chapter 3

Processes, Tools, and Materials of Technology

Sections

What You'll Learn

- **Describe** separating, forming, combining, conditioning, and finishing processes.
- **Explain** how the different processes are used.
- **Describe** the purpose of several hand tools.
- **Describe** the purpose of several portable power tools.
- **Explain** the importance of safety when using tools and machines.
- **Identify** some basic properties of materials.
- **Name** the common engineering materials.

Explore the Photo

Using the Right Tools Carpenters use tools to process materials. Processing helps build or create a house, building, or any product. *Can you think of an item that is made without processing?*

Launch the TECHNOLOGY LAB

Make a Plaster Casting

At the end of this chapter, you will be asked to make a plaster casting of an engraved object of your choice by using a technology process. Get a head start by using this checklist to prepare for the Technology Lab.

PROJECT CHECKLIST

- ✓ Start looking at buildings, such as your own school building, libraries, and museums, to find a small engraved stone or plaque.
- ✓ As you read this chapter, identify the processes you might use to do this lab activity.
- ✓ Ask your teacher to explain the Safety Reminder for this lab.

section 3.1

Technology Processes

Reading Guide

Before You Read **Preview** How are products made?

Content Vocabulary

- separating
- forming
- combining
- conditioning
- finishing

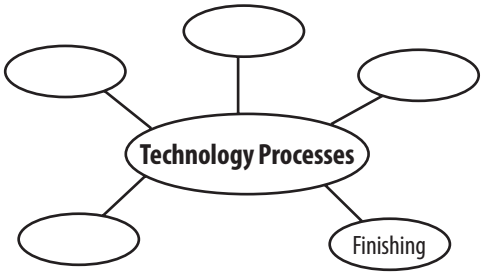
Academic Vocabulary

You will see these words in your reading and on your tests. Find their meanings at the back of this book.

- technique
- similar

Graphic Organizer

Draw a section diagram. Use it to write and organize information as you read.



Go to **glencoe.com** to this book's OLC for a downloadable graphic organizer and more.

TECHNOLOGY STANDARDS

STL 9 Engineering Design

STL 19 Manufacturing Technologies

ACADEMIC STANDARDS

Science

NSES Content Standard E Understandings about science and technology

Mathematics

NCTM Measurement Understand measurable attributes of objects and the units, systems, and processes of measurement.

STL *National Standards for Technological Literacy*

NCTM *National Council of Teachers of Mathematics*

NCTE *National Council of Teachers of English*

NSES *National Science Education Standards*

NCSS *National Council for the Social Studies*

Tools and Progress

What were some early tools?

A tool is an instrument that increases your ability to do work. The development of tools moved from simple to complex. The first tools were hand tools and muscle-powered. Cave dwellers used them for hunting and gathering—a tree limb became a club. With tools, people changed materials they found in nature.

The first machine tool was created when an inventor attached a mechanical power system to a hand tool. In every time period, people have created new tools, new materials, and new products.

As You Read

Identify What is the purpose of separating materials?

Using Technology Processes

How do processes change materials?

Whether products are simple or complex, people use different processes to make them. The steps or operations that are used change materials in some way. For example, to make furniture, wood must be cut, shaped, fastened, and finished. Most products have materials that need to be cut and shaped, but not all products have parts that must be fastened and finished. Each product is made with processes that are right for the specific material and the desired result.

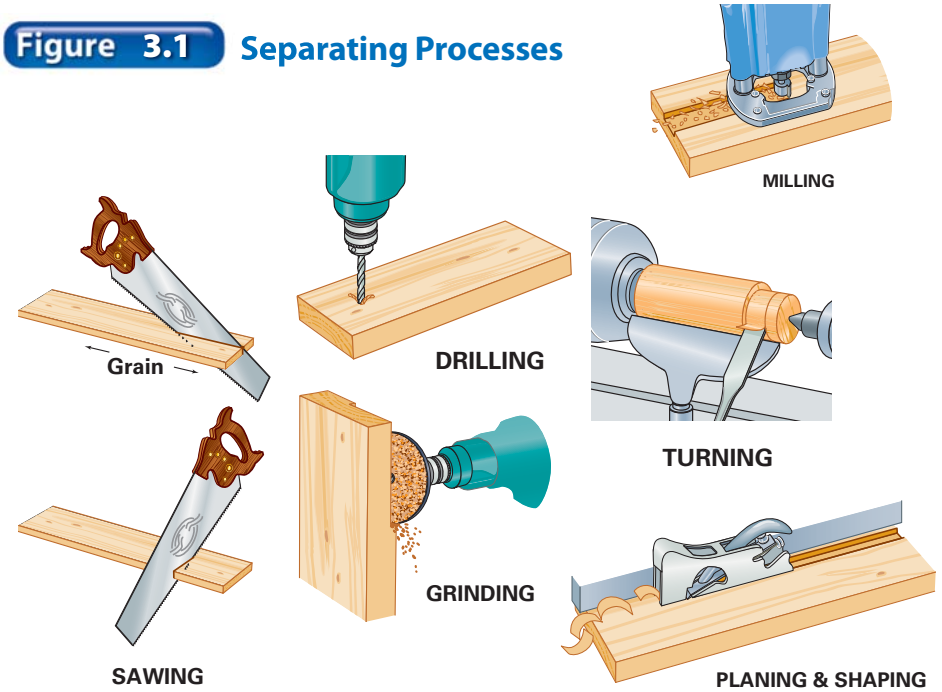
Separating

How are materials separated?

Separating is removing pieces of a material. One separating process you are probably familiar with is sawing. When you saw a board to make it the size you want, you divide it into at least two pieces. Small pieces in the form of sawdust are removed as well. Almost all separating can be done with hand tools or electrically powered tools. Separating processes include drilling, sawing, grinding, turning, milling, planing, and shaping. See **Figure 3.1**.

Reading Check **Recall** What are the separating processes?

