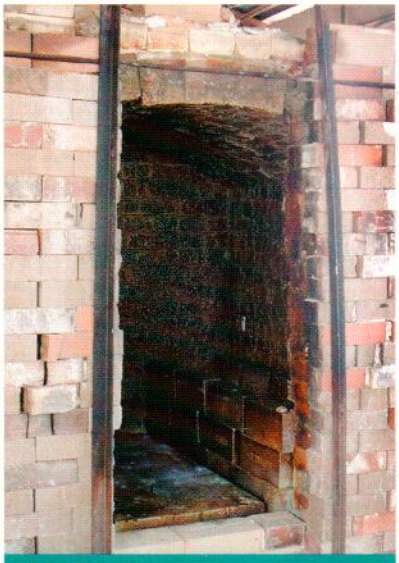
6 The Firing Process

The kiln is the potter's most important piece of equipment. Although you can make a clay pot or sculpture with only your hands, to create a durable ceramic form you must fire your work.

Whether simple or elaborate, the kiln should reasonably fit the needs of the studio or classroom. As a student, you may not be firing kilns initially; but you should have a basic understanding of the firing process, types of kilns, firing sequences, and the expected outcomes.

Kilns evolved from simple open-fire constructions that used grasses, wood, or dung for fuel to ones powered by oil, coal, wood, natural gas, propane, or electricity. Firing devices can be as primitive as a hole in the ground or as sophisticated as a computer-programmed structure.



kilns

variables

techniques

Fig. 6–2. Guardian kings ("lokapala"), commonly about three feet high and made from painted and glazed earthenware, were placed in the tombs of Chinese emperors and noblemen for protection in the afterlife. What kind of kilns do you think early Chinese artists used?
Chinese, Tang dynasty, *Lokapala*, 8th–9th cent.
Seattle Art Museum, Eugene Fuller Memorial Collection.
Photo by Paul Macapia.

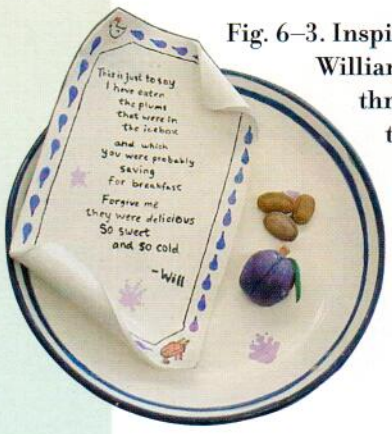


Fig. 6–3. Inspired by a William Carlos Williams poem, this work was thrown and hand-built, then glazed and fired in an electric kiln.
Dan daSilva, *Poem Piece*.
Slips, underglazes, cone 06 oxidation. Bellarmine College Preparatory, San Jose, CA.
Photo by Diane Levinson.

Common Kiln Types

When you start out, you will likely use the kiln in your school's clay studio. These powerful kilns can produce very high temperatures suitable for firing a wide range of clays and glazes. Most studio kilns are powered either by gas or electricity. Due to the high energy demand of kilns, it has not been easy to power them using solar or other alternative fuel sources—hopefully, this will change.

Safety Note Make sure indoor kilns and kiln areas are properly vented. Know where fire extinguishers are located and how to use them.

Electric Kilns

The electric kiln is simple to run and easy to manage. It is fitted with evenly spaced heating elements that encircle the firing chamber. Some electric kilns have built-in safety features like a timer and an automatic turn-off switch that activates when the desired temperature is reached.

Fig. 6–4. When stacking or loading an electric kiln, leave space between the walls and the ware. Nothing should touch the electrical elements (wires) in the kiln walls.
Richard Bersamina, teaching assistant.
Photo by Diane Levinson.

Electricity is much safer and cleaner to use than other power sources, but for indoor firing it is important to have good ventilation regardless of the power source. Gases such as sulfur and carbon monoxide are released during firings and must be removed from the indoor air.

Note It An electric kiln can be used for bisque as well as glaze firings. See page 161 to learn about the stages of firing.

Gas Kilns

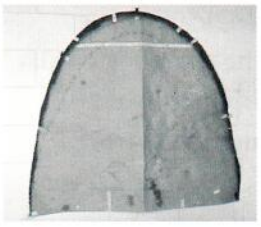
Gas kilns are fueled by natural gas that is delivered either via hookup to municipal utilities or from tanks similar to those used for liquid propane. These kilns are fairly easy to build and are usually made of soft brick or a special insulating fiber within a metal casing. Insulation makes the firing more economical and efficient: the kiln is heated and cooled more rapidly because it absorbs so little heat. Adequate ventilation is essential not only to disperse the exhaust gases, but also to avoid any dangerous buildup of fumes around the kiln.

Fig. 6–5. This car kiln can accommodate a large volume of work in a short amount of time. The housing sits on a track and can be wheeled back and forth over two beds. While one bed's load is cooling, the other can be stacked.
Photo by Maureen Mackey.

When loading the kiln, leave space between the ware and the chamber's walls to allow unrestricted circulation of heat and to prevent the burner flame from touching the pottery. With gas kilns, you can control the temperature by increasing or decreasing the amount of fuel during a firing. You can also restrict or increase the amount of oxygen (air) that flows through the chamber by closing or opening dampers (vents). See page 157, Atmosphere, for further information.

Safety Note Always leave the door ajar when lighting a gas kiln. If gasses build up in a closed area they can ignite and explode.

Fig. 6–6. Compare this work and the one by Jun Kaneko on page 152. How are they alike? Make a guess as to what kind of kilns Kaneko and Takaezu most likely use.
Toshiko Takaezu, *Untitled (Porcelain Form)*, 1989. Gas-fired, cone 10, 14¼" (36.2 cm) high, 7¼" (18.4 cm) diameter. Courtesy of the artist and Charles Cowles Gallery, NY.



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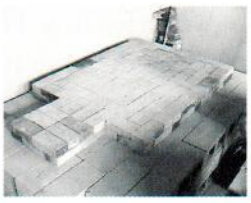

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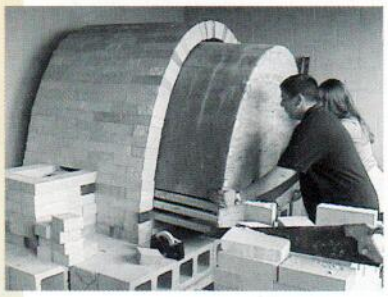

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Fig. 6–7. You can build your own kiln. This series of photographs shows students at Spruce Creek High School making a kiln that has now been in use for several years.
Photos by Timothy Ludwig.

1. A pattern attached to the wall where the kiln will be installed.

2. The brick floor, atop a cement block foundation.

3. Cutting notches in a plywood support panel.

4. Tim Ludwig (teacher) helps assemble the support.

5. Adding soft insulating bricks for inside walls and chimney.

6. Removing the wooden support from the kiln.

7. A thin layer of insulating fiber is placed over the soft bricks prior to adding a hard brick shell. Burner ports are left open.

