in Kyushu, Japan, date to around 10,500 B.C. and were made by a fishing, hunting, and shellfish-gathering culture. This pottery is called Jomon, which means "cord markings," because much of it was decorated with cord patterns. Pot shards found in other Japanese sites are believed to be even older—by about 500 years. Pieces of crude, soft earthenware excavated from a Neolithic settlement on the Anatolian Plateau of Turkey are thought to be 9,000 years old.



Scientists date this example of Jomon pottery to be circa 5,000 to 4,000 B.C.

Neolithic means "new stone" and refers to the last period of the Stone Age, when people began to farm the land and raise livestock, and to make pottery.

How Was Pottery Discovered?

There are several theories about the long-ago discovery that fire could change clay into a material that would not dissolve in water. At least two of them involve the hunter-gatherers who lived at the beginning of the Neolithic stage of cultural evolution. During this time, cultures around the world gradually were changing from a nomadic lifestyle to a more settled one. The people were learning to raise crops and keep livestock. This new lifestyle not only created a necessity for food storage, but it also gave the people more time to pursue handicrafts such as weaving and pottery.



People in ancient times discovered that the intense heat from their fire pits caused the clay in the ground to harden.

You might wonder how these people came up with the idea of making pottery. One theory holds that these Neolithic families would often camp alongside rivers and build their fires in pits that they had dug into the clay banks. When the fires burned down, the people noticed that their pits had turned into hard, sunken "bowls" that could hold water.

Another theory involves Jomon pottery. To begin with, it is thought that Neolithic people had learned from their Stone Age ancestors to line their baskets with clay and then leave them to dry in the sun so that they would hold water—at least until the clay dissolved. Because some of the Jomon pottery has a basketlike texture, some scholars

believe that it might have originated when baskets lined with clay either fell into a fire or were intentionally used for cooking. The natural fibers of the basket would have burned away, leaving behind a crude and more watertight pot.

The Development of Glaze

The earliest pots were decorated with liquid clay **slip**, a mixture of clay and water that had a practical use of holding pieces of pots together. Another form of pottery decorating, **glaze**, was discovered around 2700 B.C. in Egypt. At the time, Egyptians found that the sand they used in making their pottery created a colored glaze when overheated in a kiln. By 1500 B.C., potters learned that by sprinkling their pots with powdered lead, they could produce a glaze that covered the piece.

Around A.D. 1500, German potters found that salt made an effective glaze. This was a major contribution to the evolution of pottery and would later play an important role in English and American ceramic industries.

The First Porcelain

Porcelain was developed and first produced in China between A.D. 618 and 906 to withstand the extreme temperatures of Chinese kilns. The ware was exported to Korea, Japan, and the Middle East, where it became immensely popular.

The Chinese potters continued to refine their ware and by the 13th century had learned how to use cobalt from the Middle East to make beautiful blue-and-white ware. When supplies from Persia were cut off by the emperor's ban on overseas travel, the potters began using copper in their glazes and enamels, which gave them a range of shades from blue to green. Eventually the Chinese potters added colors such as red, yellow, turquoise, deep violet, and purple to their pottery.

The highly prized Chinese porcelain had influenced Middle Eastern potters, and their product in turn greatly influenced European potters. Middle Eastern and European potters tried to imitate the blue-and-white porcelain, which had been widely imported into Europe. They developed a tin-based glaze that was bright white on buff or red clay bodies.



Ming porcelain from the early 15th century

Japanese potters succeeded in producing true porcelain in the 16th century, having been influenced by Chinese as well as Korean ware. However, it was not until the 18th century that true porcelain was produced in Europe—first in Germany, then in England.

Hard-paste, or true, porcelain was developed in China and gradually was exported to many parts of the world. Made primarily of petuntse (china stone) and kaolin (white china clay), the semitranslucent ware fired bright white and quickly became the envy of the Western world.

During the 16th century, Italian potters tried to imitate the semitranslucent Chinese porcelain and eventually developed soft-paste, or artificial, porcelain from a mixture of white clay and frit. This ware required a lower, or “softer,” firing than that required for hard-paste porcelain, which resulted in a softer, warmer body.

Pottery in North America

The Mimbres were a prehistoric North American people who lived in the mountains along the Mimbres River, in an area now known as southwestern New Mexico. They are famous for their beautiful black-on-white pottery.

The first potters in North America were Pueblo Indians, who made plain, undecorated pots. It is thought that the earliest pots were baskets that had been smeared with clay and then dried in the sun.

By about A.D. 1000, Mimbres potters used **slips** to decorate their pottery with black-on-white designs of insects, animals, birds, or geometric shapes. Over the next few hundred years, they introduced black decorations on a red slip. After the 12th century, they started replacing these older styles with polychrome ware decorated with stylized birds, feathers, animals, and human figures along with the geometric patterns.



Mimbres pottery

When European settlers first came to North America, they brought only woodenware and some pewter mugs and utensils. They did not have china as we know it today. In fact, household pottery was not in common use among the colonists until the late 17th century when a reddish slip-decorated earthenware was imported from England.

As English, Dutch, and German immigrants came to the New World, they brought their rich heritage of pottery making with them. Soon the colonists were buying earthenwares from local farmers who also worked as part-time potters. Only the well-off had luxurious, decorative ceramics imported from England, Germany, and China.

Although there were potters in the colonies, they were so busy making bricks and tiles to meet the urgent need for building materials, they didn't have time to make pottery.