Figure 3.1 **Separating Processes**



Ways to Separate Either handheld or electric tools can separate materials. *What separating operation might use just a handheld tool? Explain.*

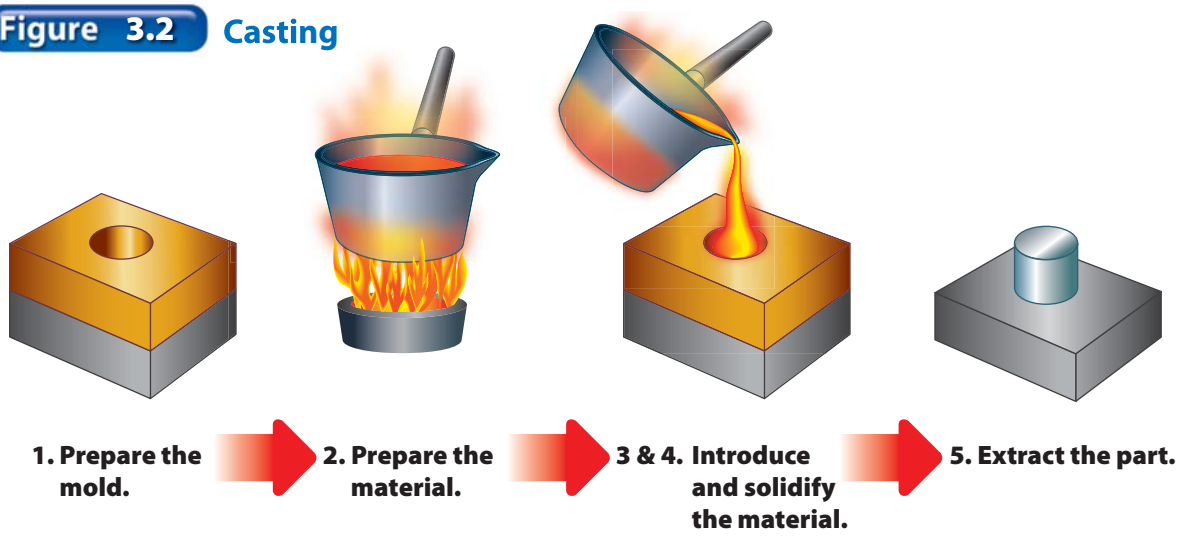
Imagine This...

Futuristic Fibers

Imagine special fibers and fabrics that are engineering materials. Designers are developing a fabric vest that becomes a personal airbag during a crash. The D-Air® vest is controlled by a small computer sewn in the vest. Other futuristic materials include shirt fabric that can monitor heart patients, balloon fabric strong enough to lift a building, and steel fibers knitted into heat-producing blankets. *Do research on the Internet to find out more about the D-Air vest. Write about your findings.*

Go to **glencoe.com** to this book's OLC for answers and to learn about smart fibers.

Figure 3.2 **Casting**



Liquid to Solid Molten metal, glass, clay, or plastic material takes on the shape of the mold as it cools. *What items do you use at home or school that might have been made by casting?*

The Forming Process

What are some different ways to form materials?

Forming is a process that changes the shape of materials. If you have ever used your hands to mold clay, then you have *formed* a material. Forming can be done in several ways.

Bending

In bending, material is formed by forcing part of it to move into a different position. This type of forming is commonly used with metal. However, wood can also be bent into different shapes by using heat and moisture.

Casting

In casting, a liquid material is poured into a mold. As it hardens, the material takes on the shape of the mold. The liquid can be a molten (hot and melted) metal, glass, plastic, or liquid clay. See **Figure 3.2**.

Compression

In compression, a flat material is pressed into a mold by a strong force, and the material takes on the shape of the mold. This is commonly done with metal sheets to form them into things such as car doors.

Forging

The **technique** of shaping metal by heating it, and then hammering it into shape is called "forging." Old-time blacksmiths formed horseshoes, door hinges, and other items by forging. Modern forging is done with huge and powerful machines.

Extruding

In extruding, softened material is squeezed through a small opening. You "extrude" toothpaste from a tube when you apply it to your toothbrush. Pipe and wire are some common items that are formed by extrusion.

Reading Check **Define** What does *forming* mean?

The Combining Process

How do people join materials together?

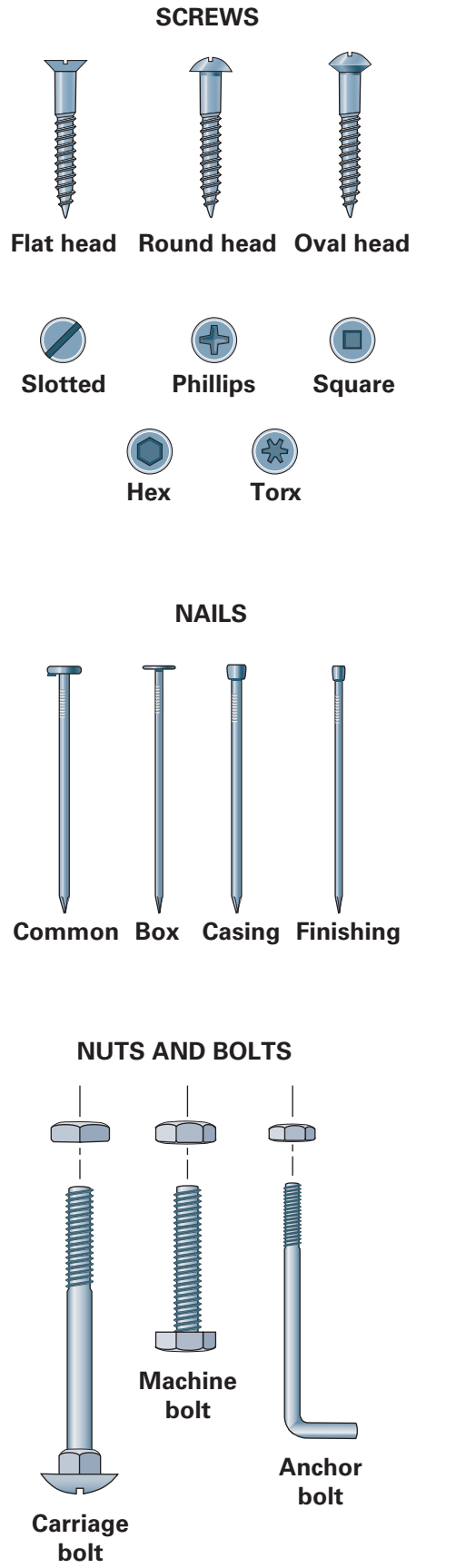
Joining several parts together to make a finished product is called **combining**. For example, a wooden pencil is made out of four different materials that are joined together: a wooden barrel, pencil graphite, a rubber eraser, and a metal ferrule, which holds the eraser to the barrel. Combining also occurs when materials are mixed together. For example, paint and cake mixes are both made of combined materials.

