Maker Skills

In the hands of students, maker skills and tools can help transform abstract concepts into tangible objects, especially those students and classrooms who need a piece of equipment that doesn't exist or is too expensive to purchase using available funds.

Maker Pedagogy has been defined as an approach that utilizes the principles of *ethical hacking, adapting, designing*, and *creating* as part of an overall way of learning about science and technology. This means that students will be involved in the learning process as they deconstruct a task into the specific building requirements needed to reconstruct a more useful model for performing scientific investigations. As students build upon this knowledge, going from simple procedures and models to more complex process and designs, they will improve their problems solving skills, analytic reasoning, and gain contextual knowledge through engaging in the "making" process.

Many students are clueless when it comes to "making" and using hand tools. As such it will become import for you to monitor students on use and safety of hand tools and "making" processes, even after students have successfully met all requirements for using hand tools in your classroom or "Maker Space."

Knowing how to handle tools is an essential skill everyone should have the ability to do correctly. Students will become more self-reliant, your supply budget money will stretch further, and students will develop a more in-depth knowledge of the concepts they are exploring when they are required to "make" their own experimental apparatus.

How to Use a Handsaw

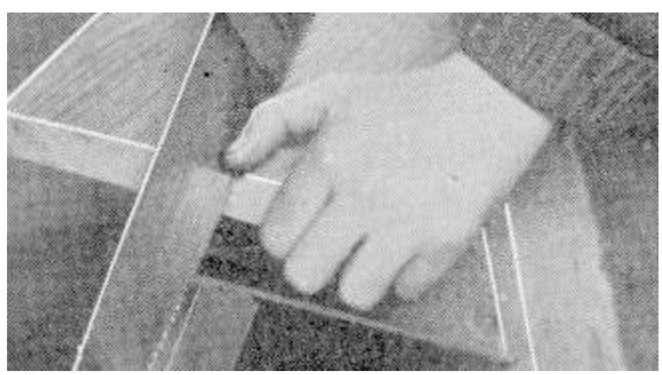
Before students put saw to wood, they need to determine what sort of handsaw they will need for the job. There are two basic designs of handsaws: the crosscut saw and the rip saw. In all actuality, which one you use depends on whether you plan on cutting with or against the wood grain. Most hardware stores sell a standard handsaw that can do both, and this type of saw will work fine for all projects described in this unit.

Many saw's are designed to allow the saw to cut on both the push and pull stroke. Typically, carpenters and woodworkers follow a few simple guidelines when using a hand saw.

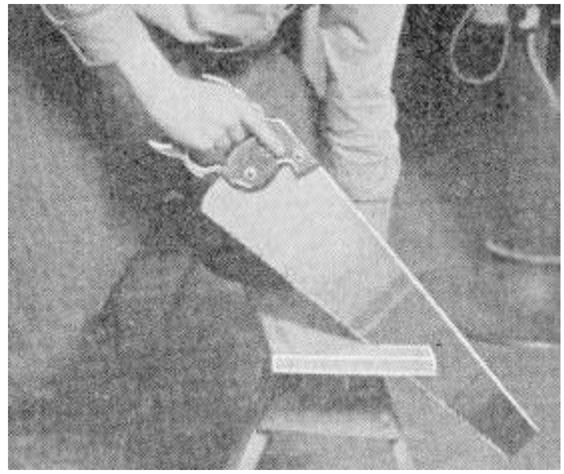
- **Mark the cutline.** Remember the timeless rule of carpentry: measure twice, cut once. Students should measure where they want a cut and draw a line marking where they want the cut to be. The line will act as a guide to help them get a straight cut.

- **Make the starting cut.** When students make the first cut, have them use their thumb or the knuckle of their thumb on the hand holding the wood as a guide to ensure they cut along the cutline.

  Have students start their cut with the teeth *near* the handle. This will give them the best control. Make a few back cuts until they get a nice kerf (opening in the wood).



It may be helpful to remind students not to start their cut right on the line. Have them cut right next to the line on the waste side, or side they do not want. It is always better to have a piece of wood that is a bit long, than a bit short. They can always shorten a piece of wood if more precision is required, but you can never stretch a piece of wood.



- **Angle the saw correctly.** After they get their kerf going, students need to angle their saw correctly to get the best cut. This is typically between 45 and 60 degrees to the cutting surface. Some carpenters and woodworkers go so far as to break it down according to specific types of saws.