The first American potteries were established in Virginia, Pennsylvania, and New York. The first whiteware was produced in 1684. A stoneware factory opened in New York in 1730, and in North Carolina, Jugtown pottery was first produced around 1750. Soon after, **terra-cotta** works began operating in Massachusetts and Pennsylvania. The first American porcelain was produced in Philadelphia in 1769.

The first of several famous potteries in Bennington, Vermont, opened in 1793. A pottery center in East Liverpool, Ohio, became established as one of the foremost in the industry by 1839. It was here that they produced the first American Rockingham ware, famous for its manganese-brown glazes.



Terra-cotta pots

Modern Pottery

In the 1900s, art pottery became very popular, and the influence of Oriental and European potters revitalized the studio pottery life beginning in about 1950. The 20th-century development of mass-production techniques and the use of synthetic materials did not diminish the demand for fine, handcrafted pottery. Major artists of the century, including Pablo Picasso and Henri-Émile-Benoît Matisse, produced exquisite ceramic works.



Historical Pottery Styles

Throughout the history of pottery, different cultures have developed individual styles, and from those styles, others have evolved.

Chinese. The Chinese were the world leaders in the production of beautifully glazed and decorated porcelain and stoneware. Some very early styles of imperial ware (porcelain made for and sponsored by the emperor's court) included a buff stoneware covered with a dense greenish-blue glaze, a stoneware washed with brown slip and glazed in colors that varied from pale green to lavender blue, and a dark stoneware with a grayish-white glaze. Most of these styles also had a well-marked **crackle** as a design element.

A style of imperial ware made during the Ming dynasty was the fine white porcelain painted in blue underglaze that made "china" a household word. Another very famous and prized Chinese pottery is celadon ware, which has a gray or grayish-white body with a transparent sea-green glaze and usually a well-marked crackle. Celadon ware was very important in China's trade with the Middle East because of the superstition that a celadon dish would crack, break, or change color if a poisoned food were served on it.

Chinese export porcelain includes most of the porcelain shipped from China from the 17th through the 19th centuries. It was specifically designed to appeal to the Western world; most of the styles were based on European pottery or metalwork designs or on a combination of Western and Oriental motifs. Blue-and-white decoration was the most common, but Chinese potters also were influenced by the Japanese Imari ware, imitating their blue, red, and gold patterns, among others.



Ming porcelain



This Imari dish is estimated to have been made in the early 1700s.

Greek. The pottery of early Greece was notable for its graceful use of human and animal figures. Commonly, the design was painted in shiny black pigment on the reddish clay body. The design was sometimes left unpainted on the red body and the black pigment was applied to the surface outside the design.





Imari ware is still made today.

In 1592, during the Japanese invasion of Korea, many Korean potters were taken back to Japan and put to work making porcelain for the traditional tea ceremony. These potters later helped to establish the Japanese porcelain industry.

Japanese. Japanese pottery was influenced by Chinese and Korean pottery. One style that became popular in the West is called Imari, a generic term for Japanese porcelain made in the Arita kilns on the island of Kyushu and shipped from the port of Imari. Imari ware is believed to date from 1616, when porcelain clays were discovered in Arita by Korean craftsmen.

Most early Imari work was blue-and-white only, but with the gaining popularity of Chinese porcelain, the

Japanese potters began to add gold and color enamels to porcelain decorated in underglaze blue. One common style was produced in red with touches of gold in imitation of some Chinese Ming porcelain. By the mid-17th century, native Japanese designs were introduced, and during that century Imari ware became so popular in Europe that even the Chinese, the English, and the Dutch imitated it.

Raku is a traditional Japanese pottery that was developed in the 16th century to replace the Chinese bowls that were being used in the tea ceremony. Traditional raku is still made today by the 14th-generation ancestors of the man who originated the technique. Potters throughout the world admire raku ware for its rugged shapes and soft lead glazes.

Raku ware is molded entirely by hand, which makes each piece a unique creation. The shape of traditional raku tea bowls was very simple: a wide, straight-sided, yet irregular form set on a narrow base. Raku glaze colors included dark brown, light orange-red, straw, green, and cream. The special firing technique used for raku ware produces unique characteristics throughout the glaze, and sometimes in the pottery itself. This technique sets it apart from any other type of pottery.



Black raku tea bowl, 16th century

Majolica. Majolica pottery is **bisque-fired** earthenware that is coated with an opaque white tin-based glaze then decorated with colorfully painted designs on the white surface before firing. Majolica was first made in the Middle East to emulate Chinese porcelain. Later, the technique spread to Spain (where it later came to be known as Talavera ware), then to Italy from the island of Majorca, Spain, where it got its name.

The tin-glazing technique used in majolica eventually spread to France, where it was called faience, and to the Netherlands, where it was called delft.



Majolica

Delft. The potters of Delft, Holland, decorated their pottery in imitation of Chinese porcelain and some Imari ware, usually in blue and white. They used the majolica technique of applying a white opaque tin-based glaze to earthenware, then painting and firing the piece. But there was a difference between the two in that cobalt was used as the main colorant in delftware.

From Holland, the art of tin-glazing earthenware was introduced to England. Generally, the Dutch and the English potters copied the Chinese motifs, but occasionally the Dutch delftware was decorated with landscapes and seascapes of windmills, dikes, and ships.

Della Robbia Ware. Luca della Robbia was a great Florentine sculptor in the 1400s. His beautiful glazed terra-cotta sculptures are most famous for the interesting effects he achieved from layering glazes.



Sculpture of Madonna by Luca della Robbia



Staffordshire ware

Jasperware was so named because it resembled the natural stone jasper in its hardness. Jasperware was the result of a long series of experiments in trying to discover the techniques of producing porcelain.