Mechanical Fastening

If you have ever nailed two pieces of wood together or tightened a screw, then you have done mechanical fastening. Mechanical fasteners are small pieces of metal or plastic that hold parts together. Examples of **similar** fasteners include nails, staples, wood screws, nuts and bolts, pins, and rivets. See **Figure 3.3**. Some fasteners hold parts together permanently, while others allow materials to be taken apart when needed.

Building Supplies Screws, nails, nuts, and bolts are all mechanical fasteners. *Are all of these fasteners used for items that can be taken apart? Why or why not?*

Figure 3.3 Mechanical Fasteners



Heat Fastening

When some materials are heated, they soften, melt, and flow into each other. This common way to combine metal parts is called "welding." A special burning gas or an electrical current heats the material until the parts flow together.

Plastic parts can also be combined using heat. Plastic requires much less heat than metal requires. If you look carefully at some plastic items, you might be able to see a spot where heat was used to melt one plastic part in order to attach it to another part.

Gluing

One of the easiest ways to join parts is to use glue. Glue is called an "adhesive" because it makes one part of an item adhere, or stick, to another part. Adhesives form a film on the surfaces being joined. The film adheres to both surfaces, which holds the parts together. White glues are used for wood. Epoxy or polyester resin (pronounced REZZ-in) can hold metal and ceramic parts together. Super glues can hold some plastics together, however glue does not work on all plastics.

Reading Check **Recall** What are the different methods of fastening?

Conditioning

How does conditioning change a material?

Conditioning is done to change the inner structure of a material. When you bake cookies, for example, you are using a conditioning process. The oven's heat changes the dough from a clay-like mass into a light, crispy cookie.

Materials are conditioned to improve their performance. Heat is used to harden ceramics and some metals. After a steel piece is formed into a certain shape, heat and chemicals can help harden its surface. This allows the item to last longer.

SuperStock

Creating with Fire The tremendous heat generated during welding softens a material until the parts can meld together. *Heat fastening only works with some materials. Why?*

Other conditioning processes may be used to soften materials. Leather, for example, is softened before it is made into shoes. Still other processes relieve stresses and strains caused by heat and forming methods. Some metals, for example, become brittle and crack if they are not treated with a conditioning process to improve performance.

Reading Check **Identify** What is an example of conditioning?

Processing Art Glass makers often reheat the glass object. Reheating removes stresses and strains built up in the piece during the forming process. *What might happen if those stresses and strains were not removed?*

Finishing

What is finishing?

Finishing is the last step in making a product. The purpose of finishing is to improve the product's appearance. It can be done in several different ways. Finishing can be simply smoothing and polishing the surface of the product. Other finishing methods use coatings, such as paints, clear finishes, or plastic.

section 3.1 assessment

After You Read **Self-Check**

1. Compare the processes of forging and casting.
2. Name the processes used to shape wire, shape a car door, glue furniture, and paint a bike.
3. Identify five examples of mechanical fasteners.

Think

4. Explain why a screw might have more holding strength than a nail.

Practice Academic Skills

Social Studies/History

5. The original paper clip was patented around the year 1900. Do Internet or library research to prepare a one-page report on the history of the paper clip. Then try to form a better one. Take a standard paper clip, straighten it out, and bend it into another shape. Test your design. Present your report and demonstrate to the class.

STEM **Mathematics**

6. Drew works in a metal shop where he forges brass hinges for doors. Each hinge requires 5.8 ounces of brass. If Drew forges 80 hinges, how many pounds of brass will he use?

Math Concept **Unit Conversion** When problems require unit conversion, it is sometimes easier to do the unit conversion as the last step.

1. Use multiplication to figure out how many ounces of brass are used.
2. There are 16 ounces in 1 pound. Divide by 16 to convert ounces to pounds.

For help, go to **glencoe.com** to this book's OLC and find the Math Handbook.

section 3.2

Tools and Machines

Reading Guide

Before You Read **Connect** Why are safety rules important to know when you use tools and machines?

Content Vocabulary

- measuring tool
- hand tool
- portable electric tool

Academic Vocabulary

- ultimate
- attitude

Graphic Organizer

Draw a section diagram. Use it to write and organize information as you read.

Safety Rules

1. Work alone	5. _____
2. _____	6. _____
3. _____	7. _____
4. _____	8. _____

Go to **glencoe.com** to this book's OLC for a downloadable graphic organizer and more.

TECHNOLOGY STANDARDS

STL 12 Use & Maintenance

STL 17 Information & Communication Technologies

ACADEMIC STANDARDS

Science

NSES Content Standard E Understandings about science and technology

NSES Content Standard F Natural hazards

STL *National Standards for Technological Literacy*

NCTM *National Council of Teachers of Mathematics*

NCTE *National Council of Teachers of English*

NSES *National Science Education Standards*

NCSS *National Council for the Social Studies*

Uses of Tools

What tools and machines are commonly used in the technology lab?

As You Read **Connect** What are some measuring tools that you use?

Primary tools and machines are used in all areas of technology. The way they are used for processing materials determines their categories. Some tools are for measuring and laying out. Others are for holding, separating, combining, conditioning, or finishing. Tools and machines can also help diagnose and repair malfunctioning products. Tools and machines designed to cut materials will also cut you if you do not use them correctly. Your teacher will demonstrate the correct use of these tools and ask you to pass a safety test before you can use them.

Measuring Tools and Machines

Is it possible to use a laser beam as a ruler?

Measuring tools help identify size, shape, weight, distance, density, and volume. Tools such as rulers measure materials directly. Others, such as a marking gauge and compass, help transfer measurements from one place to another. **Figure 3.4** shows several kinds of measuring tools. Measuring machines contain lasers or infrared beams to measure electronically.

Using Metric Measures

The metric system is based on units of ten and is, therefore, easier to work with than the measurement system used by most people in the United States. Many other countries use only the metric system. So their products, including those sold in the United States, are **ultimately** designed and built using metric measurements. To stay competitive, many U.S. industries and scientific institutions have adopted the metric system.

Reading Check **Name** What are some measuring tools?