8. Finished gas-fired kiln.

Try It Investigate and write a summary of what is needed to set up your own clay studio and market your work. Include the room size and ventilation requirements, utilities, materials and supplies list. Consider rent and location. Research how clay artworks are marketed in your area.

Variables in Firing

The type of kiln or fire used is only one aspect of the firing process that potters consider. Throughout history, potters have tried to control firing temperatures and gases. The more accurately potters monitored the heat in their kilns, the better they could gauge how the firing would proceed, yielding fewer broken pots and more beautiful glazes. Potters who could expertly manipulate the amount of oxygen and other volatile gases during the firing process could create stunning effects that increased the quality and value of their work.

Fig. 6–8. High-firing porcelain was considered to be extremely valuable in eighteenth-century Europe; in fact, King Louis XV personally oversaw the manufacturing facility that made this neoclassical vase.
France, *Sèvres Vase with Etruscan design*, c. 1785.
Chateau Fontainebleau, France. Photo: Lagiewski. Reunion des Musees Nationaux/Art Resource, NY.

Note It Two variables—atmosphere (gases) and temperature—affect the final outcome of a firing. As you fire your pots, try experimenting. Keep a record of your results.

Atmosphere

Chapter 1 talks about the historical development of kilns and how the manipulation of firing **atmospheres**, or mixture of gases, can complete the finished product (pages 14–17). Today, a potter can create a variety of glaze effects by controlling the kiln's atmosphere.

When fired in an *oxidizing atmosphere* (in which oxygen is admitted into the firing chamber), a glaze reacts to the oxygen in the air and produces a clear, brilliant color. The fire burns brightly and the clay body maintains a subtle, clear color as well.

In a *reducing atmosphere*, most of the air is shut off and the open fire is moderately smothered, causing incomplete combustion. Because the air is restricted, oxygen needed to feed the fire has to come from elsewhere. Oxygen is drawn

Fig. 6–9. In what ways are the pieces in this series alike? Does the title refer to function or form?
Gretel Walker, *Garlic*.
Wood-fired stoneware, 12" (30.5 cm) high (tallest). Stivers School for the Arts, Dayton, OH. Photo by Don Clark.

Fig. 6–10. The stirrup style of this vessel is pre-Columbian in origin. How is it similar to Fig. 1–9? How is it different? How do you think it was fired?
Edward Pina, *Untitled.*
Terracotta stirrup vessel, 14 x 9 x 7" (35.6 x 22.8 x 17.8 cm). Illinois Mathematics and Science Academy, Aurora, IL.

from materials (oxides) in the glaze and clay body—this action completely changes the color of the clay and glaze. Reduction allows for multiple glaze effects from different metallic oxides in the glaze mix. Wood or gas kilns are best for reduction firings.

Note It You can control the amount of air present in a firing chamber by manipulating the damper on a gas or wood kiln. Open it to create an oxidizing atmosphere; close it to create a reducing atmosphere.

Fig. 6–11. The glaze applied to this sculpture before bisque firing is known as "secret sauce." After firing, the artist brought out the colors by applying additional heat with a gas torch.
Patrick F. Kipp, *Nogard,* 2001.
Glazed, cone 06, 16" (40.6 cm) long. Shorewood High School, Shoreline, WA. Photo by Sally Tonkin.

Elements of Design

Color

Color appears when our vision responds to different wavelengths of light. The color spectrum, seen when a ray of white light bends while passing through a glass prism, represents the brightest colors possible. Visual artists work with colors less pure than those found in white light.

Many factors come into play to determine the final color of a ceramic piece. Glazes undergo chemical reactions when they are fired, and kiln temperature and atmosphere can affect colors in dramatic ways. Because colors resulting from a glaze firing can "make or break" the success of your work, it is important to learn about glazes. For example, mixing a blue glaze and a yellow glaze does not necessarily result in green, as it would if you were mixing paint.

Fig. 6–12. Describe the glaze effects seen in this set of sculptural pieces. How did the artist achieve these colors?
Travis Highley, *Coral Vessels.*
Stoneware, cone 10 reduction, 6 x 12 x 10" (15.2 x 30.5 x 25.4 cm). Stivers School for the Arts, Dayton, OH.

Temperature

Firing pots in a kiln is a little like baking cakes in an oven. But because of the intense heat generated in the firing chamber, you cannot open the door to check if the piece is done. Instead, potters use **pyrometers**—tools to gauge the firing temperature.

Note It Pyrometric cones are specially constructed ceramic pieces that show how much heat is absorbed in the clay body or glaze materials and thereby help measure the progress of the firing.

A pyrometer is a device specifically used to measure temperature. **Pyrometric cones** are made from a series of specially controlled ceramic formulas and are manufactured to soften and bend when a specific amount of heat has been absorbed. They are numbered to correspond to temperature and range from the lowest (cone 022) to the highest (cone 42).

Cone 017, for example, corresponds to a temperature of 1418°F (770°C). It will bend once that temperature is reached inside the kiln. Potters make a note of the temperature required to fire a certain clay or glaze. To tell when the temperature is at the right level, they look at the cone and see when it bends. Often, it's critical to turn the heat down or off once the target temperature has been reached. Without a cone, you won't know when to do this.

See the Appendix, page 188, for a chart of the cones that potters use, the temperatures they correspond to, and the type of clay or glaze that is best fired at that temperature.

Fig. 6–14. What does the structure around this clay figure suggest? Do you think this was fired in one piece or were the metal pieces added later? If it was fired in one piece, what information did the artist need to know before firing this sculpture?
Wendy Wutz, *Weeping Angel.*
Low fire with black stain, copper and steel wire, cone 04 glaze. Lancaster Central High School, Lancaster, NY. Photo by Ann Perry.

