

Lesson A3–3

Using Power Tools

Unit A. Mechanical Systems and Technology

Problem Area 3. Construction Systems

Lesson 3. Using Power Tools

New Mexico Content Standard:

Pathway Strand: Power, Structural and Technical Systems

Standard: VII: Develop skills required to use construction/fabrication equipment and tools.

Benchmark: VII-A: Use tools in the workplace to demonstrate safe and proper skills with construction/fabrication hand tools.

Performance Standard: 3. Demonstrate safe and proper techniques in using hand and power tools in construction/fabrication. 4. Demonstrate hand and power tools use to construct/fabricate an actual project according to blueprints or plans.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Explain and compare the power sources used for power tools.
2. Discuss power tool safety.
3. Explain how to operate portable power tools.
4. Discuss the operation of stationary woodworking power tools.

List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

Herren, Ray V., and Elmer L. Cooper. *Agricultural Mechanics Fundamentals & Applications*. Albany, New York: Delmar Publishers, 2002. (Textbook, Lab Manual, and Teacher's Manual—Units 14 and 15)

Phipps, Lloyd J., et al. *Introduction to Agricultural Mechanics*, Second Edition. Upper Saddle River, New Jersey: Prentice Hall Interstate, 2004. (Textbook, Chapter 5)

Power Tool Transparency Set. Danville, Illinois: Interstate Publishers, Inc.

Other Resources. The following resources will be useful to students and teachers:

Burke, Stanley R., and T.J. Wakeman. *Modern Agricultural Mechanics*. Danville, Illinois: Interstate Publishers, Inc., 1992. (Textbook, Chapters 13 and 14)

Phipps, Lloyd J., and Reynolds, Carl L. *Mechanics in Agriculture*. Danville, Illinois: Interstate Publishers, Inc., 1992. (Textbook Chapters 13 and 14)

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copies of student lab sheets
Power tools

Terms. The following terms are presented in this lesson (shown in bold italics):

Band saw
Belt sander
Chain saw
Drill chuck
Drill press
Finishing sander
Ground fault interrupter (GFI)
Grounding
Hammer drill
Hydraulic tool
Jointer
Miter gauge
Motorized miter saw
Planer

Pneumatic tool
Portable circular saw
Portable disc grinder/sander/buffer
Portable drills
Portable power tools
Power nail guns
Power staplers
Power tool
Push stick
Radial arm saw
Reciprocating saw
Rip fence
Router
Sabre saw
Scroll saw
Stationary power tools
Table saw

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Tour the shop showing the students the portable and stationary power tools available for their use. Ask students which tools they have used. Talk about the importance of knowing how to use the various tools. Touring a hardware store or a tool rental business would be helpful in seeing power tools. Use the internet to compare tools from major tool companies. Some of the major companies are Milwaukee, Delta, Black & Decker, Dewalt, and Makita.

Summary of Content and Teaching Strategies

Objective I: Explain and compare the power sources used for power tools.

Anticipated Problem: What are the power sources used with power tools?

- I. A **power tool** is any tool that has power for its operation from a source other than human force. While humans may move the power tool or parts of the power tool in its operation, the major power for operating the primary working part(s) is not from human effort. Power for power tools is from four primary sources: electricity, fuel engines, pneumatics, and hydraulics.
 - A. Electric-powered plug-in power tools are the most commonly used power tools. Saws, drills, and sanders are the popular tools. Portable battery powered drills have become very popular. The charger is plugged in to recharge the battery.

- B. Fuel engines are typically gasoline, but diesel and propane are sometimes used. Engines are used on tools that are not in locations where electricity, pneumatic, or hydraulics can be used. Chain saws, leaf blowers, post hole diggers, and electrical generators are examples of fuel engine powered tools.
- C. A **pneumatic tool** uses compressed air as power for operation. Pneumatic powered nailers and staplers are commonly used in construction.
- D. A **hydraulic tool** uses a compressed liquid, usually oil, to provide the power for tool operation. Jacks, loaders, lifts, and presses are often hydraulically powered.
- E. Frequently, combinations of two power sources are used. Hydraulic pressure is typically developed by using an electric motor or a fuel engine. Electric motors are used to develop air pressure to operate pneumatic tools. Gasoline engines are used on portable electric generators to power electric tools.