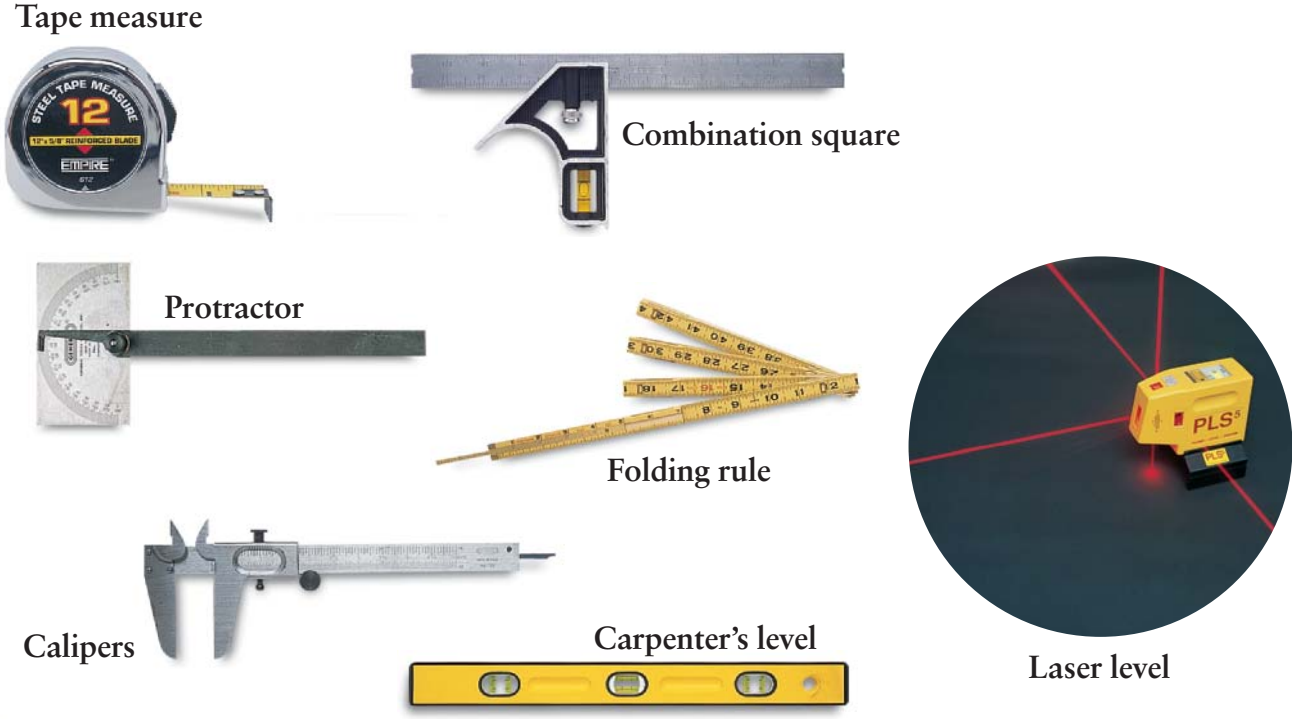
Academic Connections Math

Calculating Metric Conversions The U.S. measurement system can be converted to metric measures, but results are not always as accurate as results from using metric tools.

Apply Using the appendix at the back of this book, measure the length and width of this book using metric rules. Convert the measurements to U.S measurements. Use a U.S. ruler to measure the book and convert the measurements to metric measurements.

STEM

Figure 3.4 **Measuring Tools**



Measuring Accurately Builders and craftspeople cannot create quality products without accurate measuring tools. *What would happen if you used a ruler that had no markings?*

Figure 3.5 **Holding Devices**

Hands-Free Holding devices come in many forms. *What are two reasons for using holding devices?*

Holding Devices

Why are holding devices needed?

If the material that you are cutting is not clamped in place, your risk of injury increases. To protect you and your workpiece when cutting, bending, drilling, or hammering, place the workpiece in a vise or clamp. **Figure 3.5** shows various holding devices.

Types of Tools

How do a hand tool and a portable electric tool differ?

A **hand tool** requires your muscle power to work. A **portable electric tool**, or power tool, is a small portable tool powered by electricity. Power equipment is usually faster and more efficient than hand tools. However, hand tools can be safer to use.

Your technology laboratory might also have some large machine tools that can also perform the same processes. **Figure 3.6** on pages 55–57 shows different types of tools.

Reading Check **Recall** What is the advantage of power tools?

Thinking about Safety

Why is safety instruction important?

Equipment, tools, materials, and activities determine the dangers of a situation. Therefore, safety rules around a swimming pool, gymnasium, and technology laboratory are different. Your teacher will provide you with general safety rules, fire safety rules, safety instruction, safety tests, and an emergency exit plan to keep you safe in your lab.

Figure 3.6 Tools

The Right Tool These are the tools of the trade for many types of technology. *What are three examples of portable electrical tools? Machine tools?*

Claw hammer—the most commonly used hammer. The curved claw provides leverage for pulling nails.

Ball-peen hammer—one face used to strike cold chisels and punches; the other face for shaping soft metal

Tack hammer—a small, lightweight hammer that holds and sets tacks

Power brad nailer—drives and countersinks brads without marring the surface of the wood

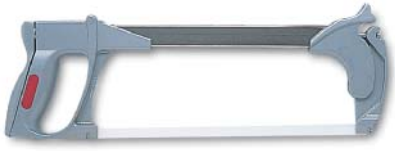
Rubber mallet—used mainly for assembling projects

Crosscut saw—cuts across the grain of wood

Band saw—cuts curves and resaws stock to thinner sizes

Backsaw—used to make fine cuts for joinery; often used in a miter box

Scroll saw—the best tool for intricate and accurate irregular curves



Hacksaw—cuts metal

Figure 3.6 continued

Coping saw—used to cut curves, scroll work, and molding as finishing trim

Circular saw—a portable saw that cuts wood and other materials

Jigsaw—makes straight and curved cuts

Brace—bores holes in wood by hand. Special auger bits must be used with the brace.

Table saw—the most commonly used saw. Its size is determined by the diameter of the largest blade it can use.

Twist bit—designed for wood. If you use it with metal, lubricate it with machine oil.

Spade bit—the long point makes it easy to place the hole exactly where you want it.

Countersink bit—drills a neat taper for the head of a wood screw

Electric drill—comes in three chuck sizes: ¼", ⅜", and ½". Most have a reverse drive and variable speed.

Hole saw—cuts large holes in wood, plastic, and thin metal

Screwdriver set—left: Phillips-head; middle: standard slotted; right: Phillips-head and standard stubby screwdrivers

Utility knife—for safety, the blade can be retracted into the handle.

