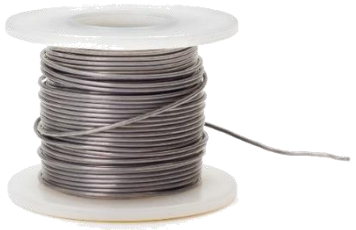
Learning to Solder

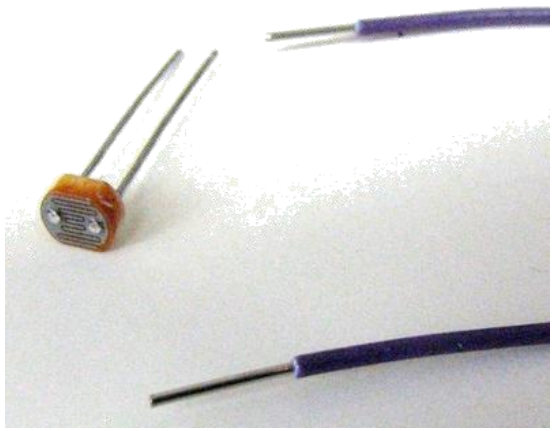
What is soldering?

Soldering is a process in which two or more metal items are joined together by melting and flowing a filler metal into the joint, the filler metal having a lower melting point than the work piece.