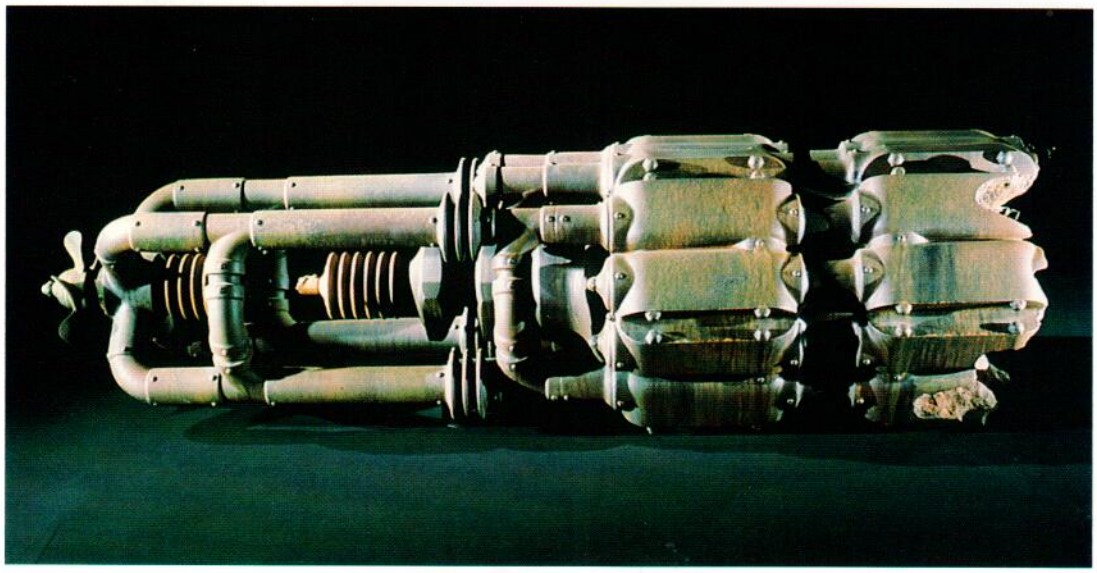

Fig. 6–13. Steven Montgomery combines hand-building, press-molding, and wheel-throwing in his sculptures of "fantasy machines." Why does firing at low temperatures best suit his work?
Steven Montgomery, *Partial Yield #3,* 1996.
Low-fired, painted, 19 x 71 x 21" (48.3 x 180.3 x 53.3 cm). Courtesy of O.K. Harris Works of Art.

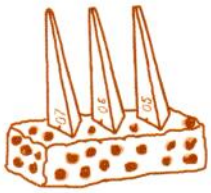

Fig. 6–15. Set cones in a "cone pack"—a wad of porous clay with holes poked in it to prevent cracking. Mount so that 2" (5 cm) of each cone is exposed above the clay, at an angle of 8°, and with enough space between them so they will not fall against each other.

Fig. 6–16. The guide cone has completely collapsed. The firing cone has bent to the correct curve. The guard cone remains in its original position. If the guard cone bends, you know you've fired too high.

Cones may be free-standing, or they may need to be propped in a cone pack (Fig. 6–15) to stand at the proper angle. Selection of cone numbers depends on the temperature needed to fire a certain clay body type (earthenware, stoneware, or porcelain) or glaze type (low or high fire). Three consecutively numbered cones are usually placed in the kiln opposite the peephole so you can tell when the kiln has reached the necessary heat for bisque or glaze firing.

The cone group is comprised of the *guide cone* (one number cooler than the desired cone), the *firing cone* (the desired cone for the target temperature), and the *guard cone* (one number hotter than the desired temperature). The firing cone should be placed in the middle between the guide cone and the guard cone.

Regularly check the cones as the firing progresses. When the guide cone begins to bend, indicating that you are close to the correct temperature, check the cones more frequently. When the firing cone bends, turn off the kiln and close all the peepholes (and close gas kiln dampers). If the guard cone bends, the kiln has been fired too high.

Safety Note Always protect your eyes with welding goggles or face shield when looking into a hot kiln. Sunglasses are not sufficient! Wear safety gloves whenever you handle the peephole plug during firing.

Fig. 6–17. Brilliant metallic imprints contrast with subtle and intense random shades of color that float like clouds on the surface of this SA-KU fired pot. See more about this firing technique in the Studio Experience on page 178.
Jerry Vaughan, *SA-KU Vessel*. SA-KU fired, 10" (25.4 cm) high, 8" (20.3 cm) diameter. Courtesy of the artist.

Fig. 6–18. Multiple firings at mid-range temperatures characterize Jean-Pierre Larocque's work. With each firing, the artist adds glaze and slip to achieve his desired effect.
Jean-Pierre Larocque, *Untitled (Horse)*, 2002.
Stoneware, 25½ x 27 x 11½" (65 x 68.6 x 29.2 cm). Courtesy of Dolphin Gallery, Kansas City.

Stages of Firing

A ceramic piece will usually be fired at least twice. The first time is the bisque firing. The second is known as the glaze, or *glost*, firing. Additional glaze firings are often done to achieve specific effects. Each type of firing has particular requirements from the beginning to the end of the process. Clay that has not been fired is known as greenware.

Note It When loading kilns, inspect the shelves for hairline cracks which can form over time due to stress. If you find one, put the shelf aside. Using a cracked shelf can result in extensive damage to pottery if it should break during the loading or firing.

Safety Note Always wear gloves when loading or unloading a kiln. Don't use your bare hands to brush a kiln shelf—sharp pieces of glaze adhering to the shelf can cut your fingers.

Bisque Firing

The bisque firing changes the chemical structure of clay and turns it to ceramic, but it also leaves the clay porous enough to soak up a liquid glaze. Moisture in greenware (unfired clay) causes the clay to expand when kiln temperatures are above the boiling point. This expansion sometimes results in explosions or cracking. For this reason, all greenware must be thoroughly dry before you load the kiln.

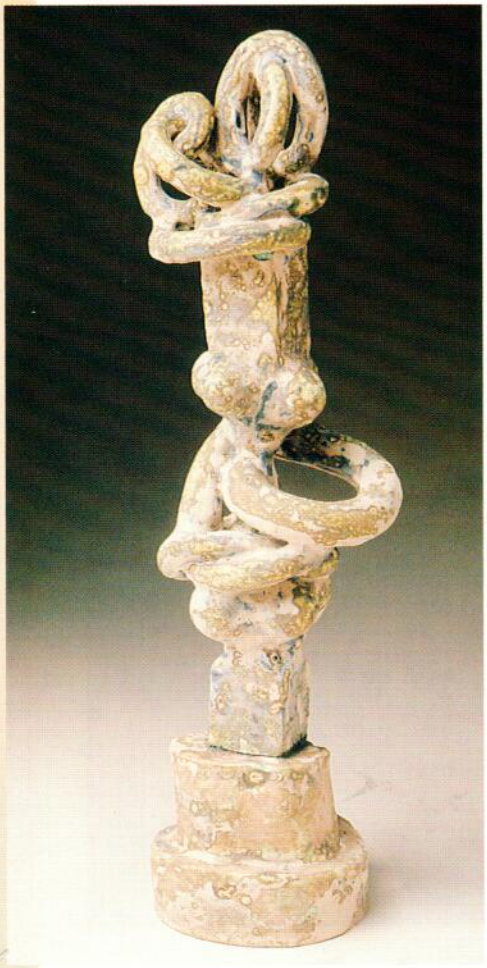

Fig. 6–19. Lisa Wolkow bisques her sculptures to cone 06, then applies white slip and refires to cone 06. She then applies glaze with a brush—a thin, even coat over the entire piece. The mottled results happen during the glaze firing, again at a temperature of cone 06.
Lisa Wolkow, *Guilford Seven #3*, 1999.
Earthenware, 16 x 5½ x 4" (40.6 x 14 x 10 cm). Courtesy of the artist.