Aviation snips—easier to use on metal than tin snips; especially designed to make curved and straight cuts in metal

Lineman's pliers—mainly for twisting and cutting wire

Tin snips—used to make straight cuts in lightweight sheet metal

Straight-jaw locking pliers—clamps firmly to an object

Slip-joint pliers—has small and large teeth to grip objects. The jaw size can be expanded.

Needle-nose pliers—used for fine work such as jewelry making

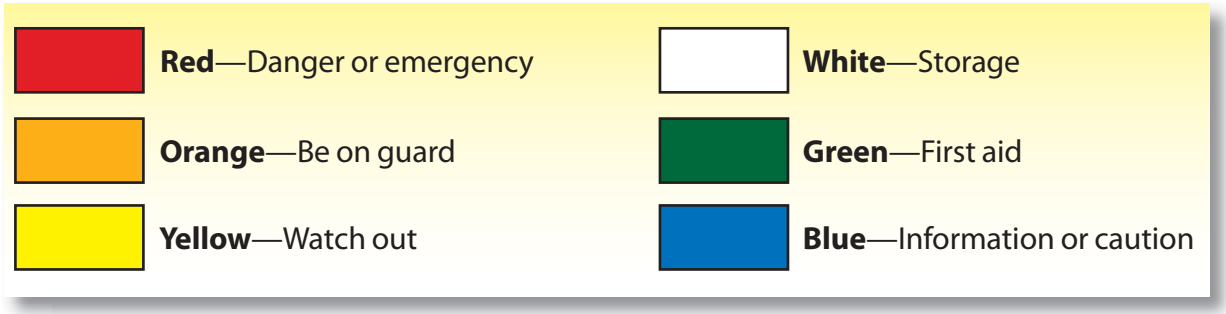
Groove-joint pliers—grips objects that are round, square, or hexagonal

Open–end wrench—has a different size opening at each end

Combination wrench—has both box and open-end heads. Both ends are for the same size bolt.

Adjustable wrench—can be used on a variety of bolts and nuts. It should be used only when a box- or open-end wrench is not available.

Figure 3.7 **Colors for Safety**



Symbolizing Safety When you see warning symbols and labels in these colors, pay attention to their meanings to maintain safety. *What color represents the most hazardous situations?*

Safety Precautions

In general, recognizing hazards is one way to avoid danger. Accidents usually occur because people are not aware of the dangers that exist around them. You can avoid accidents by having the right **attitude** and paying attention to what you are doing.

Six colors are used for signs and labels to indicate danger or other safety factors. See **Figure 3.7**. Be sure you know what they mean as you work in the lab.

Reading Check **Recall** Why do most accidents occur?

The Do's and Don'ts of Lab Safety

Use common sense and follow safety rules to make your experience in the lab enjoyable and safe. Here are a few basic rules:

- Protect your eyes by wearing proper eye protection.
- Wear a protective apron and roll up your sleeves.
- Never use equipment, tools, and materials unless your teacher has approved them.
- Never plug in or turn on an electrical device without your teacher's permission.
- Inform your teacher if you are injured.
- Inform your teacher if you find any broken, dull, or damaged tools or equipment.

Most injuries occur because people do not think about what they are doing. To avoid injury, follow these rules:

- Wear heat resistant, non-asbestos gloves if touching hot material.
- Never touch spinning rollers, which can pull your fingers into a machine.
- Never rest your fingers in areas where they can be pinched.
- Wear eye and clothing protection if using chemicals.
- Never wear loose clothing and jewelry near machines.
- Never use electric tools with broken wires or insulation.
- Never use tools that should be plugged into a three-prong plug in non-grounded wall outlets or extension cords.

The Safe Use of Hand Tools

Your teacher will show you the correct way to use hand tools to complete the activities in this book. Here are some reminders:

- Only use tools designed to do the particular job.
- Always cut *away* from yourself. Accidents happen when people cut *toward* themselves.
- Use sharp tools. A dull tool is more dangerous than a sharp one because people use more force to operate a dull tool, making it more likely to slip.
- Never use broken tools or tools without proper handles.

The Safe Use of Machines

The machines in your technology lab are not toys. They are designed to process materials. They cut, bend, and reshape what goes into them. To avoid injury, follow these rules at all times:

- Stay out of the safety area that surrounds a machine unless you are the operator.
- Never use any machine until your teacher has shown you how to operate it.
- Never use a machine until your teacher gives permission.
- Work alone. Be sure other people are clear of the area before you start any machine.
- Wear safety goggles.
- Watch what you are doing. Do not rush. Concentrate.
- If you have difficulty, turn off the machine. Request help.
- Never walk away from a machine that is running.

section 3.2 assessment

After You Read Self-Check

1. Name three tools used for separating.
2. Explain why a dull tool is more dangerous than a sharp one.
3. Discuss why you should wear safety glasses or goggles when using tools to cut materials.

Think

4. Explain why a hammer is considered a combining tool. Give examples.

Practice Academic Skills

English Language Arts/Reading

5. Read an instruction manual for a portable power tool to learn about using it safely. Make a presentation to the class about its safe use.

STEM Mathematics

6. Mike is a carpenter who makes display cases for the stores in his neighborhood. He cuts the pieces for the cases out of lumber that is 1-inch thick. He starts with a stack of wood that is 6-feet high. How high will the stack be after he uses 23 pieces of wood?

Math Concept Algebra Use algebra to analyze change.

1. The basic equation for this problem is:
   Quantity before – Quantity used = End quantity
2. Remember that 1 foot is equal to 12 inches.

For help, go to **glencoe.com** to this book's OLC and find the Math Handbook.

section 3.3

Engineering Materials

Reading Guide

Before You Read **Preview** What could be the meaning of *sensory property*?

Content Vocabulary

- organic material
- inorganic material
- mechanical property
- sensory property
- alloy
- ceramic
- composite

Academic Vocabulary

- obtain
- create

Graphic Organizer

Draw a section diagram. Use it to write and organize information as you read.

Engineering Materials

1. Wood	2. _____	3. _____	4. _____	5. _____
Furniture				
Fuel				
Const. Mat'ls				
Paper				
Books				

Go to **glencoe.com** to this book's OLC for a downloadable graphic organizer and more.

TECHNOLOGY STANDARDS

STL 7 Influence on History

STL 11 Design Process

STL 19 Manufacturing Technologies

ACADEMIC STANDARDS

Science

NSES Content Standard B Properties and changes of properties in matter

NSES Content Standard F Science and technology in society

STL *National Standards for Technological Literacy*

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Engineering Materials

Why are engineering materials important?