- **Hold your elbows close to your body.** To counteract the natural tendency to angle the blade away from perpendicular, have students hold their elbows close to their body when sawing. This will also help them prevent a twisting and tilting motion on the blade, thus ensuring a nice, clean cut.

  Students should grip the handle so that their forefinger extends along the side of the handle. This will help them "point" the saw along the line and ensures more accurate cuts. They should also hold on to the handle firmly, but not too tightly.

- **The stroke.** After students have started the groove, a few short forward strokes will deepen the cut so they can move the hand they used as a guide away from the blade. Students will then be able to push the saw with an easy, free-running motion. Remind them to use long strokes so that each tooth does a fair share of the work. Short strokes make it harder to cut.

  Students should resist the temptation to bear down on the saw. It won't do anything except tire them out. Let the saw do the work. If they feel like the saw isn't cutting properly, the saw may be binding or it may be dull and in need of sharpening.

- **For straight cuts, use a guide.** For some students, simply using the pencil line as their guide to cutting just doesn't work. If students want to ensure that they get a true and square cut, have them place a small board, as a guide, along the pencil line and clamp it to the board they are cutting. The board will now act as their guide to keep the saw on the line. If available, a miter box can be another effective means of ensuring an accurate cut

- **Correcting veering.** Even the best carpenters and woodworkers veer from the cut line occasionally. If this happens to students, tell them to avoid the natural tendency to twist and bend the saw blade so it gets back on track. This will only result in an uneven and rough cut. Instead, have students stop sawing and bring their blade back to the point where they veered off and start sawing again on the line.

- **Prevent binding.** The biggest problem students will encounter is binding. Binding occurs when the kerf closes in on the saw. To prevent this, have students place a nail in their kerf. This will keep it open. Remind students that they may need to move the nail towards them as they saw.

Cordless Drill/Driver Basics

A cordless drill/driver can handle all the drilling and driving needs for the projects described in this unit. A cordless drill/driver will give students all the benefits of a drill without the hassle of a power cord or the fatigue associated with a hand held screwdriver.

All cordless drill/drivers come with a battery and a charger, with some kits including a spare battery. For drills with **lithium-ion batteries,** you can keep a battery on the charger at all times so they will be ready whenever you have a project you want your students to complete. For other battery types, only charge the batteries as needed — this will help you get the longest life from your batteries.

All cordless drill/drivers have **forward** and **reverse** settings and a **variable speed** trigger. This means that the more pressure you put on the trigger, the faster the bit spins. There is typically a **high and low torque switch** on top of the drill/driver. Higher speeds with low torque are for drilling while lower speeds with high torque is for driving. Most drill/drivers also have an **adjustable clutch** that gives you even more control over torque and helps you prevent overdriving.

The **chuck** of the drill/driver is the part that holds the bits in place. You will want a drill/driver with a 3/8-inch chuck in order to handle bits and accessories with a shank — the portion of the bit the chuck secures — 3/8 inch or smaller. Some larger bits have a reduced shank for use on smaller drill/drivers. Any task students are required to complete along with this unit will not require a bit with a shank larger than 3/8 inch.

If students have access to a 20 to 40-piece drilling and driving accessory kit, they will have everything you need to do all projects, challenges, and investigations associated with this unit.

1. To drill a hole, have students select a drill bit that is appropriate for the task. If doing a pilot hole pick a drill bit a little smaller than the tip of the screw.
2. To insert the drill bit into the drill/driver have students hold their hand firmly around the chuck of the drill (#1 below), and keeping it still while running the drill in reverse, open the chuck (#2) or run the drill forward to close the chuck (#3).

3. When the chuck opening is big enough, have students insert the bit or driver. Remind students to not allow the bit or driver to fall to far into the chuck opening.
4. Have students hold their hand firmly around the chuck of the drill as they did before and run the drill in the forward motion until the drill bit or driver is secured in the drill (#4).

5. Students should place the tip of the bit on the desired location for the pilot hole and ensure that the drill is straight and true with respect to the board orientation.
6. While pulling firmly on the trigger, students will use a firm and steady motion, to create their hole. There should be little pressure required to drill a vertical pilot hole within a board because the weight of the drill will do most, if not all of the work. Horizontal holes will require a firm pressure while maintaining correct orientation with the board.