Either of the recommended texts contains general information on this objective. Have students read the suggested chapter. Show examples of tools powered by electricity, air pressure, and hydraulics. Use TM: A3–3A. Discuss situations when each of the power sources make sense.

Objective 2: Discuss power tool safety.

Anticipated Problem: What do I need to know in order to operate power tools safely?

- II. A big difference between hand tools and power tools is that power tools are more dangerous. Accidents with power tools are often more serious. Improper use can result in losing an eye, finger, hand, or even your life.
 - A. Never operate a power tool without reading the operator’s manual. An operator’s manual is a written description of how to safely use and maintain a power tool. A manual usually accompanies a new power tool. Proper assembly, installation, service procedures, and parts lists as well as operating instructions are given. Check out a new tool before operating it with special attention given to condition of any shields or guards.
 - B. **Grounding** is to prevent electrical shock. All electric-powered tools should be properly grounded so that if a short develops the operator will not be shocked or electrocuted. Grounded tools may be identified by the three-prong plug. Double-insulated tools use two-wire, non-grounded cords with electric parts insulated or separated from the user by special insulation inside the motor and by the use of a plastic motor housing. Check the operator’s manual of any power tool with a two prong plug to be sure it is double-insulated.
 - C. Avoid damp or wet areas when using electrical power tools. A **ground fault interrupter (GFI)** is recommended wherever electricity, people, and water are present. It breaks the circuit whenever there is a ground fault. This protects the operator from electrical shock and potential electrocution. Extension cords are now available with GFI protection. If any moisture is present, wearing rubber sole shoes will increase your resistance to possible electrical shock.

- D. The operator is responsible for selecting and using personal safety protection devices appropriate for the tools that are being used. Eye glasses, goggles, or a face shield are a must. For loud tools ear muffs or ear plugs are important. Leather shoes with steel toes are recommended in many situations. Some situations call for long sleeves, gloves, masks, or respirators.
- E. Keep tools in good condition. Always check the condition of the tool before using it. Guards, shields, cords, and hoses should be carefully inspected. Be sure blades and bits are sharp. Sharp tools will require less pressure to make the tool function resulting in a safer situation.
- F. Study the operator's manual and the recommended textbook material to learn the procedures for safe operation of the tool you want to use. In addition to learning proper procedures, use common sense to help avoid accidents.

Assign students to read the suggested chapters in the recommended resource textbooks. Ask students if they or anyone they know has ever been injured when using a power tool. Talk about what happened, why it happened, and how it could be avoided. Review tool operator's manuals to see the safety instructions. Look at safety rules posted in your shop near stationary power tools and TM: A3–3B transparency. Remind students to “think safety”. Stress the importance of the safety attitude and discuss how easily someone can get hurt. If someone in the community is available who has been injured (lost finger, etc.) use them as a guest speaker to stress safety.

Objective 3: Explain how to operate portable power tools.

Anticipated Problem: How are portable power tools properly operated?

- III. **Portable power tools** can easily be moved from job to job. They save labor and are relatively inexpensive to buy. **Stationary power tools** are too large and bulky to move about so jobs are brought to the tool. Both portable and stationary models of the power tools are designed to do the same work. Portable models are lighter and designed with handles to make them easy to use. Portable power tools with electric cords or air hoses are limited to areas where electricity is present. A cordless power tool is a tool powered by electric energy stored in a battery. Battery-operated power tools make it possible to complete work quickly and efficiently. Purchase a second battery so that one can be charging while the other one is being used. Portable power tools commonly used in carpentry are sanders, drills, saws, and routers.
- A. A **portable disc grinder/sander/buffer** is a rotating disc that is used for work where the material to be ground, sanded, or buffed is too large or heavy to move to a stationary tool. Secure the work, hold tightly to the tool, wear eye protection, and dust mask. A portable **belt sander** uses a rotating sanding belt to rapidly smooth wood. The belt sanders are usually used for rough sanding but the belts vary in coarseness. Most belt sanders are equipped with a dust bag. When putting on a new belt be sure to watch the arrow on the belt so that the belt is installed correctly. Hold the belt sander with both hands and turn on the switch before the sander touches but when it is very near the surface to be sanded. Sand with the grain gently moving the sander in a straight but slightly

sideways back-and-forth motion. A **finishing sander** is used for final sanding. It moves in a forward and backward motion or in an orbital or circular motion at a high rate of speed. Move the finish sander back-and-forth with the grain of the wood until the desired smoothness is achieved. Several fineness grades of sandpaper are available.