Materials used to make products are called "engineering materials" or "production materials." They are the building blocks of our designed world. These materials must be found and processed before they are used. Materials such as oil and natural gas are **obtained** by drilling. Then they are processed in a refinery.

As You Read

Compare What are organic and inorganic materials?

Natural materials are classified by how they originated. **Organic materials**, such as wood, leather, and cotton, come from living things. **Inorganic materials**, such as stone, metals, and ceramics, come from mineral deposits. They were never alive.

Time & Life Pictures/Getty Images

Tech Stars

Stanford Ovshinsky

Inventor, Engineer, Physicist

Stanford Ovshinsky was born in 1922. After high school, the self-taught engineer began working with amorphous materials, which do not have a definite crystalline structure. By the 1950s, he had created a new area of materials science.

Ovshinsky's discoveries led to electro-photography, printing, imaging, optical memory switching, and holographic information storage. His invention of a reversible optical memory disk was a prototype for the rewritable CD. Ovshinsky's work has also contributed to the electric car and solar energy.

Flat Screen Science Ovshinsky has earned 200 patents, which include patents for materials essential for photocopying and fax machines, and for flat panel liquid crystal displays (LCD) of computer monitors and flat screen televisions.

English Language Arts/Writing Research amorphous materials and write a few paragraphs describing them. Also identify products you own that may utilize them.

Go to **glencoe.com** in this book's OLC to learn about young innovators in technology.

Types of Properties

Engineers and designers check a material's properties to determine whether it is suitable to use for a particular project. The **mechanical properties** of materials are characteristics that determine how a material reacts to forces. There are four basic mechanical properties:

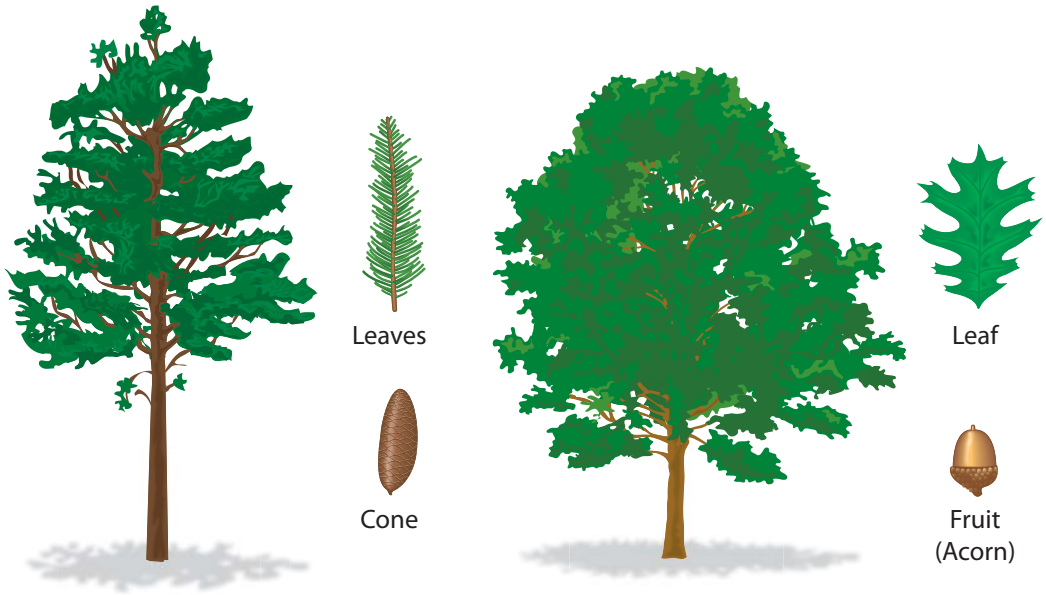
- **Strength**—The strength of a material is determined by how it withstands forces like tension, compression, shear, and torsion.
- **Elasticity**—Elasticity is a material's ability to stretch out of shape and return to its original shape.
- **Hardness**—This characteristic is determined by a material's ability to withstand scratches, dents, and cuts.
- **Fatigue**—This is the ability to resist bending and flexing.

Sensory properties are characteristics detected by our senses—color, texture, temperature, odor, flavor, and sound.

Chemical properties control how a material reacts to chemicals. Optical properties relate to how a material reacts to light. Thermal properties relate to how it reacts to heat or cold. Magnetic properties determine a material's reaction to magnetism.

Reading Check **Identify** What determines suitability of a material for a project?

Figure 3.8 **Wood Categories**



Softwood or Hardwood? Trees may be considered as either softwood or hardwood. *Which type of wood is usually used in fine furniture?*

Kinds of Materials

What materials are most often used to make products?

Our world is filled with many useful and unusual materials. However, some materials are most commonly used to make products—wood, plastics, metals, ceramics, and composites.

Wood

Trees fit into two categories—hardwoods and softwoods. If a tree bears cones and keeps its leaves all year long, it is a softwood tree. If a tree loses its leaves during cold or very dry seasons, the tree is a hardwood tree. See **Figure 3.8**.

Once harvested, trees are eventually turned into products such as furniture, fuel, construction materials, or paper. Logs are cut into lumber at a sawmill. The lumber is then seasoned to match normal humidity by air-drying the wood for at least a year or by drying it in an oven, or kiln. The lumber is then ready for additional processing.

Plastics

Plastics are synthetic materials, which means they are not found in nature. Many plastics come from petroleum. Some are produced from plants. Chemical processing can **create** plastics such as thermoplastics and thermosetting plastics.

- **Thermoplastic**—Thermoplastics are formed into products by using heat and pressure. When recycled, thermoplastic parts can be melted, formed, and made into new products. If recycled, thermoplastics are not as harmful to the environment as some other plastics. See **Figure 3.9**.
- **Thermosetting Plastic**—This type of plastic can be heated and formed into a product only once. Thermosetting plastics are difficult to recycle. They can be chopped up and mixed with other materials. Otherwise, they remain in landfills unchanged for centuries.

Figure 3.9 Types of Recyclable Plastics

Identifying Plastics These symbols are used to identify recyclable plastics. Generally, only plastics labeled number 1 or number 2 are recycled. *Why should you know the difference between plastics?*

Metals

Metals are mined from natural rock deposits. Gold mines, uranium mines, and other mining facilities are set up for separating valuable metals from the rock. A mining operation might process tons of rock in order to produce a small quantity of pure metal. For example, the Mission open-pit copper mine in Arizona processes 2,000 pounds of rock to obtain 13 pounds of copper.