Fig. 6–20. The three parts of this table were hand-built and fired as separate pieces. After decorating the bisqued pieces with airbrushed acrylic paints, the artist assembled the sections.
Maureen Mackey,
Tiger Table, 1987.
Hand-built, fired to cone 04, 42" (107 cm) high. Courtesy of the artist.

Fig. 6–21. How did the artist use relief and texture to create an interesting surface? Name some low-fire techniques one could use to fire a piece such as this.
Lexy Durik, *Timberland Deity*.
Slab-built, relief and textured surface. Whitmer High School, Toledo, OH. Photo by Corey Gray.

Start the firing slowly. In fact, it helps to preheat the kiln on the lowest setting for several hours, leaving the lid or door open. Increase the temperature gradually each hour until the color of the interior of the kiln turns a dull red. Put on heavy gloves to protect your hands, and close the lid. At this point, the atmospheric water in the clay converts to steam (between 950°F and 1300°F). Water leaves the clay along with any gases that are produced by the burning of organic materials in the clay. The temperature then can be increased more rapidly to cone 06.

Loading the Kiln for Bisque Firing

Have your teacher or another experienced person load the kiln when you first start out. Pottery can be loosely stacked to allow for the slight expanding and contracting movements that occur during the firing. Smaller pieces can be placed inside or on top of stronger, larger ones. Bowls and plates can be boxed or stacked lip to lip, tiles can be fired in stacks, and lidded vessels should be fired as one piece with the lid in place.

The elements of an electric kiln or the burner flames of a gas kiln should never come into contact with your ware. Shapes

that do not stack well should be set on shelves. Ceramic shelves and the posts that support them are known as *kiln furniture*.

Safety Note Check the area around the kiln for any combustible or flammable materials and move them well away. If you use a top-loading kiln, check the lid to be sure it is opened securely and locked in place. Test it every time you load or unload.

Loading requires a lot of bending, twisting, and lifting. Not only must you lift delicate ware into or out of the kiln, but you have to lift, fit, and stack the shelves in place as well. Follow these suggestions to reduce strain on your body:

- Bend your knees and keep your back straight when lifting objects.
- Lean against the edge of the kiln as you load or unload.
- Lift one leg as you lean over a top-loading kiln. This acts as a lever and helps you to balance.

Note It When you load a kiln, keep in mind that shelves and posts also absorb heat. Thick pieces, like sculpture, should be placed in the middle of the kiln shelf so they don't block smaller pieces from the radiating heat.

Fig. 6–22. Describe the steps you think the artist followed to construct these forms. How would you make the spouts?
Emily Collins, *Untitled*.
Stoneware, wheel-thrown and altered, cone 10 reduction, to 14" (35.6 cm) high. Stivers School for the Arts, Dayton, OH. Photo by Kim Megginson.

Glaze Firing

Once the pieces have been bisque-fired and glaze has been applied, they are ready for the glaze firing. It takes practice to become familiar with each kiln's peculiarities, especially for the glaze firing. Certain parts of the kiln can be hotter or cooler than other parts. Experience and observation help the potter to place pieces in compatible temperature zones. For example, round shapes can withstand higher temperatures, while shallow, wide vessels are likely to warp in the hot spots. Some glazes tend to overfire, while others can take stronger heat. Chemicals and temperatures affect color results.

Fig. 6–23. A textured stonelike low-temperature glaze containing trisodium phosphate (TSP) made the base for this spectacular surface design.
Jackson Medford, from *Desert Texture* series, 1985.
Incised design with brushed-on color (Mason stains in porcelain slip), cone 06, 24" (60.9 cm) high. Courtesy of the artist.

Fig. 6–24. How are shape, line, and space used to suggest rhythm and movement in this raku-fired teapot? What mood does it create?
Katy Vicory, *Untitled*.
Raku-fired, extruded, and hand-built teapot, 10½ x 13 x 3" (26.7 x 33 x 6.6 cm). Blue Valley High School, Stilwell, KS. Photo by Janet Ryan.

Preparing for Glaze Firings

Before loading the kiln, follow procedures that will protect your work and equipment. Glaze drips are difficult to remove from kiln shelves, but painting shelves with *kiln wash*—made from equal parts of kaolin and flint—will protect them from damage caused by melted glaze.

- Always inspect shelves for cracks before loading a kiln. Never use a cracked shelf in a setting.
- Mix dry kiln wash with water to the consistency of thin cream.
- Brush the shelf with water.
- Brush kiln wash on the shelf, keeping brushstrokes in one direction.
- Cover with two more coats of kiln wash, painting each coat in a different direction.
- Let the shelf dry slowly and completely before firing.

Loading the Kiln for Glaze Firing

Loading glazed pieces for firing takes special care, because glazes will fuse if the pieces touch one another. Pieces should be placed on shelves that have been painted with a thin coat of kiln wash.

Fig. 6–25. In raku firings unglazed surfaces will turn black from the carbon that forms when materials combust. What areas of this slab-built piece are unglazed?
William Penn, *Copper Pot*.
Raku, 5½" (13.9 cm) high, 8½" (21.6 cm) diameter. Stivers School for the Arts, Dayton, OH. Photo by Kim Megginson.

Pieces of approximately the same height should be placed together on a shelf with at least 3/8" (1 cm) between them. When the shelf is full, place supporting posts for the next level in the corners, and add another shelf on top of them. Continue adding levels until the kiln is full. Carefully place pyrometric cones on the shelves so that they are visible through the peepholes.

Cooling Down

Once the kiln reaches the correct temperature, it needs to be turned off. In fuel-burning kilns (like gas kilns), the dampers should remain open for a minute or two to allow any gases to escape, then closed tightly. The cooling-down period is very long. Don't remove pieces from the kiln until they are cooler than 130°F.

Note It It should take at least as long for the kiln to cool down as it does to heat up because chemical changes in glazes and clay continue to occur until cooler temperatures are reached.

Fig. 6–26. Describe the movement and rhythm in this group of teapots. How would it be different if you removed one teapot?
Diane Courington, *Teapot Series*.
Stoneware, hand-built with original press molding, cone 10 reduction. Stivers School for the Arts, Dayton, OH. Photo by Kim Megginson.

After the Glaze Firing

After unloading the kiln, follow these procedures to keep your studio well-organized.

- Scrape glaze drips off shelves using a putty knife. (Large glaze melts may have to be removed with a grinder or a chisel and hammer.)
- Repaint scraped areas with kiln wash.
- Stack shelves away from areas of traffic.
- Organize kiln furniture (stilts) according to size, and store on shelves.