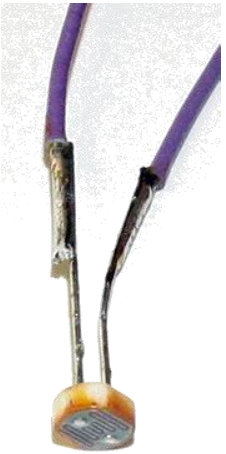
soldering iron



solder

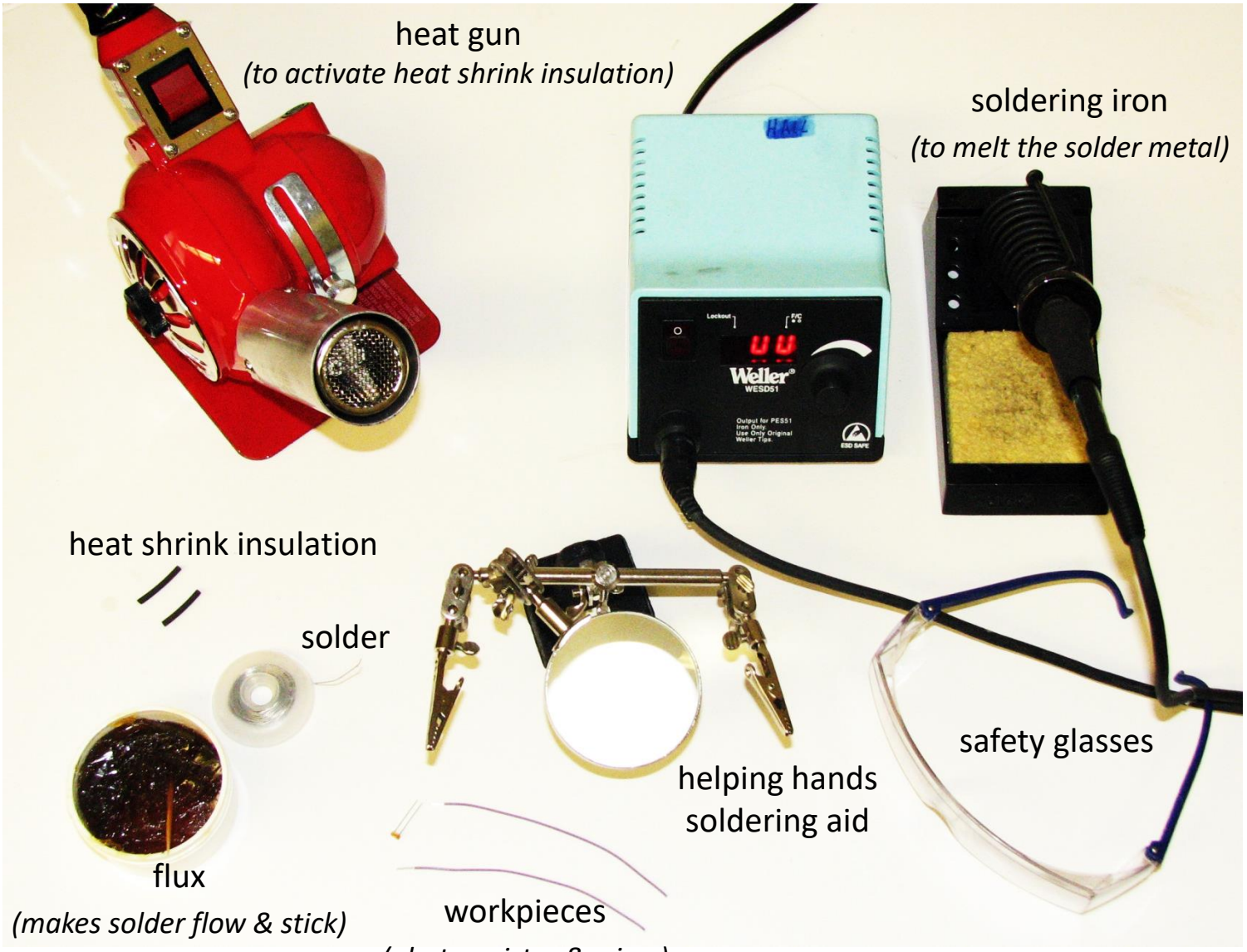


parts to solder



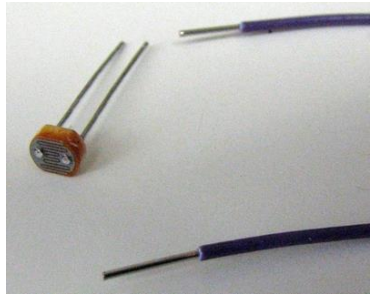
soldered parts

Equipment and Supplies



Soldering Steps

1. Cut wires to the desired length, stripping off unwanted insulation (¼ inch is good). The wire used for breadboarding is 22 gage, so use the appropriate notch in your wire stripper.



2. Apply flux to the parts to be soldered. You can dip the end of the wire into the flux. Flux cleans the surface of the parts to be soldered, making the solder flow and stick.

Globbing on flux like this will produce fumes; wipe off excess flux. A flux pen may be a cleaner approach. Some fluxes clean up better than others.

Soldering Steps

3. Turn on the soldering iron and allow it to reach the set point; common soldering temperatures are 600°F for solders containing lead and 700°F for lead-free solders. Of course, soldering temperature depends on the melting temperature of the solder you are using. Always use as low a temperature as possible since . . .
   a) high temperatures damage soldering iron tips
   b) excessive temperature can damage electronic components
   c) the flux boils away too quickly, reducing solder bonding to the parts
   d) higher temperatures could result in more severe burns

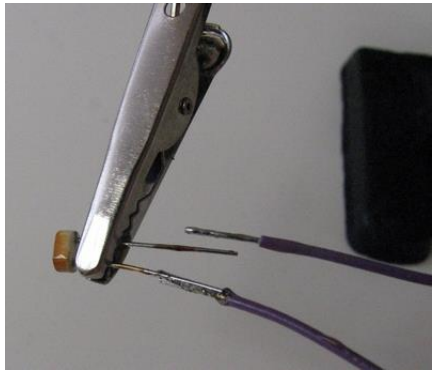
4. Clean the tip of the soldering iron by wiping it against the wetted sponge on the stand; repeat occasionally as you solder since it is important to maintain a clean tip.

5. Melt solder directly onto the tip to “tin” the tip, wiping off excess solder on the sponge until the tip has a shiny and uniform coating of solder.

Do not forget to wet the sponge!

Soldering Steps

6. Clamp the part to be soldered into the “helping hands” tool; if you are soldering a wire that is covered with insulation and is several inches long, you can hold the wire in your hand (a few inches away from where you will be soldering).



