

Junk Drawer Robotics

Facilitator's Guide



What's in Your Toolbox?

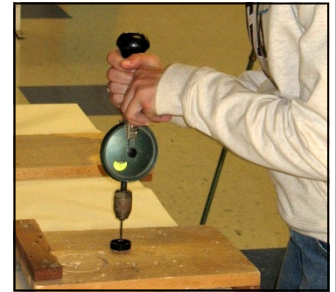
Tool Time and Safety

Tool safety is important for the activities and building that will be done in these robotics activities. Fortunately, most can be done with basic hand tools. Safety concerns will mostly focus on cutting and the potential for eye injury. Safety glasses or goggles are suggested for all activities using tools. Burns can also happen from hot glue or solder.



It is also suggested that a special area or work table be set up where tools are used. This is so youth can be supervised and other furniture will not be damaged.

A handy work area item is the bench hook, which is made of a couple of scrap pieces of pine board or plywood. It has a cleat on each side of the board at opposite ends. One cleat hooks on the edge of the table and you put your work piece on the surface, holding it against the other cleat. This allows you to hold the work piece firmly with one hand as you cut or drill on it. If you cut or drill through your work piece, it marks the bench hook not the table!



So what tools would be helpful?

A simple set of basic hand and power tools will be enough to build most *Junk Drawer Robotics* robots. A hand drill, hacksaw, pliers, and screwdrivers will be a good start for hand tools. You may have these already at home or you can get a tool box to store or take to your meetings. For afterschool programs, a rolling toolbox may be helpful.



Other tools that would be helpful are a low-temp glue gun, heavy duty punches for holes in craft sticks, special wood cutters, and clamps to hold items, especially small items.



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The following processes will be used in making the Junk Drawer Robots:

Cutting to length (size)

Scissors
Side cutters (like pliers)
Hacksaw blades
Special wood cutters

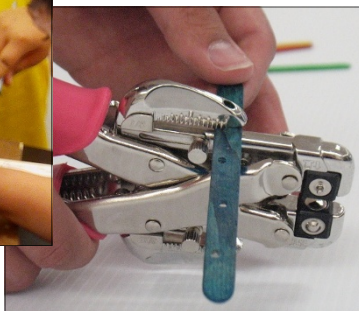
Hacksaw blades have fine teeth and may be less likely to cut small fingers, but will work well on the wood sticks, plastics, and other items suggested in the activities. A homemade handle can be made from duct tape and larger craft sticks wrapped around one end of a hacksaw blade. Special pliers like the cutters shown in the photo, can be purchased to cut small boards and craft sticks.



Making holes



For some thin materials, a punch or nail can be used to form a hole in an object. Common twist drills will work on wood, plastic, and metal to make holes. Heavy duty punches from craft stores can be used for punching holes into craft sticks and paint paddles as shown in the photo.



Paper punch
Special craft/
wood punch
Leather punch
Hand drill
Push drill
Small twist drills
Various size nails

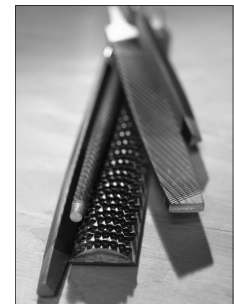


Shaping

Sandpapers
Files
Rasps



Fitting and shaping of wood and plastics can be done by sanding and filing. Smaller 6-inch wood rasps or course metal files will work well on these materials. Various grits of sandpaper (80 coarse, 120 fine, 400 smooth) can be used on wood and plastics to shape them.



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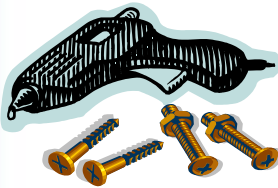
Bending and Holding

Needle nose pliers
Lineman pliers
Slip joint pliers
Vices and Clamps

Pliers are hand tools with handles that function as levers about a pivot hinge. Pliers can be used to grab, hold, twist, and bend items like wire paper clips, nails, and other metal objects. They also can be used to hold small items in place when fastening parts together.



Fastening



Much of the fastening in these activities can be done with tape and glue. The low-temperature glue gun is good for quick results on a variety of materials. **But safety is required to prevent burns.**

Small screws and bolts can be used. Brass paper brads have lots of uses and can be used to hold craft sticks together and to make electrical connections. Small hammers may be used, but most items that will be made are fragile and may not withstand hammering.