- B. **Portable drills** are usually variable speed, reversible, and sized by the maximum size hole they can drill (ex. $\frac{1}{4}$ inch, $\frac{3}{8}$ inch, or $\frac{1}{2}$ inch). When drilling metal, first mark the location to be drilled with a center punch. Be sure to secure the work with a clamp or in a vise prior to drilling. Exert pressure to help get the twist drill to go into the material. Relieve the pressure as the point of the bit begins to go through the material. The **drill chuck** is the three-jaw part that holds the bit. Older drills have a chuck key to tighten the bit while the newer drills are usually keyless, self-tightening. A **hammer drill** is a drill that not only turns the bit but also provides a rapid striking action on the bit to speed up drilling in masonry materials.
- C. Portable saws include the sabre saw, reciprocating saw, circular saw, and chain saw.
1. A **sabre saw** has a narrow blade located underneath the base that moves up and down to cut circles, curves, and holes. Most cuts begin at the edge of the material to be cut. In cutting a hole in the middle of a piece of material, first drill a hole so that the blade can be inserted. Be sure the material to be cut is firmly held in position. Move the saw slowly and carefully to achieve quality cuts. Use slower speeds for metal and faster speeds for wood. A sabre saw is also known as a jig saw or bayonet saw.
 2. A **reciprocating saw** (also known as a sawsall or tiger saw) has the blade at the end, much like the chuck of a drill. Any material to be cut should be carefully held in position. The reciprocating saw is larger and heavier than a sabre saw. Blades in a variety of lengths and widths can be used. The reciprocating saw is often used in remodeling work when holes are cut in walls to install new windows.
 3. A **portable circular saw** is a lightweight, motor-driven, round-bladed saw used where stationary saws are impractical. It is the most popular saw used in woodworking. This saw can be used for crosscutting, ripping, and beveling. Because of its high speed and the tendency to kick back, the portable circular saw can be a dangerous tool. Before operating a portable circular saw, read the operator's manual, check the working condition of the guard, see that the saw is grounded and the blade is sharp. Saw to the line. When cutting a long board have a helper support the piece being cut off so that the blade does not kick back when the board is cut.
 4. A **chain saw** is a gas or electric powered saw used in cutting and pruning trees and cutting large pieces of lumber where precision is not important. Cutting with a chain saw is by an endless chain that has teeth attached to links of the chain. The chain is similar to that found on a bicycle. Oil is regularly released onto the chain in small amounts to assure that it moves with little friction around the guide bar. Proper tension adjustment is always needed to assure safety and efficient cutting. A loose-fitting chain can jump from the guide bar and cause injury. Careful attention must be given to safety. The blade must be kept away from parts of the body, such as the

arms, legs, and feet. Always stand with good balance and securely grip the handles. Chain saws sometimes kickback. Without a good grip and balance, the operator could be cut, knocked down, or otherwise injured. Eye protection is always needed. Hearing protection is needed with a chain saw powered by a gasoline engine. Chaps (heavy leg wear), gloves, and steel-toed shoes are recommended. A hardhat is a good idea too.

- D. A **router** is a power tool that has a smooth base that is moved across the material by the operator as the protruding bit turns at a high rate of speed to create grooves and ornamental shapes on the face or edge of wood. The groove or cut is determined by the type, shape, and size of the bit. Bits that are dull, rusted, or covered with gum from the wood are dangerous and should not be used. Clean, sharp bits will provide clean even cuts if the router is held firmly to the wood. Guides and jigs can be used to help do straight lines, circular, or contour routing.
- E. **Power nail guns** are either pneumatic or use a battery generated spark to ignite a charge of gas to drive nails. **Power staplers** are like the nailers only they shoot staples. The guns have a safety mechanism that will prevent firing nails or staples unless the gun is in contact with the work to be joined.

Refer students to the appropriate chapters in the recommended texts. Each of them contains general information on the content of this objective. Use operator's manuals and the recommended texts for more information about the procedures for using portable power tools. Use TM: A3–3C to show pictures of the portable power tools. Use LS: A3–3A to complete skill development shop exercises with portable power tools. Additional lab sheets are included in the Agricultural Mechanics Fundamentals & Applications Lab Manual (Unit 14) listed in the recommended resources.

