USE OF HAND TOOLS

Description

Learning a new skill doesn’t always happen easily or quickly, and using hand tools is no different. Some students may have had a lot of exposure and practice using hand tools and are already competent. Many students will be using hand tools in a different way than they may have before. When doing electrical work, manual dexterity is important. Doing electrical work takes thought, but using hand tools takes practice. Having good hand and tool skills makes an electrician more efficient. Working safely with hand tools in the electrical field is a major skill that must be continually maintained and practised.

Lesson Outcomes

The student will be able to:

• Understand and safely use lineman pliers, wire strippers, and a utility knife
• Cut sheathing off plastic-sheathed cable and extension cord wire
• Identify common hand tools used by electricians
• Use hand tools more competently

Assumptions

• The teacher will know all the common hand tools used by electricians and be able to demonstrate how to safely use pliers, wire strippers, and a utility knife.
• Students will have little knowledge of electrical tools

Terminology

Conductors: the copper or aluminum wires located inside the wire insulation.

Fish tape: a tool for pulling wires or cables through conduits and inaccessible spaces. A fish tape is a very long metal strip with a hook at the end, which can be used to grab a wire or another fish tape, somewhat like catching fish with a hook on a line.

Figure 1—Fish tape
Hacksaw: a fine-tooth hand saw with a blade held under tension in a frame, used for cutting materials such as metal or plastics.

Hand tool: any tool that is not a power tool; one powered by hand or manual labour.

Insulation: the material that surrounds the bare conductors.

Lineman pliers: a type of pliers used by electricians and other tradespeople primarily for gripping, twisting, bending, and cutting wire and cable.
**Needle-nose pliers**: pliers with long, slender jaws used for grasping small or thin objects.

![Needle-nose pliers](image5)

**Figure 5**—Needle-nose pliers

**Non-metallic sheathed cable (NMSC)**: a common plastic-sheathed cable used for wiring wood frame construction buildings. Known by trade names Loomex (Canada) and Romex (USA). It is available as 2 or 3 conductor and sizes #14 (15 amp), #12 (20 amp), #10 (30 amp), #8 (45 amp), and some larger sizes. The conductor count does not include the uninsulated wire that is used as a ground wire. The outer jacket can be colour-coded to make the wire sizes easier to identify.

![Non-metallic sheathed cable (NMSC)](image6)

**Figure 6**—Non-metallic sheathed cable (NMSC)

**Screwdriver**: a hand tool for turning a screw, consisting of a handle attached to a long, narrow metal shank, and available with a variety of tips. Common types for electricians are Robertson® (square tip) in sizes #1 and #2, slotted (flat tip), and Phillips® (star tip).

![Types of screwdrivers](image7)

**Figure 7**—Types of screwdrivers
The parts of a screwdriver are the head, handle, ferrule, shank, blade, and tip. The length of the blade indicates the size of a screwdriver. Some screwdrivers may have square shanks that permit turning with a wrench when required for extra torque.

The stubby screwdriver is available in all sizes of slot, Robertson®, and Phillips® tips. The blade and handle are very short.
Side cutters: general-purpose cutters used to snip light-gauge wire or cable.

Figure 11—Side cutters

Torpedo level: a spirit level or bubble level is designed to indicate whether a surface is horizontal (level) or vertical (plumb). They commonly have a magnetic edge to attach to metal electrical boxes or conduit.

Figure 12—Torpedo level

Utility knife: a knife used for general or utility purposes (see Resource video).

Figure 13—Utility knife

Wire strippers: is a small, hand-held device used to strip electrical insulation from electric wires.

Figure 14—Wire stripper
Use of Hand Tools

Electrician

Estimated Time

1–2 hours

The time required to complete this activity will depend on students’ familiarity with hand tools and on the teacher’s ability to find redundant equipment (old electronics, stereos, old power tools, etc.) for students to “find their hands” and practise using different hand tools.

Recommended Number of Students

20, based on BC Technology Educators’ Best Practice Guide

Students may work individually or in pairs, depending on the availability of hand tools.

Facilities

Technology education shop with benches or similar environment

Tools

Lineman pliers, wire strippers, and utility knife at the very least (all other electrical hand tools could be used in this lesson)

Materials

14/2 plastic sheathed wire

Optional

This could be an opportunity to have an electrician come it to speak and bring electrical tools to explain their use.

Resources

Hand tool worksheet

Electrician Tools

http://www.youtube.com/watch?v=SXZXtD60t2g
ACTIVITY: STRIPPING PLASTIC-SHEATHED CABLE

The teacher should go through all of the electrician’s hand tools and explain their safe use.

Always turn off power and test for voltage when working with electrical equipment.

1. Demonstrate to students how to strip plastic-sheathed cable (scrap cable is preferred to avoid waste; small offcuts will work fine). This could be done on a bench with scrap wood under the wire.

2. Using 14/2 cable, place a short piece (minimum 12") on the surface. Push down on the utility knife in the middle of the sheathing about 6" from the end of the cable until the knife goes through. Gently draw the knife toward the end of the cable, away from the body and not in the path of the other hand.

   Note: It is important to cut the middle of the sheathing because that is where the bare ground wire is; if the knife strays to the edges it will cut into the insulation of the current-carrying conductors that run on either side of the bare ground wire. It can be dangerous if wire is installed with nicks or cuts in the insulation.