Safety Note Always wear safety goggles when chipping glaze off shelves.

Principles of Design

Movement and Rhythm

Movement is a design principle used by artists in many different ways. Some sculptors incorporate actual motion into their work—for example, in a mobile that moves when it catches air currents. Other artists create the illusion of motion, as in the student work on page 138 or Karen Brown's holographic mixed-media work on page 176. How can you incorporate movement into your own work?

Rhythm is a closely related principle—an ordered movement made by the repetition of visual elements. Guiding your eye through an artwork, rhythm can be smooth and flowing, or jagged and irregular. It can follow a definite pattern or be scattered haphazardly. Movement and rhythm can influence the viewer's mood and feelings.

Works in a Series

Clay artists, like other visual artists, often explore a "big idea," or theme, by creating a set of works that are connected in some way. A group of pots, forms, or figures that have a sense of continuity—whether in shape, color, topic, style, or design—is called a series. Although the pieces are similar, each member of a series is unique.

Discuss It Should creating thrown tableware be considered to be "working in a series"? Why or why not?

Fig. 6–27. Study the three works by Hirotsune Tashima. What do you think is the "big idea" behind his sculptural creations?
Hirotsune Tashima, *Tatami Series—Knitting*, 1999.
Multiple fired stoneware, 9 x 10 x 10" (23 x 25.4 x 25.4 cm). Courtesy of the artist.

Fig. 6–28. This artist also sculpts clay figures much larger than the examples shown here (life sized). Could a larger sculpture be a part of this series? Why or why not?
Hirotsune Tashima, *Tatami Series—Beetle Catching*, 1999.
Multiple fired stoneware, 9 x 10 x 10" (23 x 25.4 x 25.4 cm). Courtesy of the artist.

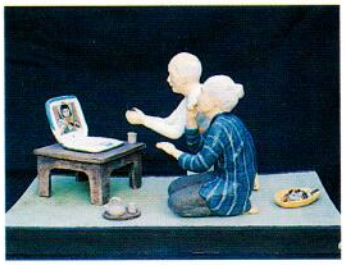

Fig. 6–29. Notice the similarities and differences between *Digital Grandchild*, *Beetle Catching*, and *Knitting*. If you could suggest to the artist a new sculpture for his series, what would it be?
Hirotsune Tashima, *Tatami Series—Digital Grandchild*, 1999.
Multiple fired stoneware, 7 x 13 x 10" (17.8 x 33 x 25.4 cm). Courtesy of the artist.

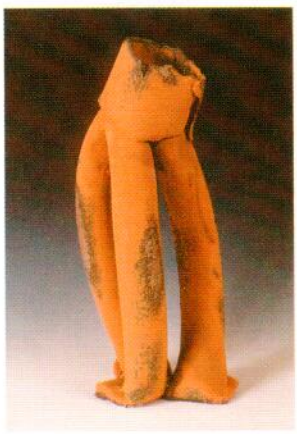

Fig. 6–30. What makes this work by Mary Kathryn Shields part of a series? Are there as many unifying factors in her series as there are in the work of Hirotsune Tashima?
Mary Kathryn Shields, *Tripod Series 3*.
Slab-built, low fire, 16" (40.6 cm) high. Spruce Creek High School, Port Orange, FL. Photo by Timothy Ludwig.

Fig. 6–31. Describe the surface treatment of this piece. How is it like the other two shown? How is it different?
Mary Kathryn Shields, *Tripod Series 1*.
Slab-built with extruded legs, low fire, 12" (30.5 cm) high. Spruce Creek High School, Port Orange, FL. Photo by Timothy Ludwig.

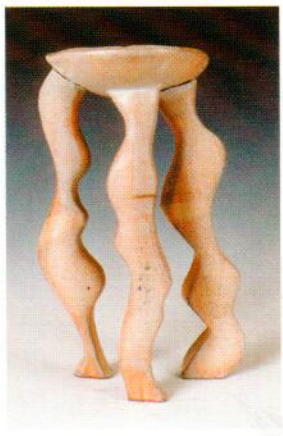

Fig. 6–32. Does this series have a theme, beyond the basic idea of the tripod form? If so, what might it be?
Mary Kathryn Shields, *Tripod Series 4*.
Slab-built, soda fired, cone 10, 12" (30.5 cm) high. Spruce Creek High School, Port Orange, FL. Photo by Timothy Ludwig.

Try It Select a form that you made in one of the earlier exercises using the pinch, coil, slab, or throw methods. It can be a successful piece or one that you feel could be improved. Think about a unifying factor to use in your series.

- Construct at least three more forms of similar shape and size using the earlier example as a guide. This group will be the basis for your series.
- Determine how to capture similarities among the pieces. Could it be through shape, texture, or color?
- Decide how to make each piece unique. Could it be by utilizing textural contrasts on the different surfaces or by forming outgrowths and protrusions on the body? Perhaps you could use a different design format with a unifying theme to decorate each piece using slip or glaze.
- Finish your pieces and be prepared to discuss how you achieved balance and unity within the series.

Finding Inspiration

How do clay artists come up with new ideas? Where do they get their inspiration? The process is different, of course, for each individual. Looking at natural shapes and forms—from a seashell to a mountain profile—can provide countless new ideas for designs and decorative treatments. Some artists are inspired by others' creations. Researching clay history sheds light on new areas to explore. Other crafts such as fabric design, jewelry, and metalwork are full of creative themes that you might adapt for clay. Books and magazines are also rich resources.

Fig. 6–33. Aurore Chabot created a series of tile installations for the University of Arizona at Tucson. She draws her inspiration from the earth's changing cycles and remnants of past eras that she finds in rocks and fossils. Viewed from a distance, one notices the large, contrasted forms of the designs and the pixel-like grid made by individual tiles.
Aurore Chabot, *Cellular Synchronicity*, 1997.
IEW-E Mural. Ceramic tile, 12.5 x 10' (3.8 x 3 m). Courtesy of the artist. Photo by Balfour Walker.

Fig. 6–34. Chabot's tile murals remind one of the layering process built into developing life forms—her use of inlays gives a rich textural surface to the tile face. A close-up view shows the inlaid images in each unique tile.
Aurore Chabot, *Cellular Synchronicity*, 1997 (detail).
ECW Mural, Marley Building. Courtesy of the artist. Photo by Balfour Walker.

For Your Sketchbook

Bring your sketchbook whenever you visit a gallery, sculpture park, or museum. When a specific work draws your attention, spend some time with the piece. Record your observations and draw specific features of the work that you'd like to remember and think about later.

Fig. 6–35. What famous work of art inspired this student?
Andrew Redd, *Tree.*
Coil and slab built. Bellarmine College Preparatory, San Diego, CA. Photo by Diane Levinson.