Objective 4: Discuss the operation of stationary woodworking power tools.

Anticipated Problem: How are stationary woodworking power tools operated?

- IV. Stationary power tools are large machines that have a permanent location in the shop. Plan the location of each machine to allow sufficient room to work. Keep guards and shields in place. Keep blades, knives, and bits sharp. Follow manufacturer's recommendations for the installation, use, adjustment, and repair of each machine. Use a safety tape to mark the safety zone around each machine where only the operator is allowed to stand. Wear safety glasses and be sure to shut off the machine before leaving the safety zone.
 - A. A **drill press** is a stationary drill designed for accurate and heavy drilling jobs. A drill press gives an operator an easy control mechanism for feeding the drill bit into the work. Be sure to clamp the work to be drilled securely to prevent accidents. If too much pressure is applied, the bit will overheat or break. Be sure to wear safety glasses and use a sharp bit.
 - B. A **table saw** has a platform or table with a circular blade where the wood to be sawed is pushed into the blade. Adjust the blade depth so it protrudes $\frac{1}{4}$ inch through the material to be cut. Either the table or the blade may be tilted to cut angles. A **miter gauge** is

the guide that is used to line up the wood to be pushed into the blade. The miter gauge can be set to make square or angle cuts. When cutting long boards they need to be supported to avoid kickbacks or pinching of the blade with the wood. A **rip fence** is adjusted to a desired width to guide the wood being pushed through for ripping. A **push stick** is a 12 inch long piece of wood with a notch in the end used instead of the fingers to push the wood when it gets close to the blade. Whenever the table saw is used the guard should be in place and the kickback fingers set to touch the wood.

- C. A **radial arm saw** has the motor and blade suspended on an arm over the table of the saw. While the wood is held against the fence, the blade is pulled into the wood to be cut. The blade/motor unit can be pivoted to cut angles or to rip boards. The most popular use of the radial arm saw is for cutoff work, including squaring boards, cutting them to length, and cutting them at angles or bevels.
- D. A **motorized miter saw** (also called cutoff saw and chop saw) has a circular blade that is lowered into the material that is being cut. Because of its spring-loaded mechanisms once the cut is made the blade unit returns to the up position. The saw is capable of cutting 45 to 90 degree angles. With a fine-toothed blade this saw is used to cut the angles for molding. The same saw with a carbide tip blade becomes the chop saw used to cut 2 × 4's when framing a house.
- E. A **band saw** uses a long continuous blade that moves between guides, pulleys, and wheels. An electric motor turns the drive wheel using belts and pulleys. The blade has teeth on one edge that can quickly cut material. Band saws are used to make curved and straight cuts. The material to be cut is placed on the platform and pushed into the blade. Care should be taken not to push the material into the blade too rapidly. Band saws may be equipped with a tilting table, a miter gauge, and a rip fence. A table mount saw similar to the band saw only smaller with a blade that moves up and down instead of in a circle is called a **scroll saw**. It is used mostly for cutting thin material to make craft projects.
- F. A **planer** has sharp knives in a wheel that turns to shave or dress the sides of boards to a uniform thickness. The planer is an excellent tool to level and smooth wide pieces made by gluing boards together. The depth of cut is the main adjustment. Trying to remove too much wood in one pass through the planer is a common problem. Once a board is started in the machine, the machine is self-feeding. Be sure to carefully examine any board to be planed for freedom of nails and screws. They can cause major damage to the cutting knives. Sharp, properly installed knives are essential to successful planning.
- G. A **jointer** uses sharp knives fastened to a cylinder turning at a high rate of speed to straighten and smooth edges of boards and to cut bevels. The jointer is potentially a very dangerous tool. The knives can inflict severe cuts and lumber may be thrown if not handled properly. All knives need to be installed so their cutting edges extend to the same height and leave the board smooth and even as the cutter head rotates. The rear outfeed table is adjusted so it is level with the cutting edges of the knives. The height of the front infeed table determines the depth of cut. Be sure the guard is in place and covers the knives except where the lumber is against the fence.

Assign classroom reading in the recommended textbooks. Use TM: A3–3D and a tour of the shop to identify stationary power tools. Demonstrate the proper operation of the tools. Use operator’s manuals and recommended texts for additional information about adjustments and proper operation. Use LS: A3–3B to help students develop skills using stationary power tools. Unit 15 of *Agricultural Mechanics Fundamental & Applications Lab Manual* has additional lab sheets.