Metals are used directly or mixed with other metals or materials to create **alloys**. For example, by itself, copper is used to make copper wire and electronic components. It can be alloyed with tin to make bronze. Iron is alloyed with carbon and other materials to make types of steel. Other metals used in industry include aluminum, chromium, zinc, and lead.

Metals can be processed into many different shapes. Steel, for example, is made into beams for construction that are I-shaped, U-shaped, or L-shaped. Other metal shapes include a sheet, bar, rod, square, hexagon, tube, angle, channel, and octagon.

Ethics in Action

A Call to Recycle

Consumers buy and enjoy having new phones with the latest designs and features. As a result, Americans discard 125 million used cell phones each year. People throw them away even if they still work.

Bad Call Unfortunately, many electronic devices contain toxic substances that can harm the environment. So, electronic waste, or "e-waste," is becoming a major problem in the United States and other countries.

English Language Arts/Writing

Can You Hear Me Now? Many businesses recycle electronic devices. Do some research on the Internet about recycling.

1. Find out which businesses and organizations recycle cell phones.
2. Find out where to recycle or donate used cell phones in your area.
3. Design a poster that includes your findings and encourages recycling.

EcoTech

Environmental IT

How do you make a computer run "green"? Cleaner manufacturing, energy-efficient cooling systems, and recycling old parts help the environment. Using computer memory efficiently is another way.

Try This Back up files and use your disk space fully. Delete junk mail, spam, and unnecessary files in your e-mail inbox to gain more memory.

Ceramics

Ceramics are made from inorganic, mostly nonmetallic, minerals, such as clay, sand, or quartz. High temperatures fuse these minerals into useful products. The firing of clay and sand are ancient technologies.

The two oldest ceramic products, pottery and glass, are very different. Pottery and almost all other ceramics except glass are *thermosetting* materials. Once they are heated and formed, they can never be softened again. Glass, however, can be formed again and again by using heat. Ceramics are used to make sandpaper, pottery, dinnerware, bathroom fixtures, spark plugs, space shuttles, and a variety of other products.

Reading Check **List** What are the most used materials?

Composites

A **composite** is a material created by combining two or more materials to form a new material that is better than each of the original materials would have been. A composite's ingredients provide the correct physical properties, and a binder holds the materials together.

Composites are made with glue, resin, or epoxy binder to bond layers of wood or wood fibers, Kevlar®, or metal together. Concrete is a composite material that is made by mixing sand, gravel, and Portland cement. Most buildings could not be built without using concrete.

section 3.3 assessment

After You Read

Self-Check

1. Name three organic materials that technology turns into products.
2. Explain the difference between a thermoplastic and a thermosetting plastic.
3. Define the words *softwood* and *hardwood*.

Think

4. Name three materials used to make this textbook.

Practice Academic Skills

English Language Arts/Writing

5. Investigate one of the material properties discussed in this chapter. Develop a chart, report, or display that shows what the property is all about.

Social Studies

6. The material used to make the products we use comes from all over the world. Choose a common household product or industrial product. Determine the materials from which the product is made. Research where these materials are found, and then write a short report on your discoveries.

Exploring Careers in Technology

Jess Clark

FORESTRY TECHNICIAN, REMOTE SENSING AGENT

Q: *What do you do?*
A: I use remote sensing (satellite imagery) to create maps of wildfires that show the most severely burned areas. I highlight areas of greatest concern that could be affected by weather events after a fire. One of the biggest problems after a wildfire is the loss of natural vegetation. The ground is more likely to erode during the next rainstorm, and there is a danger of floods and mudslides.

Q: *What kind of training and education did you need to get this job?*
A: I have a degree in geographic information systems (GIS) and a Master of Science in geography, with an emphasis on remote sensing. I also interned with the U.S. Forest Service while I was in college. That government internship turned into a full-time job after I graduated. I worked on my master's degree while working full time.

Q: *What do you like most about your job?*
A: Mapping wildfires is exciting. I map fires all over the country and look at some pretty fascinating imagery. People in the field use my maps, which show the burn severity, to make fast decisions in emergency situations.

Q: *How did you get interested in your job?*
A: I loved geography in high school and was good on a computer. Remote sensing and GIS are perfect fits for me.

English Language Arts/Writing

Tools of Technology The tools that people use to do their jobs have advanced over time.

1. Identify the tools used by a forestry technician, remote sensing agent.
2. Research these tools and the tools that forestry technicians used in the past.
3. Write a short report on your findings.

Go to **glencoe.com** to this book's OLC to learn more about this career.

Real-World Skills
Speaking, listening, analyzing, problem-solving, flexibility

Academics and Education
Geography, computer technology, meteorology, cartography

Career Outlook
Growth as fast as average for the next ten years
Source: *Occupational Outlook Handbook*

chapter 3 Review and Assessment

Chapter Summary

Section 3.1 Separating is removing pieces of a material. Forming changes the shape of materials. In bending, material is formed by moving a part into a different position. In casting, a liquid material is poured into a mold. In compression, a flat material is pressed into a mold. Forging is shaping metal by heating and hammering. In extruding, softened material is squeezed through a small opening. Combining is joining several parts. Mechanical fasteners hold parts together. Conditioning changes the inner structure of a material to improve it. Finishing is the last step.

Section 3.2 Measuring tools are used to identify size, shape, weight, distance, density, and volume. Muscle power operates a hand tool. Electricity supplies the power to operate a portable electric tool. Before you begin a "hands-on" activity, stop and think seriously about safety.

Section 3.3 Mechanical properties of materials relate to how a material reacts to forces. Sensory properties are those we perceive with our senses. Lumber comes from trees. Plastics are synthetic. Metals that are mixed with other metals or other materials create alloys. Ceramics are made from minerals. Composites are two or more materials combined to form a new material.