Fig. 6–36. What are some words you would use to describe the expressive qualities of this form? How does the title capture the artist's idea?
William Gregg, *Spirits of the Fire.*
Raku, slab construction, 10" (25.4 cm) high. Stivers School for the Arts, Dayton, OH. Photo by Kim Megginson.

Visit museums and galleries. Read artists' statements and analyze how they use imagery to express their ideas. Take time to sit, think, and notice what interests you. As always, carry your sketchbook to record your thoughts and impressions. You will soon discover that you have more ideas than you have time to carry out.

Once you've learned the basics and practiced various construction techniques and surface treatments, you may feel drawn to work in a particular style or technique. Some people prefer throwing tall, cylindrical objects, while others tend to like low bowls or platters. You might find that you most enjoy making hand-built forms.

Develop a series of pieces in an area that interests you. Explore all aspects of your chosen area. Research and try new techniques to simplify or enhance your creative process. When you have sufficiently explored your special area, gradually enlarge the scope of your work—begin to incorporate imagery, colors, and designs that have inspired you.

Fig. 6–37. What qualities make this series interesting? In what ways is each piece unique? How would you react if all the pieces were identical?
Ryan Thomas, *Wood Fired Bottles.*
Stoneware, wheel-thrown, wood fired, to 9" (22.8 cm) high. Stivers School for the Arts, Dayton, OH. Photo by Kim Megginson.

Firing Problems and Solutions

Sometimes, when your pots emerge from the kiln, you'll be delighted at the unexpected character of your finished pots. Other times, however, your finished product may be disappointing. This section describes some factors that can cause your final piece to be different from your expectations. Once you identify the cause of the problem, the solution is often quite simple.

Inadequate Venting

If the bisque ware looks too gray or glaze colors are dull, your kiln may not have adequate ventilation. A buildup of carbon monoxide and sulfur gases in the firing chamber can affect firing results and glaze colors. See if the kiln's vent system is functioning properly.

Firing Too Fast

A number of problems can result when pots are fired too quickly. If you experience any of the results below, you need to slow the firing rate for your pots.

- *Bloating* is when blisterlike areas form on a pot's surface. It occurs when gases that are trapped inside the clay expand.
- *Firecracking* can occur if the temperature increases too quickly. Water vapor turns to steam and can fracture the clay. Fine slips painted on the clay surface reduce the size of the pores through which water escapes, requiring slower heating. Thick-walled pieces also require slower heating.
- *Spalling* happens when moisture in the center of the clay wall expands and causes large pieces about half the thickness of the wall to separate away. This usually happens if the walls are thick and not dried completely before firing. This can be avoided by increasing the amount of time you take to preheat the ware.
- Gray/black patches occur in bisque ware when carbon materials remain in the clay body because not enough time was allowed in the firing to burn them all out. These patches weaken the piece, and glazes are more likely to craze, pit, blister, or bubble.

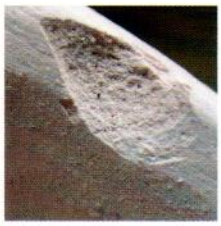

Fig. 6–39. Spalling can occur when clay is fired too fast.

Overfiring

A variety of defects can result when pots are fired for too long at a high temperature. If you notice any of the following problems, monitor the temperature of the kiln carefully during future firings and shut it down as soon as it reaches the correct temperature.

- *Warping* is the distortion of a form caused by mild overfiring. (See the example on page 153.)
- *Squatting* happens when the clay body behaves like molten glass and begins to collapse.
- *Flowing* is the ultimate stage of overfiring when the clay completely fuses to the floor or shelves of the kiln.

Cooling Too Rapidly

Dunting cracks appear when a vessel is cooled very rapidly. Because heat is lost most quickly from the rim, the tension between the warmer and cooler parts of the vessel cause these cracks to occur at the rim. Prevent dunting cracks by allowing the fired ware to cool down slowly and completely before removing it from the kiln. Dunting can also occur if a clay body has been fired higher than its recommended temperature.

Fig. 6–40. Dunting can occur when fired clay is cooled too quickly.

Additional Firing Techniques

Firing in a ready-made kiln is the most common technique used in high-school ceramics studios. But, in traditional communities and in artists' studios around the world, many other firing techniques exist with numerous purposes and effects. As you develop your craft, you may want to explore other ways to fire pottery. Many of these techniques use relatively low-temperature firings and the pieces that result may not be suitable for holding food or liquid.

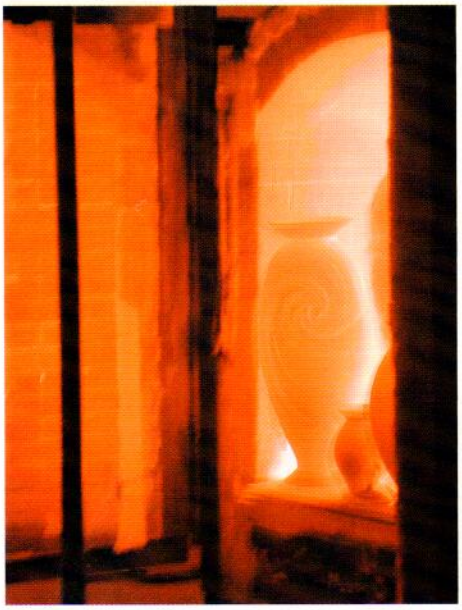

Fig. 6–41. At 1800°F, Menchhofer's large kiln is opened and the car is rolled to a post-reduction chamber. The chamber is then lowered to enclose the ware for the raku reduction process.
Courtesy of Paul Menchhofer.

Safety Note Do not attempt bonfire, pit, sawdust, wood, or raku firings without a knowledgeable adult present.

Fig. 6–42. This raku car-kiln was designed and built by Paul Menchhofer (see page 180), who uses it to fire his large-scale raku pieces.
Courtesy of Paul Menchhofer.

Fig. 6–43. A variation of the bonfire method is currently being used by potters of Mata Ortiz. (See page 26.)

Bonfire

A simple bonfire is the most ancient firing system, still used in many parts of the world. The process is relatively fast, because the combustibles used to fuel the fire burn quickly. Sometimes a fast firing can cause pots to break. Using grog, sand, or organic material in the clay can help reduce thermal shock and breakage.

Potters usually warm the ware to be fired in a bonfire by first burning straw inside the pots. They dry out any remaining water vapor in the pots by setting them upside down atop the embers of a wood fire. The thoroughly dried pots are then piled high on a bed of sticks, covered with shards (broken pottery fragments), and overlaid with sticks and more firewood. The lit fuel surrounds the pots with fire. More wood and grasses are added to

increase the temperature of the fire. Grasses also insulate the pots from cold air, ensuring against breakage.

The pottery that emerges from the firing is naturally colored black where the carbon from the smoke has been trapped against the surface. Bonfire kilns generally reach earthenware temperatures of around 1290°F (700°C).