Review/Summary. Use tools and transparencies to compare power sources for power tools. Stress the safety attitude and the importance of reading/following the operator’s manual. Review procedures for operating the various tools.

Application. Using the lab sheets provides the opportunity to use the power tools. Build a project that would incorporate the use of several power tools. A variety of plans for projects all the way from tool caddies, bird houses, and sawhorses to utility buildings are readily available.

Evaluation. Complete the written text. Grade lab sheets and the project built by the students.

Answers to Sample Test:

Part One: Matching

1 = d, 2 = c, 3 = b, 4 = a, 5 = e, 6 = f, 7 = g, 8 = h, 9 = i, 10 = j

Part Two: Completion

1. pneumatic
2. hydraulic
3. Portable, stationary
4. Belt, finish
5. Drill chuck
6. compressed air, electric

Part Three: Short Answer

1. Electricity, fuel engines, pneumatics (compressed air), hydraulics.
2. Miter gauge is used for pushing the wood for crosscutting. The rip fence is used to set the width when crosscutting or ripping. The push stick is used to push the wood into the blade when finishing the ripping of a board.
3. A Sabre saw has a narrow blade located underneath the base while a reciprocating saw has a blade at the end much like the chuck of a drill. The reciprocating saw is used for rough cutting and is generally larger with a longer blade.

Test

Lesson A3–3: Using Power Tools

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

- | | | |
|----------------|------------------------|---------------|
| a. band saw | e. motorized miter saw | i. scroll saw |
| b. chain saw | f. planer | j. table saw |
| c. drill press | g. radial arm saw | |
| d. jointer | h. router | |

- _____ 1. Uses sharp knives fastened to a cylinder to straighten and smooth edges of boards.
- _____ 2. Stationary tool used to make holes in material.
- _____ 3. Used to prune trees and make rough cuts in construction work.
- _____ 4. Uses a long continuous blade and the wood is pushed into the blade.
- _____ 5. Also called a chop saw and used to cut square or angle cuts.
- _____ 6. Used to shave or dress the side of a board.
- _____ 7. Blade/motor unit is suspended from an arm and the blade is pulled into the wood.
- _____ 8. Used to cut grooves and ornamental shapes by sliding the face of the tool over the wood.
- _____ 9. Usually a table mount saw that has a narrow blade that moves up and down to cut curves in thin material.
- _____ 10. A stationary tool with a circular blade protruding through a platform and the wood is pushed into the blade.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

1. A _____ power tool is powered by compressed air.
2. A _____ power tool is powered by a compressed liquid, usually oil.
3. _____ power tools can easily be moved from job to job while _____ power tools are too large and bulky to move about so jobs are brought to the tool.

4. _____ sanders are for rough sanding and _____ sanders are for final sanding.
5. _____ _____ is the three-jaw part that holds the bit.
6. Power nailers are either _____ or _____ powered.

Part Three: Short Answer

Instructions. Provide information to answer the following questions.

1. What are the four ways that power tools are powered?

2. How are a miter gauge, rip fence, and push stick used with the table saw?

3. What is the difference between the sabre saw and reciprocating saw?

POWER TOOL POWER SOURCES

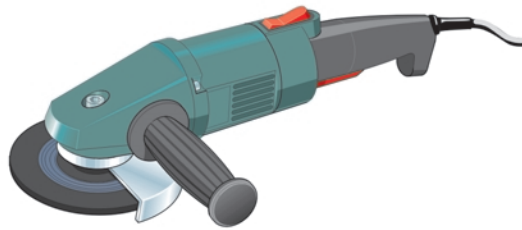
POWER SOURCE	EXAMPLES
1. Electricity	Saws
a. Plug-in Drills	Sanders
b. Battery Power	Drills
2. Fuel Engines (Gasoline & Diesel)	Chain saws Leaf blowers Post hole diggers Electric generators
3. Pneumatics (air power)	Nailers Staplers
4. Hydraulics Jacks	Loaders Lifts Presses