Review Content Vocabulary and Academic Vocabulary

1. On a sheet of paper, use each of these terms and words in a written sentence.

Content Vocabulary

- separating
- forming
- combining
- conditioning
- finishing
- measuring tool
- hand tool
- portable electric tool
- organic material
- inorganic material
- mechanical property
- sensory property
- alloy
- ceramic
- composite

Academic Vocabulary

- technique
- similar
- ultimate
- attitude
- obtain
- create

Review Key Concepts

2. **Identify** the different technology processes.
3. **Explain** how the different processes are used.
4. **Describe** the purpose of two hand tools.
5. **Describe** the purpose of portable power tools.
6. **Discuss** how to prevent injury using tools.
7. **List** some basic properties of materials.
8. **Identify** common engineering materials.
9. **Explain** metric measurements.
10. **Explain** natural materials.

Bill Miles/Corbis

Real-World Skills

11. **Self-Assess** Think about accidents you have had in the past. What could you have changed about your behavior that might have prevented the accidents? Write a paragraph discussing your conclusions.

STEM Technology Skill

12. **Joining Processes** Glue is an adhesive that forms a film on surfaces that are to be joined. This film adheres to both surfaces being joined and holds the parts together. Different glues are used for different materials.
    a. Use the Internet to find a glue manufacturer that sells different types of glue and explains their uses.
    b. What kind of glue is used on wood? What kind is used on ceramics?

Academic Skills

STEM Science

13. Many products are made from nonrenewable resources. Choose a product that uses such material. Research materials made of renewable resources that could be used to make the product. Find out why companies are not using them. Present your findings in class.

STEM Mathematics

14. Eric is a roofer in charge of laying down sheets of protective material before shingles are applied to a roof. The roof he is working on is 43 feet long and 19 feet wide. What is the area of the material needed for the roof?

Math Concept Area Surface area is found by multiplying the length times the width of a two-dimensional surface. Calculating surface area will result in an answer in square units.

WINNING EVENTS

TSA TECHNOLOGY STUDENT ASSOCIATION

Product Designer

Situation Your team is designing a product to sell to students. The prototype will be made of any materials available. Use discarded material from local businesses. Use tools and machines in your lab to make a prototype.

Activity Brainstorm things to make. Choose and make sketches and prototypes of the best ideas. Compare all prototypes by evaluating which would produce the greatest profit. You may survey classmates as research.

Evaluation The prototypes will be evaluated by these criteria:

- Product design—inventive, easy to make
- Marketable—students will want to buy it
- Profitable—team will make a profit

Go to **glencoe.com** to this book's OLC for information about TSA events.

Standardized Test Practice

Directions Choose the letter of the best answer. Write the letter on a separate piece of paper.

1. Which process is a forming process?
   A separating **C** casting
   B combining **D** conditioning
2. Organic materials come from mineral deposits.
   T
   F

Test-Taking Tip Space your studying out over a few days or weeks, and continually review class material. Do not wait until the night before to cram and learn everything at once.

chapter 3

TECHNOLOGY LAB

Make a Plaster Casting

Some buildings and monuments have engraved cornerstones that are inscribed with the date of construction or other information. You can cast a copy of these inscribed images after you make a mold from the original image.

Tools and Materials

- ✓ Heavy-duty aluminum foil
- ✓ Scissors
- ✓ Adhesive tape
- ✓ Foam shaving cream
- ✓ Thick, heavy-duty cardboard or lightweight wood larger than the image
- ✓ Plaster of Paris
- ✓ Bowl, stirring stick, and water for plaster mixture
- ✓ Paint or dark wax shoe polish

Set Your Goal

Your goal for this lab is to first locate an engraved image that you would like to copy. Then you will make a mold and cast a replica of the engraved image.

Know the Criteria and Constraints

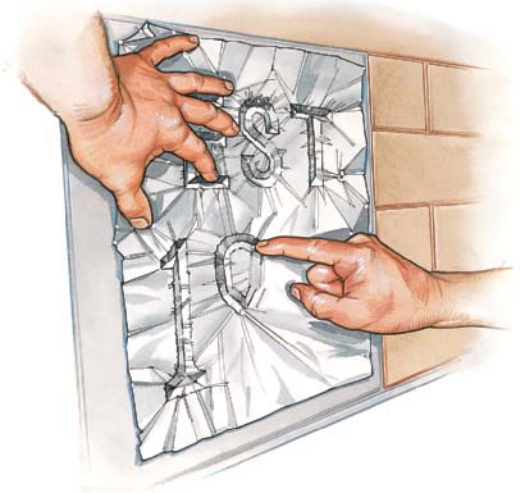
In this lab, you will:

1. Determine if you want to copy an image that is part of private or government property.
2. Obtain permission from the owner or manager of the property.

Design Your Project

Follow these steps to design your project and complete this lab.

1. Find an engraved image that is fairly small, about 8 inches by 10 inches.
2. Go to the site of the engraving with a group.
   - Bring foil, scissors, tape, shaving cream, and cardboard.
   - Cut a piece of aluminum foil that includes a 3- to 4-inch border.
   - Center the foil over the image and carefully push it into the image with your fingers. Work slowly and carefully to avoid tearing the foil.



SAFETY

Reminder

In this lab, you will be using tools and materials. Be sure to follow appropriate safety procedures and rules so you and your classmates do not get hurt.

3. Create a mold of the engraving.
   - While one person holds the foil, another covers the piece with shaving cream.
   - Quickly place the cardboard or wood on the shaving cream, which acts as a light glue.
   - Carefully pull back on the cardboard to pull the foil from the building surface.

4. Return to your classroom.
   - Place the cardboard on a table with the foil facing up.
   - Fold up the edges of the foil, and double them over to form sides.
   - Strengthen the corners of the mold with tape.
5. Create the casting.
   - Mix the plaster of paris according to directions. Make enough to cover the mold.
   - Pour the plaster into your mold and shake the mold a little to help prevent air bubbles. It hardens in a short time, so work quickly.
   - After the casting hardens, peel away the aluminum foil. Your casting will be a brilliant white.
6. Paint or rub the background with dark wax shoe polish to make the message easier to read.
7. Display the casting in class with a description and photo of the original image.

Evaluate Your Results

After you complete the lab, answer these questions on a separate piece of paper.

1. Did your first casting turn out as well as you expected?
2. How long did the plaster remain workable before it hardened?
3. What properties did it have that made it suitable for this activity?

Note: If you wish, make another casting to improve your skill.

Academic Skills Required to Complete Lab

Tasks	English Language Arts	Math	Science	Social Studies
Research local sites to find engravings.		✓		✓
Make mold and plaster cast.		✓	✓	
Write evaluation of process.	✓		✓	
Create presentation of cast.	✓		✓	✓
Present to the class.	✓			