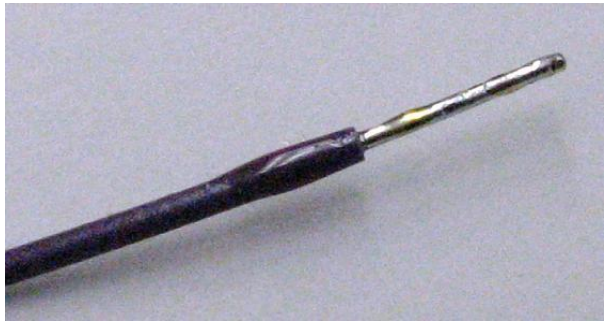
bend solder wire so you can safely melt some onto your tip

7. Bend your solder so that about 1.5 inches of solder is protruding from your roll of solder. With your solder tip pointing <u>downward</u>, melt some solder onto the tip of your soldering iron. You should see a small bead of solder on the tip, ready to be deposited onto the workpiece.

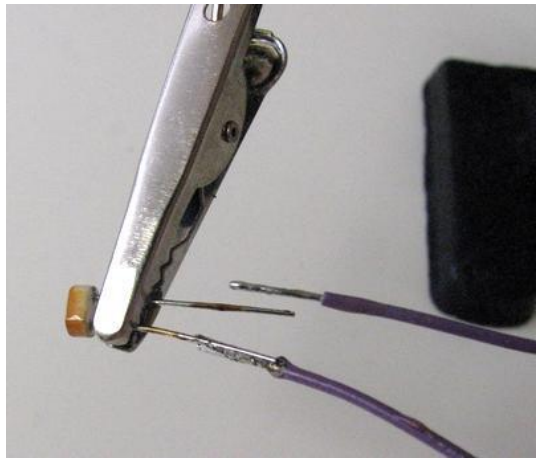
depiction of solder on tip of a vertically oriented soldering iron (solder will be silver, not red)

Soldering Steps

8. Before soldering the parts together, they should first be coated with a thin layer of solder; this process is called “tinning.” Touch the tip of the vertically oriented soldering iron on the area to be soldered. Solder should flow onto the part with a smooth and even coat.