SAFETY IN USING POWER TOOLS

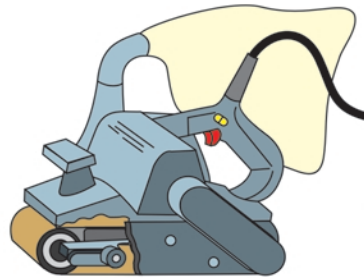
- 1. Read and heed the operator's manual**
- 2. Use grounded or double insulated tools**
- 3. Use GFI protection where moisture is present**
- 4. Use appropriate personal protection equipment**
 - a. Eye glasses, goggles, or face shield**
 - b. Leather shoes with steel toes**
 - c. Ear muffs or ear plugs**
 - d. Long sleeves**

- e. **Gloves**
 - f. **Mask or respirators**
- 5. Check the condition of the tool before operating**
- a. **Guards, shields, cords, hoses**
 - b. **Sharpness of blades and bits**

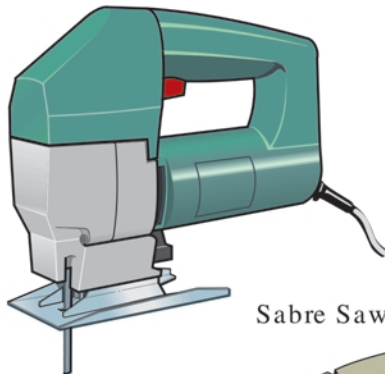
EXAMPLES OF PORTABLE POWER TOOLS



Portable Disc Grinder/Sander/Buffer



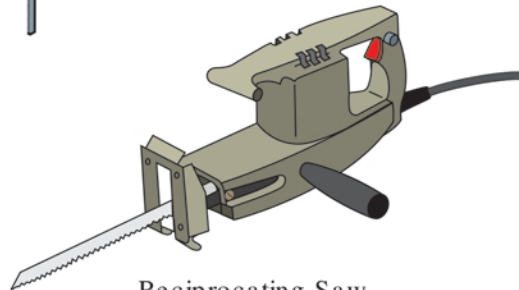
Belt Sander



Sabre Saw



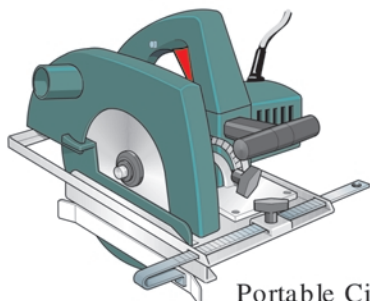
Portable Plug-in Drill



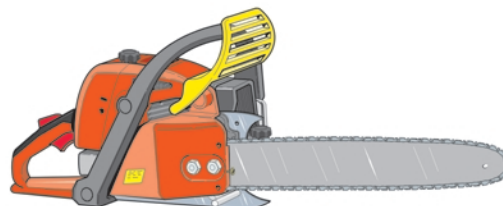
Reciprocating Saw



Router



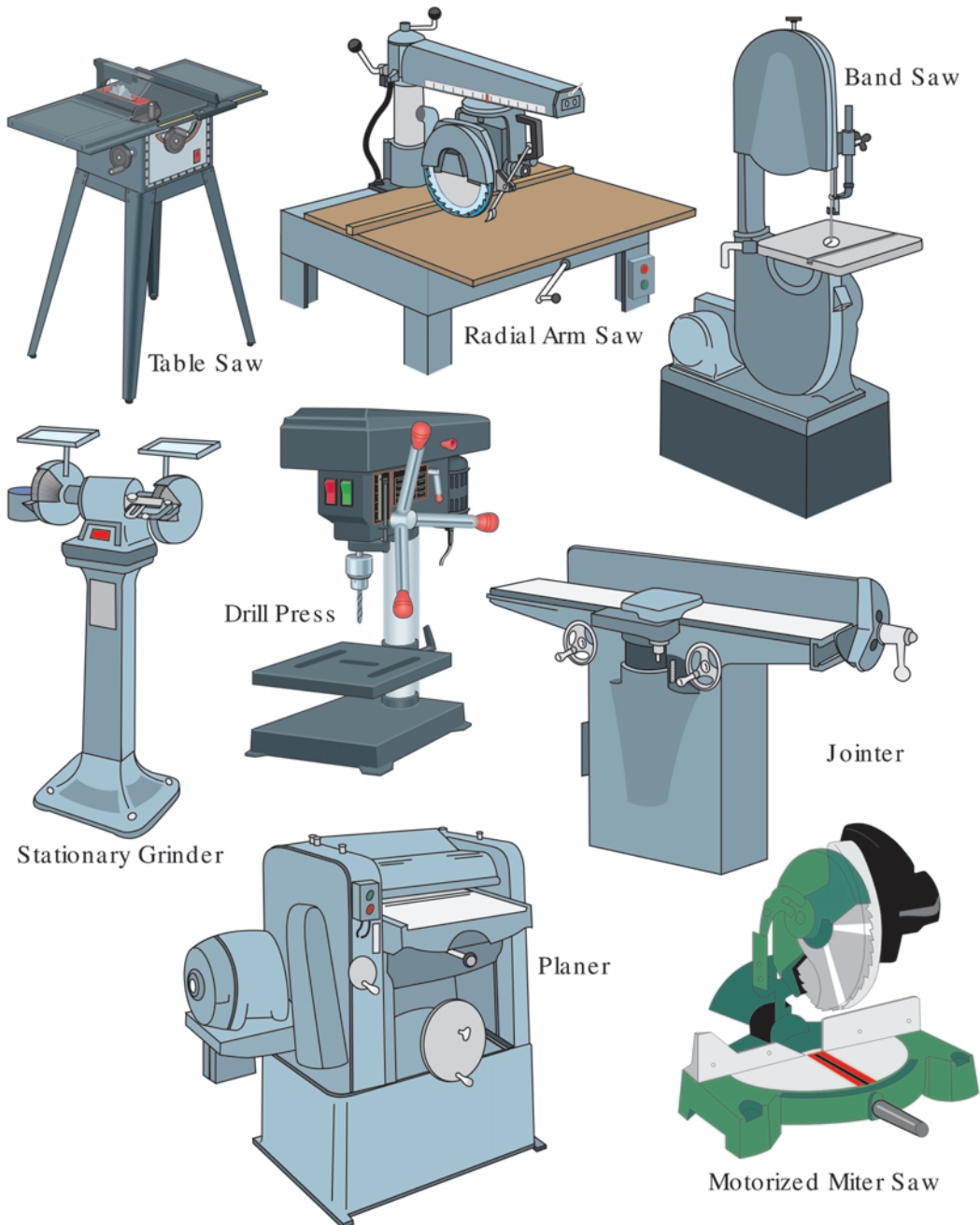
Portable Circular Saw



Chain Saw

(Courtesy, Interstate Publishers, Inc.)

COMMON STATIONARY POWER TOOLS



(Courtesy, Interstate Publishers, Inc.)

Lab Sheet

Portable Power Tool Skill Development Shop Exercises

... wear safety glasses and inspect the condition of all tools prior to use

- _____ 1. Measure, mark, and cut a 2×4 twelve inches long with a portable circular saw.
- _____ 2. Clamp the board and use a belt sander to smooth one side of the 2×4 .
- _____ 3. Turn the board over, re-clamp, and use the finish sander sand that side smooth.