English. Staffordshire ware is a famous English stoneware that began production in the late 17th century in and around Staffordshire, England. The local abundance of coal and clay gradually turned a small community of farmer-potters into a substantial industry by 1740, and the area later became the center of England's pottery industry. The first products were lead-glazed earthenware and unglazed or **salt-glazed** stoneware. Porcelain was first made in Staffordshire around 1750.

John Astbury was a pioneer of English pottery technology and was one of the earliest great Staffordshire potters. It is said that he pretended to be an idiot so that he could learn the secrets of the craft from potters who had emigrated from Holland in 1688.

English potter Josiah Wedgwood started his manufactory in Staffordshire in the mid-18th century. By 1765, he was famous for his version of creamware, a lead-glazed earthenware that soon replaced tin-glazed ware in popularity. In 1775, he introduced jasperware, a fine-grained, unglazed stoneware adorned with white figures or Greek classical scenes in relief on soft or dark blue, sage green, lilac, black, or yellow backgrounds.



Jasperware

Before 1800, Josiah Spode II, also of Staffordshire, introduced bone china after successfully adding bone ash (ground bone) to porcelain clay, which strengthened the porcelain and gave it an ivory white look. Bone china is still one of the more popular types of porcelain. Some say it is the most successful English porcelain ever made.

English potters in the 17th century dug their clay from the roads so they could conserve land for cultivation. Eventually the roads became so dangerous that a law was passed to forbid the potters from continuing the practice. Many believe it was the potters' unpopular practice that gave us the term "pothole."

Sèvres. In the mid-1700s, King Louis XV sponsored a famous pottery in Sèvres, France, to produce extravagant dinner services, urns, centerpieces, and serving ware. Made of the highest quality soft-paste porcelain, Sèvres ware prospered and became widely known for its superb glazes and richly colored backgrounds in royal blue, turquoise, yellow, green, and rose. It was decorated with floral patterns and birds, often in white panels outlined in gold, and lavishly trimmed in gold on the edges, handles, and bases.

American Indian. This pottery often was **coil-built** and smooth, decorated with colored slips, and **burnished** before being pit fired. Common designs were geometric patterns or forms inspired by animals. Most American Indian pottery has continued in this style.



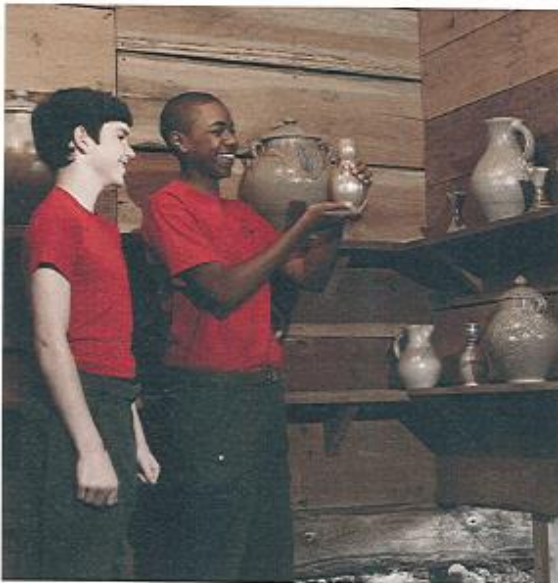
American Indian pottery



Pottery on Parade

To get a better feel for the long history of pottery making and the great beauty of the wares produced, visit a museum, art gallery, artist's studio, or other place where pottery is made or displayed. Many museums have large collections of ceramic works. Some exhibit modern ceramics; others specialize in early ceramics or the pottery-making traditions of different cultures.

Whether you see contemporary works of art or pottery shards from ancient civilizations, a museum visit is worthwhile. Look in the phone book under "Museums," or ask your merit badge counselor for advice.



You may be able to locate an artisan or a pottery studio or co-op in your community just by looking in the phone book under "Pottery" or "Art Galleries." A gallery exhibits and sells artists' creations. Look for a gallery that offers ceramics and pottery. Some represent only ceramic artists, while other galleries offer many kinds of art, from paintings and sculptures to jewelry and glass. Your merit badge counselor can help you arrange a visit.