Masking tape,
Low temperature
glue gun,
Screwdrivers/
screws
Small hammer/
nails

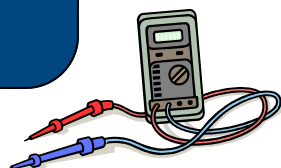
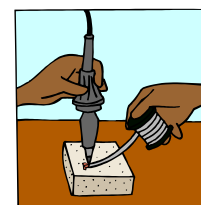
Electrical

Wire cutters (side cutters),
Wire stripper
Electrical tape
Soldering iron
Continuity tester/
VOM meter
Other electrical
tools.

The youth can use the wire cutters, strippers, and tape for many of the wiring connections.

A soldering iron can be used to solder lead wires on the toy motors for easier connections to switches and batteries.

A VOM meter or continuity tester can be used to check circuits and electrical values.



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Make Your Own Drilled Sticks

You can easily make your own building sticks from common crafts sticks and paint sticks by drilling spaced holes in them. These sticks come in a variety of sizes. From craft stick and tongue depressor size to ruler and yardstick size, you can mix and match them as needed.

If you are buying craft sticks, try to get the multicolored ones to add to the sorting activities, plus they are just more fun! Paint sticks can be found at hardware and paint stores. You may even be able to get some donated for your use.

Drilled sticks can be reused, additional holes can be drilled where needed, and you can make more as needed.

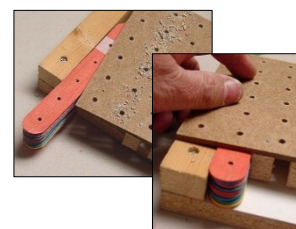
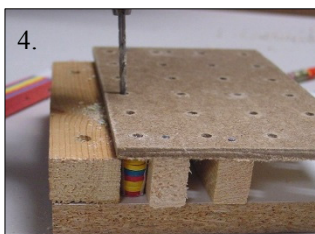
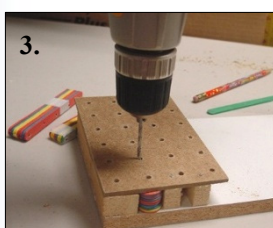
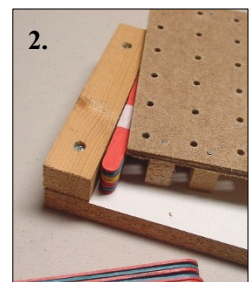
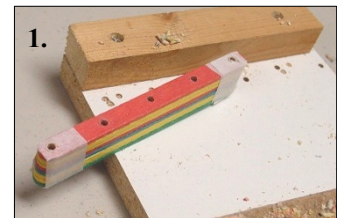
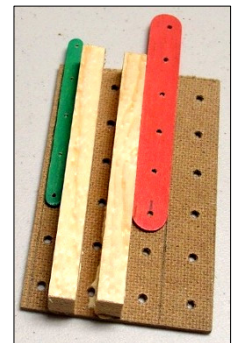
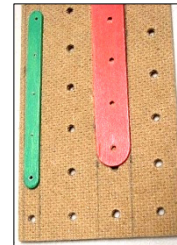
A 1/8-inch-diameter hole using 1 inch hole spacing seems to work well on standard craft sticks.

A drill press works to drill the holes, but you also can use a regular electric hand drill. If you want larger building sticks, consider using wooden paint stirrers, yard sticks or trim boards cut in shorter lengths.

Use a piece of pegboard, glue and nail a small 3/4 inch wood cleat so that a craft sticks will line up centered on a line of holes in the pegboard.

This procedure can be modified to fit the size of sticks you use and the size of the holes you need (drill bit diameter).

1. Tape the end of a stack of sticks to hold them and protect ends from splitting.
2. Place the stack on a bench hook as shown, hold craft sticks in place with the homemade pegboard spacer.
3. Drill at 90° through holes in the pegboard.
4. Drill slowly to be careful not to split the sticks as you drill.