3. When the cut is finished, peel back 6" of the sheathing and cut it off with side cutters or pliers.

4. Show students how to use the proper wire gauge notch on the wire strippers to cut insulation from wire.

5. Using the #14 gauge stripper hole on #14 wire, strip a piece of insulation about 1" in length from the end of the conductor.
Figure 15a, 15b, 15c—Cutting sheathing and finished cut sheathing
Improper Use
1. Strip a piece of insulation about 1" in length using the #16 gauge stripper hole on #14 wire.
2. Remove the insulation. The wire will be scored because the strippers will cut into the conductor. A scored wire will break if the wire is bent back and forth a few times.
3. Explain how this could be a problem with electrical wires. Scored wire or nicked insulation can create a dangerous situation for high-resistance faults, electrical shorts, or open circuits.

Proper Use
Students should practise cutting sheathing to learn how to do it safely without cutting the insulated cables inside the sheathing.

1. Have students strip small lengths of insulation (1") from the conductors from which they have stripped the sheathing to practise and get a feel for the wire strippers.
2. Have students strip wire to 1" and practise making some hooks by holding the wire with one hand then using needle-nose pliers to rotate the end of the wire to form a hook.
3. Students could also practise using the hole in the wire strippers to make a hook. Insert the tip of the stripped end of the conductor into the hole of the wire strippers. Twist the wire strippers in a rotating motion to make a hook on the stripped end of the conductor. The hook should form a 180° bend in the wire when complete.

Students will benefit greatly by spending as much time as possible using all of the electrician’s hand tools to increase their manual dexterity. Taking apart and reassembling equipment is an effective way to increase student awareness of electrical tools; it gives them hands-on opportunities to use many of the hand tools.

Note: Students will be making hooks and will be wiring devices in Activity Plan 10: Wiring Devices.

• Have students complete the hand tool worksheet.

Evaluation Guidelines
Check for nicked conductors after sheathing has been removed. Insulation on the conductors inside the sheathing should not be cut or nicked.

The student:
• Works safely and responsibly
• Can remove cable sheath and conductor insulation correctly
• Matches pictures of tools to names on hand tool worksheet
• Describes safety tips when using hand tools
**Extension Activity**

Try to find old electronic equipment, stereos, power tools, or any other type of redundant equipment that could be taken apart and reassembled with precision.

**Note:** Students will practise stripping an extension cord in *Activity Plan 13: Assemble an Extension Cord.*
Hand Tools Worksheet

Electrical Tools

Most electrical wiring jobs are relatively easy to handle with a few inexpensive tools.

Circuit tester (Voltage tick): Simple and inexpensive, a circuit tester plugs into a conventional outlet and will tell you whether the circuit is “hot” (charged) or whether it’s properly grounded.

![Figure 1—Circuit tester](image1)

Continuity tester: A small, battery-operated continuity tester costs less than $10. It can be used to determine whether wiring is broken and whether electrical circuits are complete.

![Figure 2—Continuity tester](image2)

Lineman’s pliers: A pair of these is the best tool to use for cutting heavy wire or cable and twisting wire ends together. To twist two wires together, hold them side by side with one hand, their stripped ends aligned, and point the blunt end of the pliers in line with them, clamp down, and twist in a clockwise direction.

![Figure 3—Lineman pliers](image3)
**Long-nose pliers:** Long-nose pliers are great for bending small loops at wire ends or for cutting off wires (most include a wire-cutting section). Use the pointed end of the pliers to form a smooth, ¼-circle at a wire’s end, designed to circle around a screw terminal (always hook the wire onto the terminal with the end of the bend sweeping clockwise from the wire).

![Figure 4—Long-nose pliers](image)

**Multi-meter:** You’ll want to have a multi-meter on hand for making a variety of continuity checks, checking voltage, and other similar tasks. Read the manufacturer’s instructions for a thorough understanding of techniques. Multi-meters, which do the job of ohm meters, volt meters, and related tools, are sold at consumer electronics stores.

![Figure 5—Multi-meter](image)

**Neon voltage tester:** This helpful little tool can tell you whether wires are “hot” or not. When using it, be sure to hold only the insulated probes—not the bare parts. Touch one probe to what you suspect is a hot wire and the other probe to a neutral wire or grounding wire (or grounded metal electrical box). If the small light glows, the circuit is live.

![Figure 6—Neon voltage tester](image)
**Screwdrivers:** You’ll want an assortment of screwdrivers with insulated rubber grips. Be sure to get both flat-bladed and Phillips-head drivers.

![Assorted screwdrivers](image)

**Figure 7—Assorted screwdrivers**

**Wire stripper:** Most electrical wires run inside a sleeve of insulation, a plastic, rubber or paper coating that prevents bare conductors from shorting against each other or shocking you. When splicing wires (connecting two or more wires together) or connecting them to devices, you must remove the insulation, a relatively simple job when you have the right tool—an inexpensive wire stripper.

![Wire stripper](image)

**Figure 8—Wire stripper**

The stripper should be set so that it cuts the insulation but doesn’t nick the wire (or use the slot that matches the wire conductor’s size). Hold the wire with one hand, bite into the insulation with the stripper, about \( \frac{1}{4} \) to \( \frac{3}{4} \) from the wire’s end, rock the stripper back and forth, and pull the insulation off the end of the wire.
Directions: Write the correct name beside the tool.

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