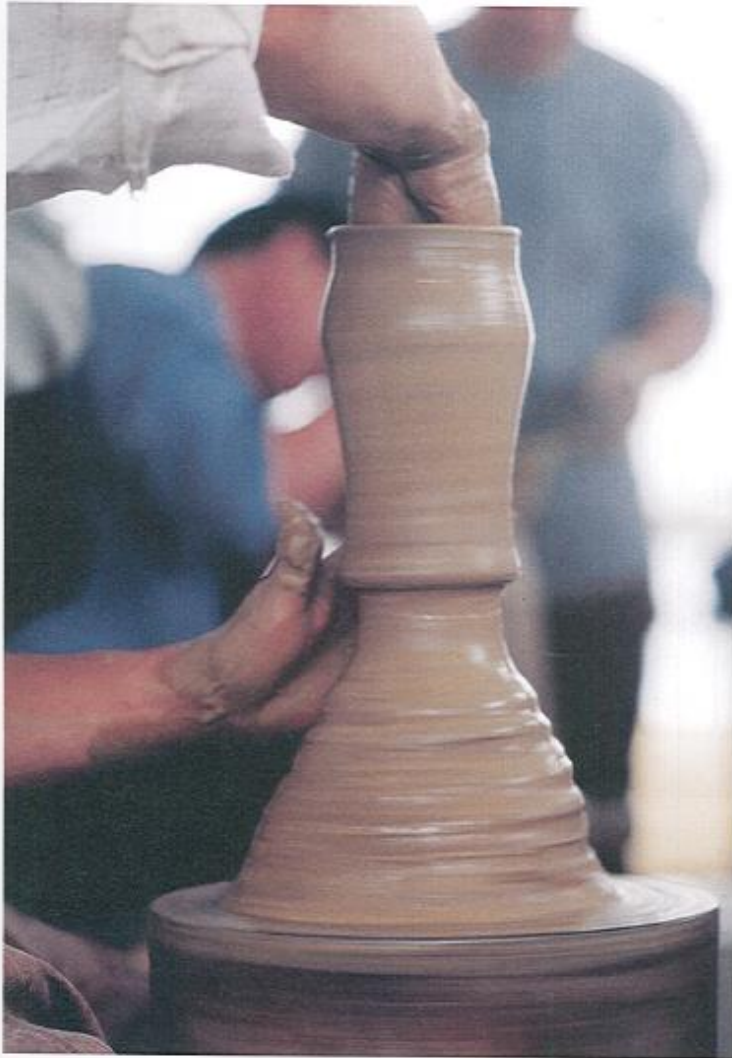
Your community may have an art fair or festival; check with your local or regional arts council or foundation. Such organizations often publish calendars of events. You may be able to find a local arts council listed in the phone book under "Arts Organizations."



No matter where you live, a festival or similar event is likely to be within reach. To widen your search, try these:

- At the public library, ask for information on arts festivals or organizations. The reference desk librarian may help you find calendars of events.
- Be alert to radio, television, and newspaper announcements about festivals, events, museum exhibits, and classes.
- Use the Internet (with your parent's permission) to locate nearby festivals. In a search engine, type in the city or state and the phrase "art festivals" or "art fairs."

If you cannot visit a museum or gallery or see hand-made ceramics at a festival or studio, learn from other sources about the historical and cultural importance of pottery. The resources section at the end of this pamphlet lists books, magazines, and Web sites that are good sources of information.



All About Clay

Clay is found almost everywhere, maybe even in your own backyard. It can be white, beige, buff, gray, green, red, brown, or, in rare cases, black. When moist, it is soft and malleable, which means it can be molded or modeled. Some potters get clay by digging it out of the ground, or they buy it from brickyards, potteries, ceramic factories, trade and crafts schools, hobby shops, or from other retailers of clay and ceramic supplies.



Clay can be created from inexpensive dry clay powder. The powder can cost a few cents per pound for common clay to around a dollar a pound for imported English porcelain.

Many suppliers advertise in pottery-related magazines; their ads explain how to contact them for a catalog.

Properties of Clay

Pure clay is made of chemically combined silica, alumina, and water. In its natural state, it is rarely pure and usually contains impurities such as sand, limestone, pebbles, iron oxide, and traces of other elements it has accumulated over the long period of time it has taken to become clay. These impurities—in any combination—provide the clay with a unique set of properties that make different types of clay useful for different purposes.

Pure clay, with little or no impurities, lacks some of the properties that a potter needs. One of these properties is plasticity, which refers to how well the clay holds a shape when bent or molded. Clay that cracks when bent around an object is called nonplastic or short.



The fired piece at left shows the effects of shrinkage when compared with an identical piece, right, which has not yet been fired.

Shrinkage is another property of clay. The process begins naturally as water evaporates from air-drying clay. During firing, further shrinkage occurs when the clay particles undergo chemical changes that cause them to fuse into a solid material.

The hardness, or strength, of a particular clay is another important property. It refers to how well the clay stays together when it is **leather hard**, **bone dry**, and in the fired state.

Color and texture are two more properties of clay. When planning pottery projects, you will want to know what color a particular type of clay will be when fired and whether it is coarse and rough or fine-grained and smooth.

One of the world's few natural sources of pure clay is in Cornwall, England, where there are vast deposits of kaolin, or china clay. The mining industry in that area creates huge heaps of mined clay that cause the local streams to run milky white in rainy weather.

Kinds of Clay

Choosing the type of clay for the project is the first step in making pottery. Choose from several types: kaolin, ball clay, stoneware clay, fireclay, and earthenware clay.



A kaolin mineral mine in Bulgaria.

Kaolin. Kaolin, or china clay, is a very pure form of clay, weathered from granite rock by water, dissolved carbon dioxide, and organic acids. It fires white in color and **vitrifies**, or becomes glasslike, at very high temperatures. Kaolin is an essential ingredient in high-fire whiteware and porcelain clay bodies.

Ball Clay. Ball clay, also weathered from granite rock, is a plastic, fine-grained cream- or white-firing clay. It is deposited by wind or water erosion in swampy areas where the organic acids and gases have broken it down into fine particles. Ball clay provides plasticity and dry strength in clay bodies. It generally can be fired to high temperatures, but it is rather sticky and shrinks more than other kinds of clay. Ball clay is not useful alone and is used only in combination with other clays.

The term "ball clay" has been traced to historic mining methods in England. The clay was scooped and rolled into balls of 30 to 50 pounds each and measuring about 10 inches in diameter, then wrapped in burlap for shipping.

Stoneware Clay. Stoneware clay is usable right from the ground as a **clay body**. Other clays and chemicals often are added to stoneware clay to introduce various properties such as color and texture and to affect **maturation** temperature. This clay will **vitrify** when fired at middle- to high-range temperatures. Some stoneware clays are smooth like ball clays; others are coarse like fireclay. Iron and other impurities color stoneware clay, which can be white, beige, buff, red, brown, gray, or, in rare cases, black. It usually has an attractive fired color.