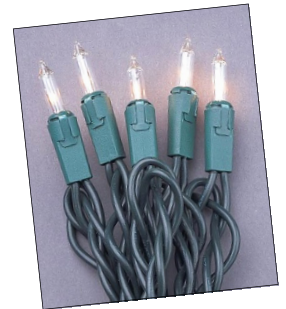
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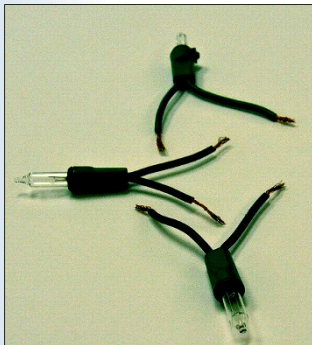


Make Your Own Mini Lights

Throughout the *Junk Drawer Robotics* curriculum, lights and wires are needed to complete some activities. This section will explain how to use holiday lights. While the whole string of mini lights plug into a household electrical outlet of 110 volts, when cut apart, the individual light bulbs will work with 1.5 volt batteries.



Safety Note: DO NOT have the light string plugged into the electric circuit when you cut apart the light sockets.

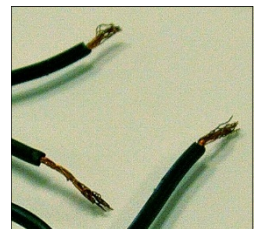


Regular incandescent mini light bulbs needed for *Junk Drawer Robotics*, Level 3, Module 1, Activity A - Series/Parallel and Activity B - Off and On, can easily be gathered from mini holiday light strings.

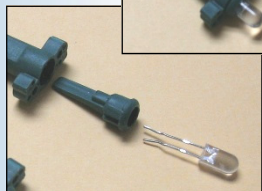
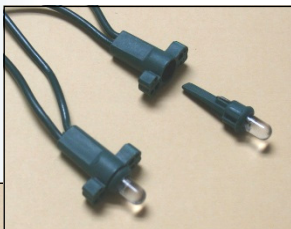
It is easier to untangle the wires on the holiday lights first; making a long line of holiday lights will make it easier to know where to cut. Use wire or side cutter pliers to cut out the holiday mini lights. Select one bulb and find the two wires that come out from the bottom of the socket. Leave as much wire as you can but at least 1.5 inches of wire from the bottom of the light bulb. Continue this with all the light bulbs on the string.

Once all the light bulb wire leads have been cut, you will need to strip off the insulation to expose the bare wire. Only strip off about 1/4 inch to 1/2 inch of wire; this will give enough spacing to make the connection.

An optional step, if there is enough time and you know enough about soldering, tinning the exposed wire will make it easier for kids to make connections. It also helps the youth avoid getting poked by loose strands of wire.



Holiday mini lights also come as **LED** (Light Emitting Diode) lights that can be used in Level 3, Module 1, Activity C - Direction of Flow. Normally LEDs come as single components to be placed into circuit boards. But, using holiday LED light strings as the holders for the LEDs makes them easier to use and connect in the *Junk Drawer Robotics* activities. LEDs react different than regular mini lights since LEDs are current direction sensitive. If a LED doesn't light in a circuit, try switching the battery or LED leads around to see if will light. This is part of the learning topic in Level 3, Module 1, Activity C.



Please Note that the Level 2, Module 2, Activity E - Light Up My Life, recommends using regular flashlight bulbs to enhance the learning opportunity for that activity.



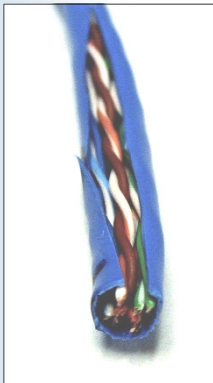
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Make Your Own Wires

The easiest way to get wire to use in the *Junk Drawer Robotics* activities is to buy spools of electrical wire in the 18 to 24 AWG gage size. (Note: the bigger the number, the smaller the wire size). To save money, scrap wire from telephone and computer cables can be used.



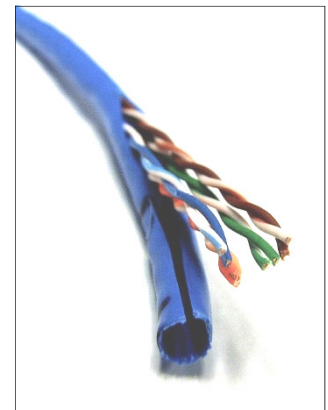
Recycling scrap wire:

Cut up and strip out unwanted pieces of telephone or Ethernet cable. The cable will typically have up to eight single 22 AWG wires. You may get scraps from an electrician or phone installer of short lengths two feet or less.