- _____ 4. Use a portable drill to drill a $\frac{1}{4}$ inch hole centered in a 2×4 located two inches from the end of the board.
- _____ 5. Obtain a piece of plywood from the instructor, measure/mark a six inches diameter hole, and use the sabre saw to cut out the circle.
- _____ 6. Cut a 2×6 ten inches long with a reciprocating saw.
- _____ 7. Cut a 4×4 into with a chain saw.
- _____ 8. Use the router to round the edge of a 1×6 twelve inches long.
- _____ 9. Use a power nail gun to drive a nail in the 4×4 .
- _____ 10. Use a power stapler to drive a staple in the 4×4 .

Lab Sheet

Stationary Power Tool Skill Development Shop Exercises

... wear safety glasses and check the condition of the machines before operating

- _____ 1. Square, mark, and cut the end of a 2×4 with the radial arm saw.
- _____ 2. Measure, mark, and cut the other end of the 2×4 so that the board is 12 inches long.
- _____ 3. Use the 12 inch board on the motorized miter box to cut a 45 degree angle on one end.
- _____ 4. Use the jointer to joint one edge of the 2×4 .
- _____ 5. Use the drill press to drill a $\frac{1}{4}$ inch hole centered in the 2×4 located four inches from the square end.
- _____ 6. Use the table saw to rip a 1×4 in half (be sure to use a push stick).
- _____ 7. Use the band saw to cut a six inch circle in a piece of plywood.
- _____ 8. Use a planer to plane one side of a piece of rough oak until it is smooth.