Fireclay is widely used in making brick.

Fireclay. Fireclay has a coarse texture, but some fireclays are smoother than others. Fireclay can withstand high firing temperatures without disintegrating or deforming. Fireclay also is used in clay bodies to lend strength and decrease shrinkage. Coarse fireclays often are used for the gritty texture they add to clay bodies.



Earthenware Clay. Earthenware clay is found in every part of the United States and is often used in its natural form. Earthenware clays are usually full of iron impurities, which give it color but also cause it to melt at a low temperature. If left unglazed, earthenware is **porous** after firing and is useful for making flowerpots, tile, and brick.

Clay Bodies

Nature is not always kind enough to combine the right kinds of clay in just the right proportions for a specific ceramic purpose. An experienced potter mixes several different kinds of clay and other substances in specific proportions according to a formula, or recipe, to get a certain result. This mixture is called a clay body.

If you desire whiteness in your finished piece, use kaolin clay; for plasticity, add ball clay; for dry strength, fireclay; and for red color, earthenware clay. Chemicals also can be added to a clay body to make just about any color.

The terms "clay" and "clay body" do not have the same meaning. Clay is a naturally occurring material, but a clay body has been mixed from several clays and other ingredients. The difference is similar to the difference between flour and a cake mix. For your project, you can use a premixed clay body or mix your own to suit your needs, with guidance from your merit badge counselor or an experienced potter.

The Qualities of a Clay Body

When mixing a clay body, you need the right clay for the job. To do this, you must know which qualities the clay body must have for a particular project. For instance, any clay body must be plastic—it must hold together and bend and mold easily. In a clay body, the clay provides the plasticity. Also, the clay must be appropriate for the kiln. Some kilns will not produce the high temperatures required for some clays to **mature**. It also is wise to choose a clay that is easily available.

Next, a material must be added to help the clay melt into a solid material when fired. This is the **flux**. Flux is like the glue that holds the clay particles together when fired.

The final kind of material in any clay body is the **filler**. Fillers lend fired strength, determine **porosity**, and affect shrinkage. Very porous clay bodies usually contain sand or **grog**, which creates more space between their clay particles than between those of dense clay bodies that have no sand or grog. Porous clay bodies can be used to make bigger, thicker pots that will not crack, warp, or burst when dry or fired.



Kinds of Clay Pottery and Their Clay Bodies

Each of the three major types of clay pottery—earthenware, stoneware, and porcelain—are made by creating a unique mix—or recipe—for their clay bodies. The ingredients in the recipes are what give each type of pottery its distinguishing qualities.

Earthenware

Earthenware, the oldest and simplest form of pottery, usually is full of impurities that, aside from giving it color in ranges of buff to red and gray to black, cause it to mature at low temperatures. As a result, the clay does not completely solidify into a watertight state. For this reason, depending on the intended use, glaze can be applied inside and out.

Terra-cotta is a type of earthenware pottery. Common orange clay flowerpots are made from terra-cotta clay. Because of its attractive color, terra-cotta is often left unglazed. Throughout history, beautiful glazed and heavily decorated pots also have been made from terra-cotta. One example would be majolica, which is first bisque-fired, then covered with an opaque white tin glaze that is allowed to dry, and then over-painted with colored **oxides** before being fired a second time.

Here is one recipe for a white-colored earthenware clay body:

- + 30 percent plastic kaolin
- + 30 percent ball clay (the clays)
- + 40 percent talc (the flux)

And here is a terra-cotta earthenware recipe:

- + 15 percent ball clay
- + 15 percent stoneware clay
- + 40 percent earthenware clay (the clays)
- + 10 percent nepheline syenite
- + 10 percent talc
- + 10 percent borax frit (the fluxes)



Unglazed terra-cotta

Stoneware

Stoneware fires to higher temperatures, which leaves the surface very hard and **nonporous**. It is usually opaque, but when thinly potted can be somewhat translucent. Stoneware is more plastic than porcelain, which makes it much easier to use in **throwing** on the wheel or in **hand-building**. Some natural clays are stoneware, but often several clays are combined to make a stoneware clay body. Grog or sand can be added for wet strength.

Here is a good recipe for stoneware:

- + 18 percent ball clay
- + 55 percent stoneware clay
- + 12 percent fireclay (the clays)
- + 10 percent potassium feldspar (the flux)
- + 5 percent silica (the filler)



Unglazed stoneware

Porcelain

Porcelain is known for its beautiful, smooth, white surface when fired. Some kinds of porcelain objects are known as whiteware, including some restaurant and hotel china, fine china, and plumbing fixtures such as toilets and sinks. China is a kind of porcelain that has special properties. It is usually fired to a high maturing temperature before being glazed at a lower temperature.

A good mix for whiteware follows:

- + 55 percent plastic kaolin (the clay)
- + 25 percent potassium feldspar (the flux)
- + 20 percent silica (the filler)



The name "china" was coined by the British, who tried to imitate the porcelain made by Chinese potters. This piece is unglazed.