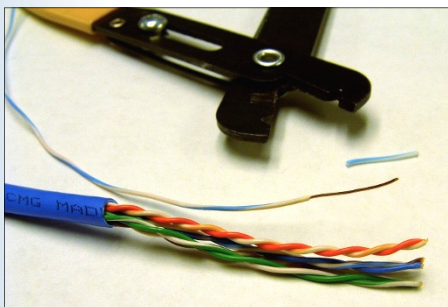
If using longer cable pieces, cut the cable into one to two foot lengths.

All you need to do is remove the small wires from inside the cable covering.

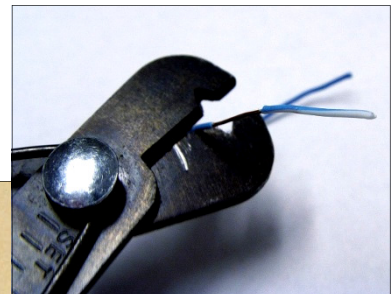
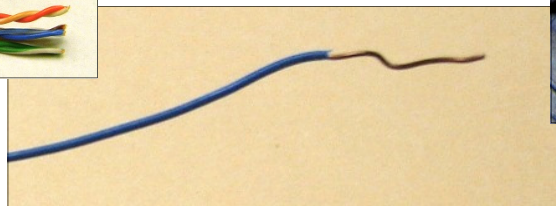
Pull the individual wires out of the cable. You can use pliers to grip the ends of the wires as you pull them out of the cable. If they are hard to grip, cut lengthwise down the outside insulation cover to expose the different wires inside the cable. Be careful not to cut too deep as you might damage the wire inside.



Preparing wires:



Cut the wires to the length needed for the activities. Remove (strip) the plastic insulation from the ends of each wire make the electrical connections. Strip about $\frac{1}{2}$ to 1 inch from the ends.



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How to Solder Wires on Motors

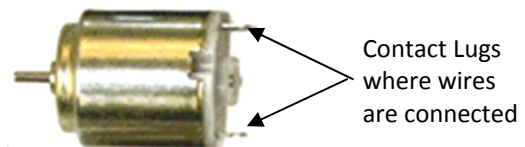
Most motors do not come with attached wires for the leads to the battery or switch. While you can get motors with attached wires, they cost more and may be delayed in delivery. With a soldering iron, a few small wires, some solder, and electrical tape, you can add wire leads to your wireless motors.



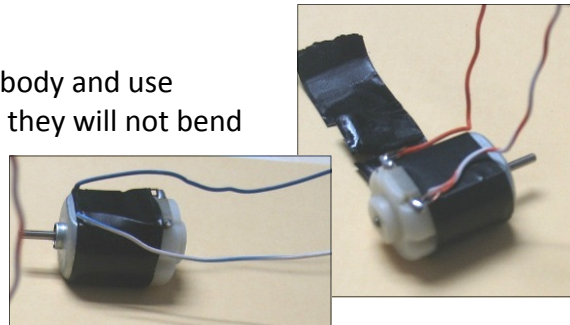
How to connect wires on motors

The wire size needed for those projects using electrical power is in the range of 18 gage (larger) to around 24 gage (smaller).

It will help the participants to have 6 to 12 inches of wire attached to the (two) motor contacts lugs. The contact lugs have holes to insert the wires, place the wire through the hole, and fold wire over by hand or with pliers.



Place the wire (with insulation) next to the motor body and use electrical tape around motor to hold lead wires so they will not bend and break the lugs. To insure that there is a good electrical connection of the wire and motor lugs the wires should be soldered to the lugs.

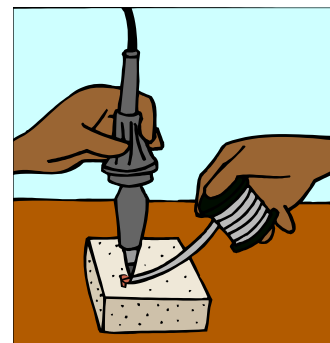


How to solder wires on motors

Use a small electric soldering iron and rosin core solder. Plug in and heat up the soldering iron.