Safety Note Make sure the area is clear and safe from combustible materials and have a water hose handy just in case the fire gets out of hand.

Pit Firing

There are many ways to pit-fire ceramic ware. Firing pottery in a pit is more effective than the bonfire method, because the earth walls insulate the firing chamber and maintain its heat. The fire is easier to control and can reach higher temperatures than in a bonfire. A groggy clay body (such as one formulated for raku) is a good choice for this type of firing. Pieces should be bisqued at a low temperature (cone 018) before firing. There is less breakage with pit firing as opposed to using a bonfire because the firing is more even and the cooling process is slower.

Safety Note Make sure a knowledgeable adult is present. Keep fire hose and extinguishers handy and know how to use them.

Fig. 6–44. The artist made this wheel-thrown vessel while blindfolded. The work was then pit-fired.
Gretel Walker, *Blindfolded Vessel.*
Stoneware, 4" (10.2 cm) high, 4H" (11.4 cm) diameter. Stivers School for the Arts, Dayton, OH. Photo by Kim Megginson.

Fig. 6–45. Using sawdust is a popular pit-firing technique. If this piece had been fired with blue glaze instead, what kind of mood might it create? How would it be different?
Courtney Teschner, *Untitled.*
Coil-formed, sawdust fired, 12 x 24" (30.5 x 61 cm). Spruce Creek High School, Port Orange, FL.

Fig. 6–46. Some clay artists spend years developing ways to control pit-firing techniques. Jane Perryman is noted for refining the various effects of smoke on clay. Jane Perryman, *Burnished Vessel*, 1999. Coil-built with paper, clay, and wax resists; smoke fired with paper and sawdust, 11 x 9¾" (28 x 25 cm). From the collection of Attie Tordoir, Amsterdam. Photo courtesy of Graham Murrell.

Sawdust Firing

Sawdust can be used in a pit firing, as on page 173, or in a metal trash can. Burnishing and painting colored slips, oxides, or stains on the ware yields interesting results with this type of firing.

- Drill ½" (1.3 cm) diameter holes about 6" (15 cm) apart in the bottom, lid, and sides of the can to allow air to circulate. Raise the can off the ground by setting it on bricks.
- Place crumpled newspaper in the bottom of the can and cover with about 4" (10 cm) of sawdust.
- Spread a light layer of torn newspaper and twigs on top of the sawdust.
- Add sawdust-filled pots, leaving space between each pot, and between pots and metal walls. Lightly spread torn newspaper and twigs over the pots and heap another 4" (10 cm) layer of sawdust on top. Place a grill or iron rack atop the sawdust to hold a second layer of pots, if desired.
- Cover the top layer of pots with sawdust and three full sheets of newspaper. Make a paper log and place on top, then cover with a wire screen to prevent sparks from escaping. Light the paper at the top and the bottom with grill lighter torch. When (after about fifteen minutes) the sawdust catches, cover with a metal lid. The sawdust will burn very slowly.
- A sawdust firing can last from a few hours to several days. Wait until the smoking has stopped and the ware has completely cooled before removing the pottery from the can.
- Wipe the pots with a soft cloth. You can also apply shoe polish (neutral color) or oil-based furniture polish, and buff with a soft cloth to enrich the finish.

Wood Firing

At one time, most firings were fueled by wood. A number of special wood-burning kiln designs have evolved and been developed. In the Far East, multichambered wood-firing kilns have been built into hillsides. Western-style wood kilns usually have a single chamber with a chimney to draw the heat upward, thus ensuring even circulation of gases within the kiln. The kiln is fueled by burning wood from a fire beneath the chamber. For school studio use, electric and gas kilns are safer and more practical, and so they are more popular.

Controlling a wood firing is difficult—success relies upon an investment of

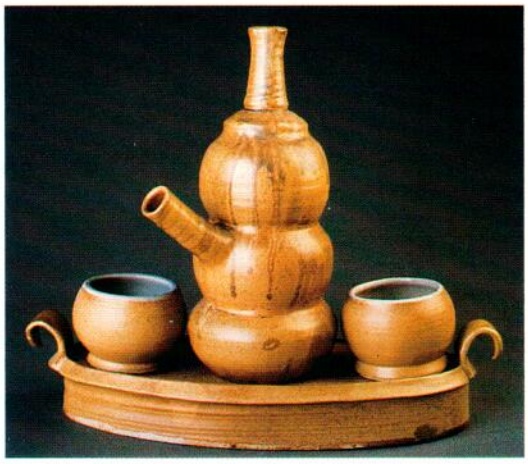

Fig. 6–47. How does the artist use repetition of basic thrown forms to create an interesting composition?
Canaan Good, *Wood Fired Service*.
Stoneware, wheel-thrown, wood fired, 14 x 7½ x 17½" (35.6 x 19 x 44.5 cm). Stivers School for the Arts, Dayton, OH. Photo by Kim Megginson.

time, skill, and hard work. A firing starts slowly and builds to intense heat. For at least one entire day, the potter must constantly watch the fire, stoke it, and keep it replenished with additional fuel (dry, seasoned wood). Stoking and manipulating the dampers scatter ash upon the ware and create flashings from the flames on the surface. The ash can create beautiful shades of orange and green on unglazed ware.

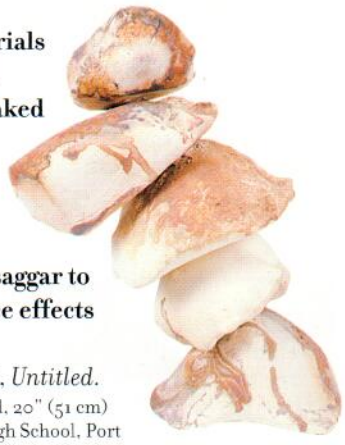

Fig. 6–48. Materials such as sawdust, rock salt, hay soaked in salt brine, wood chips, and a banana peel were enclosed in the saggar to create the surface effects seen here.
Leanne Siegfried, *Untitled*.
Coil-built, saggar fired, 20" (51 cm) high. Spruce Creek High School, Port Orange, FL. Photo by Timothy Ludwig.

Saggar Firing

A **saggar** is a fire resistant container. It can be made of brick, a large pot that is turned upside down over what you're firing, or other fireproof material. This technique was originally developed by the Chinese during the Sung dynasty (tenth to thirteenth century AD) to shield porcelain ware from the ashes that accompany a wood firing.

Today, saggars serve an "opposite" purpose. Potters fill them with combustibles, metals, and chemicals to produce different and unusual surface effects on the clay. Some common materials used in saggars are plants, leaves, flowers, wire, steel wool, household cleansers, and metallic compounds. Saggar firings can be low or high temperature.