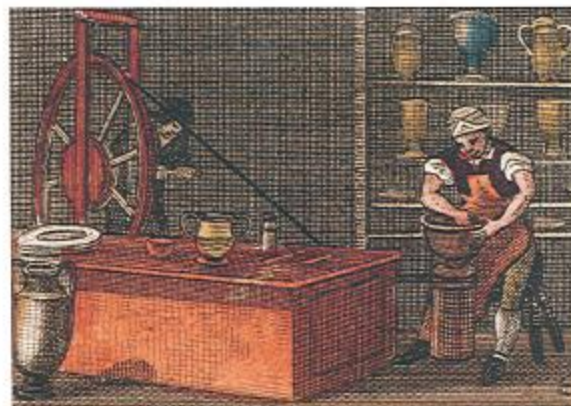


Equipment and Tools

While your hands and fingers can be used to make almost any kind of pottery, most potters also employ basic tools to create their works.

The Potter's Wheel

It is not known exactly when the potter's wheel was invented, but the earliest evidence of the device is shown in ancient Egyptian paintings. It is known that the potter's wheel was widely used in Egypt and Mesopotamia before 3000 B.C.



Early potter's wheels were just circular slabs of stone or wood that pivoted on a wooden axle so that the wheel head revolved freely in a horizontal plane. The wheel was hand-turned either by an assistant or by the potter moving a stick that fit into a notch on the wheel's surface. These wheels rotated very slowly and even wobbled a bit.

The wheel remained unknown in North America until the arrival of Europeans, although it is thought that the native peoples of this country might have used a turntable occasionally.



The power provided by electric wheels is helpful when making objects that require more than 15 pounds of clay.

In contrast, modern potter's wheels are precise machines that turn quickly and smoothly. Although there are many variations of each kind of wheel, three types are now most common: the kickwheel, the treadle wheel, and the electric wheel.

The first potter's wheel was turned by hand, which made for slow, difficult work. Next came the kickwheel, which was turned by foot. By the 18th century, the wheel was no longer powered by the potter's foot but by small boys who worked as apprentices to learn the pottery-making trade.

Kickwheel

The modern kickwheel usually has a heavy, round flywheel near the ground, with a shaft that connects it to the wheel head. The wheel head and shaft are usually made of metal, and the flywheel, either concrete or metal. Ball-bearing attachments fasten the shaft to a frame, which in most cases includes a seat.

To use a kickwheel, sit in the seat and turn the flywheel with your right foot, which turns the wheel in a counter-clockwise direction. The faster the flywheel is turned, the faster the wheel head turns. This fast foot motion is the "kicking."



Kickwheel

Treadle Wheel

A treadle wheel is similar to a kickwheel. It also has a flywheel (usually lighter weight), a shaft, and a wheel head. A treadle bar—a straight bar attached to a central point on the frame and to a cog on the flywheel—is pushed with the foot. It must be pedaled constantly, usually with the left foot, to keep the wheel rotating. The rhythm of the pedaling controls the rhythm of the throwing. Some treadle wheels have seats, while others are used while standing.



Treadle wheel

Electric Wheel

The electric wheel is popular with potters and is the type most commonly used at colleges and crafts schools. Electric wheels can be small and portable, and they usually have a foot pedal that allows the potter to control the speed. Most electric wheels do not have an attached seat.



Electric wheel

Tools

Potters use a variety of tools in their work. Perfectly wonderful pots can be made using only the most important tools—hands and fingers—but potters also enjoy using tools for various jobs. Pottery tools can be sophisticated or simple. For example, to **score** a clay surface, a serrated rib, a needle tool, a wire brush, a cork with sewing needles sticking out of it, or a kitchen fork could be used.



Ribs are tools used for shaping or for adding surface texture to clay articles. They can be made of wood, flexible steel, rubber, or plastic. Some creative potters cut ribs out of expired credit cards or from the sides of empty plastic detergent bottles.



Commercial tools

Carving and modeling tools come in an amazing array, and most are made of wood, metal, or plastic. Discarded (and sterilized) steel dental tools are excellent for detailing, as are wood-carving tools. Restaurant suppliers and hardware and kitchenware stores are great sources for tools that can be used in pottery making. Cookie cutters, molds, paddles, cheese slicers, sandpaper, utility knives, rasps, chamois cloth, wallpaper rollers, drill bits, soft paintbrushes, and sponges are just a few worth mentioning.

An experienced potter probably has collected a variety of tools, but beginners will do well with a basic tool set from a clay supplier. These sets commonly contain a sponge, a metal rib, a rubber rib, a metal loop tool, a wooden stick, a metal needle tool, a **fettling** knife, and a **cutoff wire**. Pottery tools should be kept handy and safe in a sturdy container.



Handmade and improvised tools can be found just about anywhere.

Potters use objects as tools in unusual ways.

For instance, small, very smooth river stones are useful for **burnishing** and **compressing** clay surfaces, as are spoons. Use seashells or pinecones to make interesting textures on pottery.

Kilns

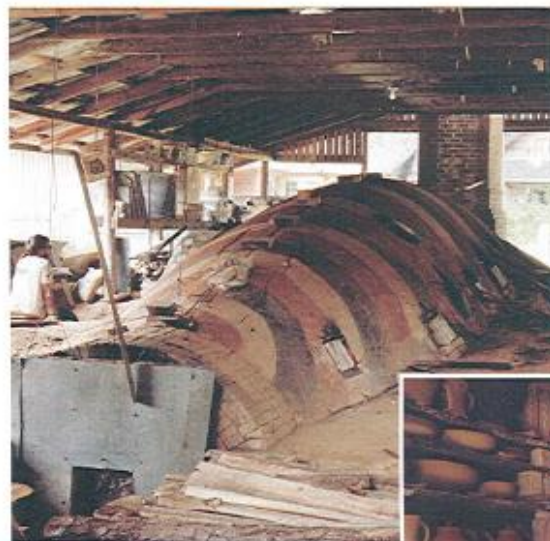
A **kiln** is a structure that generates and holds heat. The first kilns were just open trenches covered with firewood and a dome of broken pots to hold in the heat. Although today's kilns are more sophisticated, the principle is the same. Heat is introduced into the space where the clay articles have been placed. The temperature is raised and the amount of oxygen around the ware is controlled according to the needs of the clay and the glaze.