1. Place the tip of the soldering iron on the wire and connection lugs to heat them up.
2. When the connection lug is hot, touch the end of the solder to wire and lug. If hot enough, the solder will melt and flow around the wire and lug.
3. Remove iron tip from the connection lug.
4. Repeat on other wire and connection lug.

When done correctly, finished solder joint will be shiny, not dull. If soldering is not correct, the joint can be re-heated. When the joint is re-heated, the wire can be removed or replaced, or the solder can be re-melted.



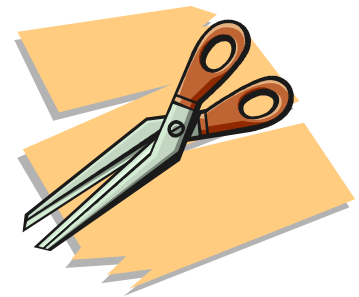
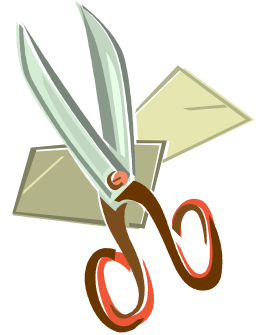
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Safety: Scissors and Shears

- Focus on the task at hand when using scissors. Stop using the scissors if you want to look up.
- When using scissors, cut in a direction away from your body - fingers, hands, arms, and legs.
- Do not attempt to catch a dropped pair of scissors. Let the scissors fall and then pick them up.
- Use scissors in well-lighted work areas.
- Never engage in horseplay with scissors.
- Only use scissors for their intended cutting purpose. Do not use scissors for prying, screwing, scraping, or pounding.
- Do not run or climb while carrying a pair of scissors.
- Use the proper type of scissors for the task at hand. For example, use fabric scissors or pinking shears for cutting cloth and trimming scissors or a thread clip for cutting loose threads.
- Always pass a pair of scissors handle first to another person.
- When using shears, cut away from your body in regular, small strokes. Resting the shears against a table allows for better cutting control. It is easier to cut from right to left when you are right-handed and from left to right when left-handed.
- Practice good posture when using scissors. Avoid bending over a table when cutting with scissors.
- Whenever possible, use scissors with your wrist held in a neutral position and not bent at awkward angles or positions.
- When finished, clean the work area (including the floor) and return scissors to the assigned storage space.
- If you suffer an injury while using a pair of scissors, tell your group leader, parent, or guardian. Seek medical attention if the injury is serious.



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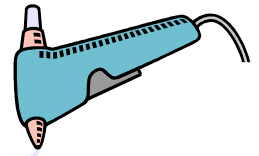
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Safety: Hot Glue Gun

- Thoroughly review and understand information provided in the hot glue gun operator's manual with particular attention given to descriptions of safety procedures.
- Before using, always inspect the hot glue gun for damage to the casing. In addition, assure the on/off switch (if equipped) is functioning properly and inspect the electrical cord and plug for fraying or other damage. If the hot glue gun fails your inspection, inform your group leader, parent, or guardian and remove it from use.
- Wear leather or heat-resistant gloves and safety glasses or goggles when using a hot glue gun.
- Keep the hot glue gun away from flammable materials and use in clean and dry work areas.
- Use a safety stand to hold the hot glue gun when not in use. Never lay a glue gun on its side.
- Place a piece of paper or cardboard under the safety stand to catch hot glue drips.
- Always focus on the gluing task. If you need to look away from gluing, stop using the hot glue gun and place it in the safety stand.
- Do not touch the heated nozzle of a hot glue gun.
- Prevent inhalation of hot glue vapors by using the glue gun in well ventilated areas.
- Never point a hot glue gun nozzle at another person.
- Unplug the glue gun and allow it to cool before changing the nozzle.
- Do not tilt a hot glue gun nozzle upwards or use a hot glue gun to glue overhead items.
- Never leave a plugged in hot glue gun unattended.
- Skin that comes in contact with hot glue should be immediately plunged into cold water.
- If hot glue contacts an eye, irrigate the eye with cold water and seek medical attention immediately.
- If you are injured by a hot glue gun, notify your project leader, parent, or guardian. Seek medical attention if the injury is serious.