Fig. 6–49. How would you describe the sensory and expressive qualities of this work?
Sherman Edwards, *Tornado Lidded Form*.
Slab-built, saggar fired with sawdust, 18" (46 cm) high. Spruce Creek High School, Port Orange, FL. Photo by Timothy Ludwig.

Fig. 6–50. How has sculptor Karen Brown used the elements and principles of design in her work? What do you think might have inspired her?
Karen Brown, *Faceted Biovoid with Layered Grid*, 1997.
Raku/holography, 12" (30.5 cm) high, 9" (22.9 cm) diameter. Photo by Robert Neroni. Courtesy of the artist.

Fig. 6–51. A long narrow neck dominates the shape of this vessel. How is this contrasted by the bottom?
Teressa Riney, *Untitled*.
Raku, copper sand glaze, 25 x 10" (63.5 x 25.4 cm). Courtesy of the artist. Photo by Maureen Mackey.

Raku Firing

Raku firing is a fast-paced, fun process to witness or participate in. Previously bisqued and glazed pieces are fired quickly to a low heat that is sufficient to melt the glaze. Once the glaze matures (bubbles and melts to a smooth glassy surface), the potter pulls the piece from the kiln and places it in a receptacle containing organic materials such as leaves, paper, or wood shavings. By quickly setting a lid on top of the container, the potter smothers any flames and creates a reduction atmosphere. The carbon from the smoke permanently colors the clay body black. Once the pot has cooled, it can be removed from the container and washed to remove any firing residue. Glaze treatments produce crackled surfaces, metallic flashes, and other special effects that can occur between the pulling and the smoking parts of the process.

The raku-firing technique originated in Japan during the sixteenth century.

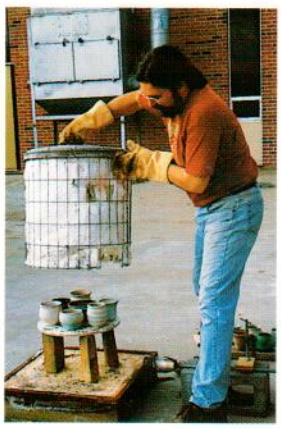

Fig. 6–52. Teacher Robert Putnam prepares a raku kiln for firing at Blue Valley High School, Stilwell, KS.
Photo by Kristen Holcomb.

Fig. 6–53. Glassy raku glazes get very bubbly as they melt. You can tell a piece is ready to pull when the glaze has melted into a smooth coating. The bottom of this piece was formed by slumping clay into a bowl; the rest of the piece was coil-built.
Dan daSilva, *The Herring Bone Incident*.
Raku fired with copper luster glaze. Bellarmine College Preparatory, San Jose, CA.

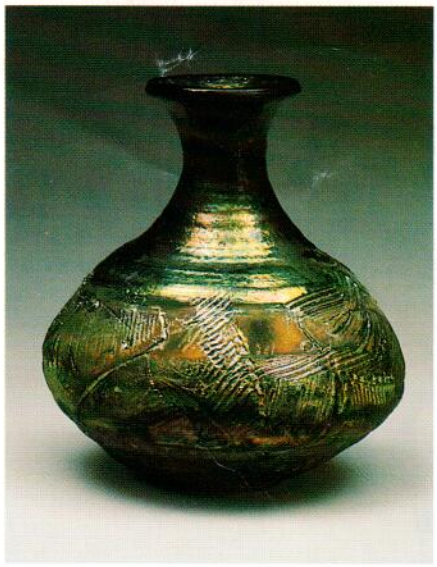

Fig. 6–54. What qualities immediately identify this as a raku piece? How does the texture enhance these qualities?
Kimberly Hardiman, *Untitled*.
Raku textured slab and thrown bottle, 7½ x 6 x 6" (19 x 15.2 x 15.2 cm). Blue Valley High School, Stilwell, KS. Photo by Janet Ryan.

Traditional raku firings used a small wood-burning kiln. Contemporary post firing and smoking techniques were developed in the twentieth century by American artists Hal Riegger, Paul Soldner, and others. Today, raku can be done in any kiln where the fuel and rate of firing can be readily controlled and there is easy access to the firing chamber.

Temperatures for raku firing range from 1481°F to 1904°F. Raku ware should be constructed from clay that contains a large amount of grog or sand, which helps it withstand extremes in temperature during the firing. You can buy commercially formulated raku clay or mix your own by combining equal parts fireclay, stoneware clay, ball clay, and grog.
Supplies you need for raku firing:

- a welder's mask
- long, protective, heat-resistant gloves
- long-sleeved cotton shirt
- long pants
- tongs for drawing the ware out of the hot kiln
- organic material such as sawdust, wood shavings, paper, or leaves
- a trash can with lid

Safety Note When working with raku:

- keep a water hose handy for fire prevention.
- wear a welder's mask when removing ware from the kiln and placing it in the reduction chamber.
- wear heat-resistant gloves while unloading ware.
- wear heavy-duty shoes or boots to protect your feet from flames and red-hot ware should you accidentally drop it.
- keep the area around the kiln clear. All flammable materials should be kept in a covered container well away from the kiln.

Fig. 6–55. Molly Rodgreller dons leather apron, gloves, and a welder's mask to shield herself from the heat of the raku kiln.
Photo by Maureen Mackey.

Chapter Review

Recall What two variables affect the outcome of a firing?

Understand Explain why most ceramic pieces need to be fired more than once.

Apply Take two bisqued pieces of roughly the same size, shape, and clay type. Use the same glaze on each piece. Fire one in a reduction atmosphere, the other in an oxidation atmosphere. What differences do you notice in the finished pieces?

Analyze Examine the Sèvres vase shown in Fig. 6–8. What surface decoration techniques do you think were used? Estimate how many times this piece was fired.

Fig. 6–61. Only the coil edging and swirling relief decoration on the panels of this piece were glazed. How can you tell that this work was raku fired?
Maureen Mackey, *Untitled*, 2001.
Raku, 15" (38.1 cm) high, 11½" (29.2 cm) wide.

Synthesize How do kiln firings differ from traditional firings? Which firing allows you to better control the outcome? What are some reasons for choosing a firing whose outcome is less certain?

Evaluate Pieces that are porous are not suitable for holding food or liquid. Which firing techniques are best suited for creating functional ware? Why?

Writing about Art

You have had a chance to work with clay in several ways and have used a variety of processes. Carefully consider the materials, techniques, forms, and design elements with which you work best. Write a self-evaluation. What it is about these materials, forms, and techniques that draws you? Is there one particular form or theme that you favor, or several? What about materials and techniques? Have you worked in series? Do you lean toward particular elements or principles of design? Are there any environmental, cultural, or historical influences that you tend to incorporate into your work?

For Your Portfolio

Document various firing experiences with slides or photographs. Indicate title, date, and size of different pieces. Write a description of the SA-KU technique and include it with pictures of your SA-KU work.