Electric Kiln

Electric kilns are popular and easy to use. Electricity generates heat from wire elements attached to the brick walls of the kiln. Because electricity generates the heat, the oxygen level in the kiln remains the same as in the atmosphere outside the kiln. This kind of atmosphere is referred to as neutral.

Electric kilns are commercially built of a soft brick that enables them to heat up and cool down quicker than fuel-burning kilns. It generally takes 10 to 20 hours for an electric kiln to reach low-fire temperatures and another 12 to 15 hours to cool.



Mark Hewitt's 900-cubic-foot kiln was modeled after a 14th century kiln from northern Thailand.



Fuel-Burning Kiln

Kilns also can be heated by burning oil, wood, natural gas, propane, or coal as fuel. Natural gas and propane are the most common fuels for these types of kilns. Fuel-burning kilns have in common several construction features:

- Entry ports for the fuel
- Controlled air intakes
- Interior baffles to deflect and spread the flame from its source
- Exit flues
- Dampers to control air flow
- Chimneys to draw air through the kiln



This loaded wood-burning kiln is ready to fire.



A typical fuel-burning kiln will take 12 to 24 hours to reach high-fire temperatures and another 24 hours to cool.

Wood is sometimes used as the primary fuel in a kiln. Wood gives a particular quality to pottery. As the wood burns, it creates ash that is so light it flows through the kiln and lands on the pottery, creating a special glaze. Also, the variable flame produced by the burning wood creates **flashing marks** on the pottery.

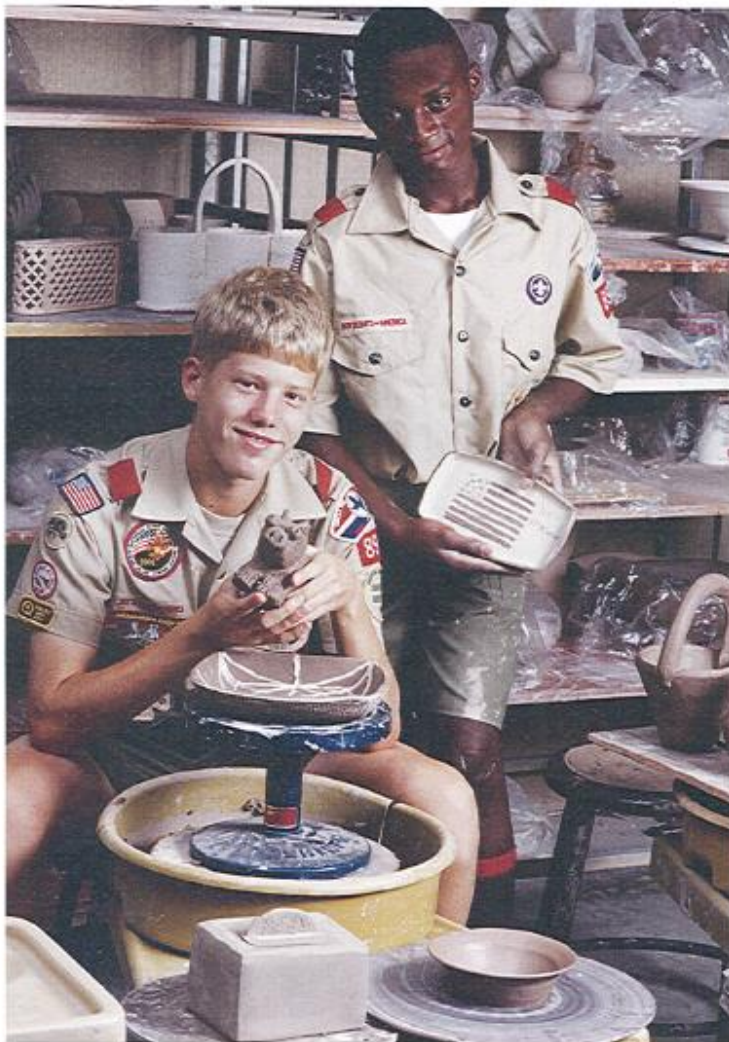
Wood-burning kilns need more open space around them than other fuel-burning kilns because the fire must be stoked regularly. Such kilns can be fired continuously for days. They also need larger fireboxes and chimneys and produce more smoke and fumes than other kilns.

Kiln Furniture

Kiln furniture is the shelves, posts, or bricks used to support clayware in the kiln. The items are made of ceramic **refractory** materials, which means that they are heat-resistant and will not melt. Kiln furniture is available in many shapes and sizes. Potters also use kiln accessories like steel-pointed stilts to raise pieces that have glazed bottoms.



Kiln shelves can be expensive, so it is wise to take care of them properly. Before use, make sure the shelves are dry and there are no cracks, and apply kiln wash to shelves for protection against glaze drips. Kiln wash is a thick solution of 2 parts kaolin and 1 part silica or alumina mixed in a bucket of water. Apply kiln wash with a brush or roller, to the tops of the shelves only, and allow it to dry completely before using the shelves in the kiln. Once the kiln shelves are protected, any glaze drips can be easily scraped away.



Pottery Projects

As with any project, you should know the general safety rules and the basics of the craft before you begin.