- **Create a pilot hole.** When driving screws into wood, it's a good idea to drill a pilot hole first. Without pilot holes, screws tend to follow the grain of the wood, which results in crooked screws. Thus, pilot holes ensure that students drive the screw in straight.

  Pilot holes also help prevent the wood from splinting as students drive in screws. For small screws, a pilot hole can be made with a small diameter drill bit. For larger sized screws and all screws in hardwood, drill a pilot hole using a drill bit with a counter sinking ability.

  After students have drilled their pilot hole(s), they can attach their screwdriver bit and drive the screw in. Attachment of the screwdriver bit, and driving their screw, is accomplished the same way as inserting a drill bit and drilling a pilot hole.

Driving a screw with a screwdriver. Place the screw on the driver tip and hold both screw and tip together with the fingers of one hand. Align the screw tip with the pilot hole drilled previously and apply very little pressure on the driver. If using a cordless drill/driver, apply a small amount of pressure to the trigger to begin the driving process. If using a hand held screwdriver, begin by turning in a clockwise direction until the screw engages the wood.

When the screw's thread engages with the wood, move fingers that were holding the screw in place to the screwdriver shank. Use this hand to hold the piece of wood securely in place. Apply enough pressure on the screwdriver or trigger of the drill/driver to keep the driver tip engaged with the screw.

Screwdrivers only do one job: drive and draw screws. No matter how much care you take with your screwdrivers, they are bound to get worn or chipped. If you notice your screwdriver's tip being a bit rounded or chipped, avoid using it. You risk the screwdriver slipping from the screw and injuring your students.

It is important to keep a watchful eye on students when using the cordless drill/driver as they often provide more torque and power than is needed. If students are not careful, they can strip the screw or cause injury to their hand and other nearby objects. Using a pilot hole prevents these sorts of things because the screw will drive more easily and run true to the pilot hole.

When you are driving a screw, you will want to use a screwdriver bit in the end of your drill that matches the type of screw you are driving. Most likely, you will need to use a Phillip's head drill bit but you may also choose square head and star (torx) head screws.

How to read a Tape Measure

Many skills are used to investigate the world around us. We make observations by gathering information with our senses. Some of these observations are simple while others may needto have measurments taken. Measurements are perhaps one of the most fundamental concepts in science, engineering, construction, manufacturing, and many other occupations and activities.

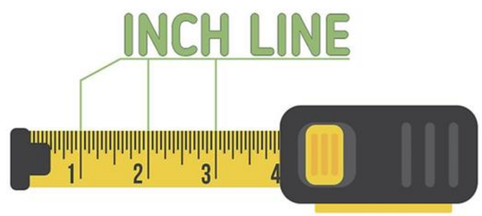
Measurements require tools that provide their user with a quantity. A quantity describes how much of something there is opr how many theire are. A good example of measurement is using a ruler to find the length of an object. The object is can be measured to determine a length, weight, volume, or any other number of physical properties.

All activities in this unit will require students to measure lengths using a standard tape measure. Students will then be taught how to convert these values into other usable units. A standard tape measure is used because it is what the majority of students will be required to use in their jobs and careers.

There are several types of measurements made during the activities of this unit. The most common measurements are length, mass, and time. Length is a measure of how long an object is and can be determined by using a tape measure or rule. Length, mass, and time are classified as base units, meaning that they are independent of all other units. Students will learn more about base units in lesson 4 of this unit.

Using a tape measure can be a quick, easy way to get needed information or obtain the needed components to a project. Knowing how to use and read a retractable measure can be a major asset to anyone working with his or her hands.

All tape measures have big numbered markings to aid in measure for inches. These numbers are associated with other marks on the tape measure, the most prominent of which are the one-inch marks. These marks are typically long, thin lines with a corresponding number.

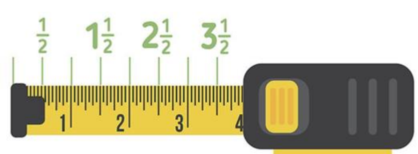


- Every 12 inches, there will often be a foot marking. This is usually in a different color than the other markings — often red in contrast to the normal black markings. The numbers next to each inch mark will keep a continuous count while the foot markings may be followed by a repeat from 1 - 11. This can vary from tape measure to tape measure.