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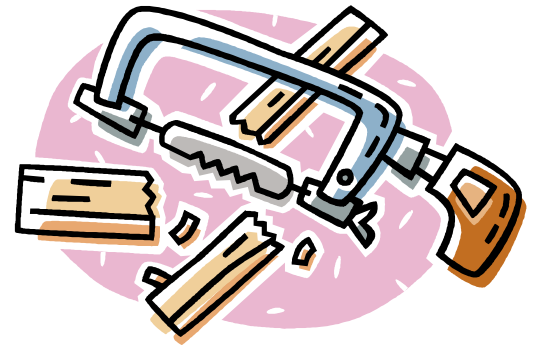
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Safety: Handsaw/Hacksaw

- Prior to use, always inspect saws for defects such as splintered or cracked handles, missing saw-blade teeth, loose saw-blade connections, and bent saw blades or frame handles.
- If a handsaw fails your pre-use inspection, notify your group leader, parent, or guardian. Do not use the handsaw until it has been repaired.
- Wear eye protection when using a handsaw.
- Do not test saw teeth on hands or fingers to determine whether a saw is sharp.
- Use the proper type of saw for the material to be cut or type of cut to be made. For example, use a rip handsaw for cutting along the grain of the wood and a cross-cut handsaw for cutting across the grain of the wood.
- Select the correct type of hacksaw blade for the type of material to be cut.
- When preparing to cut wood, inspect the wood stock for nails or other imbedded objects that could damage the handsaw.
- Begin cutting by starting carefully and slowly to prevent the saw blade from jumping or binding.
- Place stock in vise or hold stock firmly when sawing. Use a helper or bench to support long stock.
- Use the length of the blade during each saw stroke.
- Always carry a handsaw by its handle with the saw end pointed down.
- Keep all handsaw blades sharp and clean.
- When finished with the handsaw, return it to its assigned storage place.
- If you suffer an injury while using a handsaw, tell your volunteer leader, parent, or guardian. Seek medical attention if the injury is serious.



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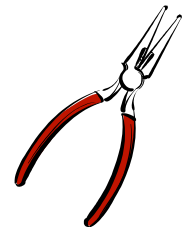
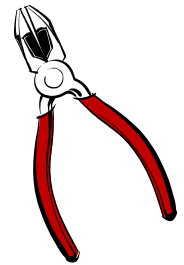
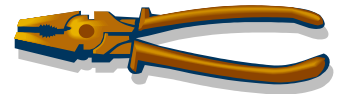
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Safety: pliers

Pliers are hand tools with two handles that function as levers about a pivot hinge. Most types of pliers have serrated jaws located at the tips. Pliers are primarily used for gripping, twisting, turning, and cutting objects. Common types of pliers include adjustable or slip-joint pliers, needle-nose pliers, channel-lock pliers, lineman's pliers, vise grips, and diagonal or side-cutting pliers.

- Never use pliers that are broken, chipped, corroded, cracked, or have worn jaws or a loose pivot. Remove damaged pliers from use.
- Only use pliers for their intended purpose. Do not use pliers for tasks that require the use of a hammer or a wrench. Never use pliers to remove (turn) nuts or bolts.
- Wear eye protection if there is the possibility of generating flying particles or pieces of wire when using pliers.
- Assure cutting edges of pliers are sharp and jaw teeth are clean and unworn.
- When using side-cutting pliers, always make cuts at right angles. Do not rock side-cutting pliers from side to side or bend wire back and forth against cutting edges.
- Never use pliers on live electric circuits. Be aware that cushion grips on pliers are not designed to protect against electrical currents.
- Do not use pliers to push items away from you. If the pliers slip, you may jam your hand or fingers against a stationary object. Always use pliers to pull items toward you.
- Avoid exposing pliers to high temperatures. It could cause pliers to lose their hardening or tempering and fail unexpectedly.
- Do not use extensions on plier handles to increase the leverage force. Find and use a larger size pair of pliers in order to increase the leverage force.
- When cutting wire, secure the end of the wire in a vise while holding the other end in your free hand. This will prevent the cut piece of wire from uncontrollably flying through the air.
- If you are injured while using pliers, notify your project leader, parent, or guardian. Seek medical attention if the injury is serious.