Handling Clay Safely

Clay dust can be a serious health hazard. A deadly lung disease called silicosis can be contracted from breathing in fine clay particles. It is very important to protect yourself whenever you are working with clay. Follow these guidelines at all times.

1. When using dry, bagged clay, wear a protective mask.
2. Do not sweep a dusty studio. Always wet-mop to prevent clay dust from flying into the air.
3. Do not use sandpaper or other abrasive materials to refine a pot unless you are wearing a protective mask.
4. Work outside when possible.
5. Do not eat or drink in an area where clay dust might be in the air or might be contaminated with chemicals.



Take care when using knives, needles, carving tools, scissors, and other sharp or pointed tools to cut and shape clay.

In rare cases, a skin rash called dermatitis can develop on the hands and arms from handling wet clay. This form of dermatitis is an allergic reaction to the clay. If you notice any redness, itching, tenderness, rash, swelling, or even a feeling of warmth in the exposed area, wash the affected skin thoroughly with lots of water, and avoid any further contact with the suspected irritant until you have seen a health-care provider. Do not try to treat the condition yourself; some remedies can actually make the condition worse, especially if overused. It is wisest to let a medical professional treat you.

You should learn and follow all pottery safety guidelines. People of all ages all around the world have found that working with clay is fun and rewarding—be sure to keep your pottery-making experience a safe one.

Getting Started

Before starting each project, think about the desired look and size of the finished piece. Sketch the design in actual size, and remember to allow for shrinkage. Be sure to design the piece so your fingers can reach inside.

Some potters like to use **templates** to help check their work as they build. Templates are easy to make. When you are satisfied with the shape and size of the piece, make a final drawing of it on cardboard, then cut the template from it.



Templates can be especially useful for geometric forms that fit together at precise angles, such as squares or parallelograms. If you decide to use templates, don't be afraid to change the design during the building process. In other words, don't limit your creativity just because you have made a sketch or a template of your design.

Another step to be done before you begin the project is to prepare the clay by thoroughly **wedging** and **kneading** it so that the moisture is evenly distributed and there are no air bubbles, lumps, or hard spots. The clay must have a consistent texture for it to be suitable for working.

Wedging Clay. Wedging is the first phase in preparing clay for pottery making.

Step 1—Use the cutoff wire to slice the block of clay into several uniform slices.



Step 2—Lay the slices down, turning every other slice sideways. Then, pick up the first slice and slam it down on top of the slice next to it. Slam the next slice on top of those two and continue until all of the slices have been slammed onto the stack.



Step 3—Reform the clay into a block (with the slices still alternately vertical and horizontal). Turn the block on its side so that the slices are perpendicular to the work surface, then repeat the slicing, turning, and slamming together until the clay is well-mixed.

Kneading Clay. One kind of kneading, known as “ox’s head,” “ram’s head,” or “dog’s head” kneading, is accomplished this way.

Step 1—Take a lump of clay the size of a grapefruit from its container and form it into an oval ball.



Step 2—Grasp the oval ball with both hands, one on each end. Press the heels of your hands downward and toward each other at the same time, pushing the clay into itself.

Step 3—Rotate the top edges of the clay forward with your fingertips and again press the heels of your hands downward and toward each other, pushing the clay into itself.

To get the proper consistency, you should repeat steps 2 and 3 about 40 times.

Slab Pottery

Clay slabs are simply sheets of clay; they can be of any size or thickness. The slabs are pieced together to make forms.

When working with slabs, pay attention to the amount of moisture in the clay. Low-moisture, stiff slabs will be difficult to curve without breaking, but they are good to use for making box-shaped forms. High-moisture, soft slabs will curve easily but might not stand up without complete support.

Forming a Clay Slab

There are three basic ways to form a slab.

Rolling by Hand. Begin by preparing the working surface. Spread out a piece of heavy fabric, such as canvas, to prevent the slab from sticking and to make it easier to move the slab to another working space. Flatten a ball of clay in the center of the fabric.



Using a rolling pin or other long wooden cylinder, roll along the surface of the ball to further flatten and smooth it into a slab. Some potters place guides at the sides of the slab to support the rolling pin and force the clay into a uniform thickness. These guides are made from wooden or metal strips that are at least $\frac{1}{4}$ inch thick.

Roll the slab on one side, then cover it with another piece of heavy fabric, flip it over, and roll it again. This action compresses both sides of the slab and strengthens it.

Throwing. This is just what it sounds like. Start by forming the lump of clay into a fat, bunlike shape. Grasp the clay in both hands, extend your arms out in front of you, then quickly throw the clay down on the table at an angle toward your body. This will cause the clay to spread in one direction and thin into a slab.

Rotate the clay 180 degrees and repeat the process to prevent the clay from becoming too thin in one direction. Repeat the slamming and turning until the slab reaches the desired thickness, commonly about $\frac{1}{4}$ inch.



Using a Mechanical Slab Roller. These rolling machines have a series of gears or cables and rollers that squeeze the clay into a uniform slab. They are expensive and difficult to repair, but they make uniform slabs quickly and easily.

To use a mechanical slab roller, prepare the clay by wedging it and flattening it into a thick pancake shape. Spread a piece of heavy fabric on the bed of the slab roller and place the clay pancake on top. Place a similar piece of fabric on top of the pancake, making sure that the fabric does not overlap the slab roller bed. The fabric will keep the clay from sticking to the bed or the roller.

Turn the handle of the slab roller to finish rolling the slab.



Generally, slabs must be made while the clay is soft and then allowed to dry out a little before use.