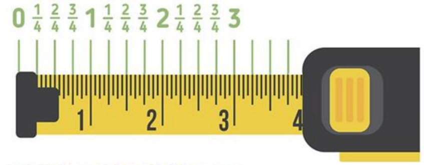
- Note that the line next to the number marks each inch, not the number itself.

Reading a tape measure

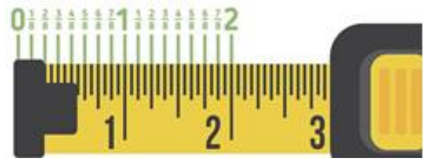
1. Use the bigger marks between two inch markings for half-inches. A half-inch mark is always centered between any two one-inch marks. It almost always has the second-longest marking (after the one-inch marks). There will be one half-inch mark between each one-inch mark, but it is important to remember that there are two half-inches per inch.
   - Note that, starting with half-inch marks, not all lines may be labeled with numbers. In this case, students will need to use the markings on either side to guide them. For example, the half-inch mark between inches three and four stands for 3 1/2 inches, even though it's not labeled.



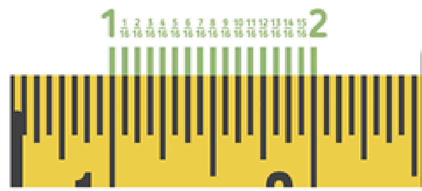
2. Use the smaller lines between half-inches for quarter-inches. These markings are smaller than half-inches but usually bigger than the 1/8 and 1/16 inch marks around them. They are evenly spaced between each half-inch mark and one inch-mark. There are four quarter-inches in one inch.
   - Note that lines marking a quarter of an inch sometimes aren't any different in size from eighth-inch marks. In this case, students will need to remember that two eighths of an inch make a quarter.



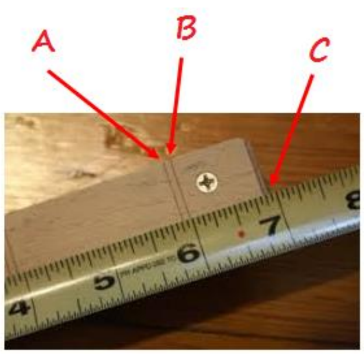
3. The next smaller marks are for one-eighth-inches. These markings are centered between the inch marking and the quarter-inch marking, the quarter-inch marking and the half-inch marking, and so on. There are eight one-eighth inches per inch.



4. The tiny, densely-packed marks are for sixteenths of an inch. These are the shortest lines of all on most measuring tapes are the sixteenth-inch marks.



1. Catch the hooked end on one side of the object you're measuring.
2. Stretch the tape across your object. You can use one hand (or a friend) to hold the end of the tape in place as you pull it back. Let tape out until it stretches all the way across the distance you're measuring.
3. Read directly from the tape by looking at the point where the tape meets the end of the thing you're measuring or the desired measurement on the tape measure.
4. The nearest number below the end of the tape is your number of units you're measuring and the markings between this number and the one above it correspond to fractions of the unit.

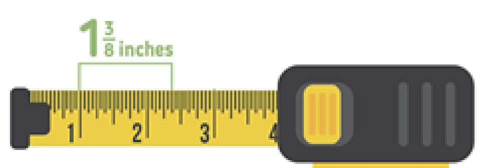


measurement A = 5 and 7/8 inches

measurement B = 6 inches

measurement C = 6 and 15/16 inches

5. Add the inch segments to determine total length. When you are measuring a length, getting an accurate value just means seeing where the tape lines up. Find the nearest inch before this point. Then, find the nearest half-inch before this point. Then, the nearest quarter-inch, and so on. Add up your inches and fractions of inches until you have an accurate measurement. This is a lot easier than it sounds — see below for an example.
   - Let's say that we've measured past the one-inch mark, past one quarter-inch mark, and past one eighth-inch mark. To find our measurement, we need to add:



   1 (our inches) + 1/4 (our quarter-inches) + 1/8 (our eighth-inches).

- Since there are two eighth-inches in a quarter-inch, we can rewrite this as:

  1 + 2/8 + 1/8 = 1 3/8 inches.

- Students may need assistance with adding fractions like 1/2, 1/4, 1/8, as they can be tricky for some students.