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Safety: Soldering

Most injuries while performing soldering are burns to the fingers and hands. Many of these are due to operator error or inattention and could have been avoided by following these soldering safety precautions.

- Prior to use, inspect the soldering iron or gun for damage or disrepair, including the tip or element and electrical cord (cut or frayed cord) and plug (missing or burnt prongs). If the soldering iron or gun fails your inspection, inform your group leader, parent, or guardian and remove it from use.
- Always wear appropriate personal protective equipment when soldering, including eye protection. It is recommended that a long-sleeve shirt, long pants, heat resistant gloves, and closed-toed shoes be worn to protect the skin from hot solder spatters and drips.
- Never touch any tip or element of a soldering iron or gun. Always assume the tip or element is hot.
- Avoid contact with fluxes which contain acids that may cause skin, eye, or lung irritation.
- Perform soldering in a well ventilated area. Avoid breathing solder and flux fumes.
- Always place the tip or element of the soldering iron or gun in a stand. Do not lay a soldering iron or gun on a work table.
- A good safety practice is to conduct soldering on a fire resistant soldering mat.
- Keep focused on the soldering task and do not look away from your work while using a soldering iron or gun.
- Never solder parts of a live circuit.
- When possible, use a clamp to hold the piece being soldered.
- When soldering small items, use a pair of long-nose pliers or tweezers to hold the item to the soldering tip or element.
- Keep combustible solids (wood, paper) and flammable liquids (gasoline, solvents) away from areas where soldering takes place.
- Never use a soldering iron or gun in wet conditions.
- Keep the soldering tool tip clean by wiping it on a wet sponge.
- Unplug the soldering iron or gun when it is not in use.
- Always wash your hands with soap and water at the conclusion of the soldering task.
- If you are injured while soldering, notify your project leader, parent, or guardian. Seek medical attention if the injury is serious.



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Safety: Basic Electrical

While you may be using an electric drill, glue gun, or other tool in this project, none of the activities will require using any voltage over 12 volts. **Do not use household outlet voltage for any of the *Junk Drawer Robotics* activities or experiments!**

- Electricity naturally seeks the path of least resistance to the ground.
- If your body happens to be in the path of least resistance due to a shorted wire/receptacle or malfunctioning power tool or appliance, the electricity will pass through you and into the ground (i.e., the earth) unless you are standing on a non-conductive surface.
- You will experience a shock as the electricity passes from you to the ground. If it passes through your vital organs, it can result in a serious injury.

Basic Electrical Safety Practices

- Do not use frayed, defective, or damaged power cords/plugs, receptacles, switches, cover plates, appliances, or power tools and equipment.
- Never stick anything other than a plug into an electrical receptacle. Always insert plugs into receptacles with similar prong or blade patterns.
- Never alter a plug by removing, bending, or twisting the prongs or blades.
- Flickering/dimming lights, tripped circuit breakers, blown fuses, and warm receptacles or electric cords are signs of potentially overloaded circuits.
- If a circuit appears to be overloaded, reduce the load by disconnecting appliances or power tools and equipment from the circuit.
- Always disconnect the power source before performing maintenance or repairs on power tools or equipment, including changing or adjusting saw blades, drill bits, sand paper, abrasion wheels, belts, pads, discs, or blades.
- Never touch energized power tools or appliances that are wet or lying in water. Always de-energize, by unplugging wet tools or appliances before touching.
- Do not yank on power cords to disconnect appliances, equipment, or tools. Always grip the plug when disconnecting appliances, equipment, or tools.
- Never replace a correctly-sized fuse with a larger-sized fuse.
- Ground fault circuit interrupters (GFCIs) should be used whenever electricity and water are within six feet of each other.
- A grounded three-prong adapter must be used to connect a three-prong plug to a two-prong receptacle.
- Always be aware of the electrical hazards present in your environment.
- Plug power strips directly into wall outlets. Do not daisy chain (or connect) two or more power strips together.

Adapted from the University of California Agriculture and Natural Resources Environmental Healthy and Safety Services