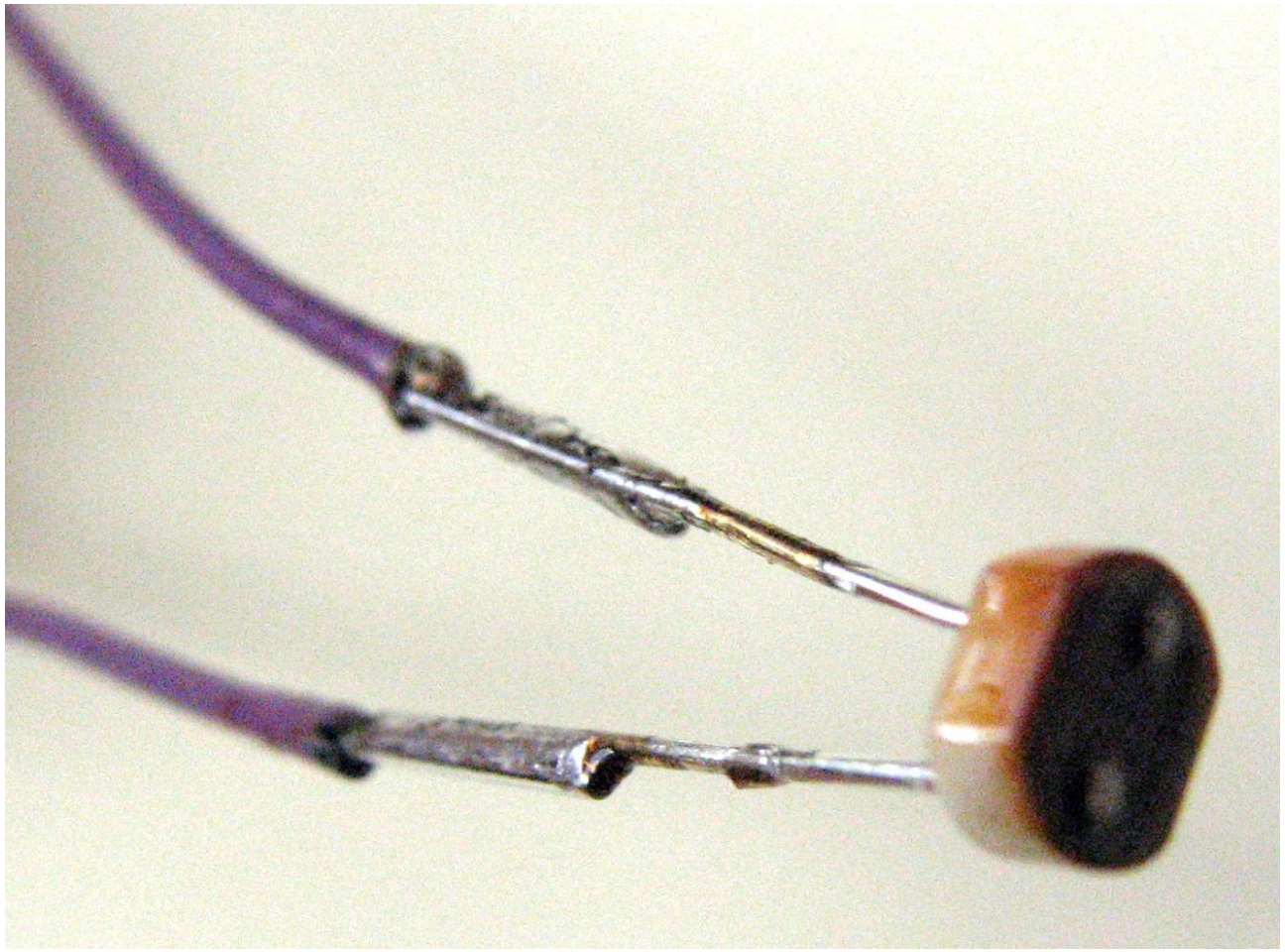


9. Melt more solder onto the tip if needed and bring the parts to be soldered together in the proper position, touching the solder bead on the vertically oriented tip to the area where solder is needed. Leave the soldering iron in place briefly (about one second) until the solder flows into the joint. Hold the parts together briefly until the solder solidifies.



The helping hands device improves safety and allows you to hold parts in the correct position.

Appearance of Solder Joint



The flux that remains on the soldered surface can be removed if desired by cleaning with an appropriate solvent (water or alcohol are common, depending on the type of flux).

Another Method of Soldering Wires or Leads

While the above procedure is a quick and easy way to join together two wires or leads, globbing solder onto the tip of the soldering iron and transferring it to the connection is considered a “no-no” by professionals; the flux is boiled away before it has a chance to do it’s job. A more proper set of steps is provided below:

1. Clean and tin the tip of the soldering iron.
2. Tin the ends of both wires or leads:
   a. Secure the wire or lead in the helping hands device.
   b. Place the tip of the soldering iron below the wire to be tinned.
   c. Feed in solder on top of the wire, moving the tip and the melting strand of solder up and down the length of the region to be tinned.
3. Bend a small hook in each of the two wires/leads.
4. Place the tip of the soldering iron on one side of the connection, and feed in solder from the other side until the joint is soldered.

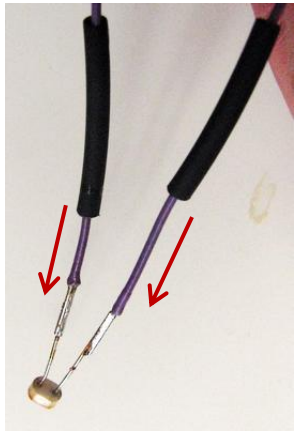
this melting of the insulation could be prevented by using a heat sink (shown later)

tinned and bent wires before joining

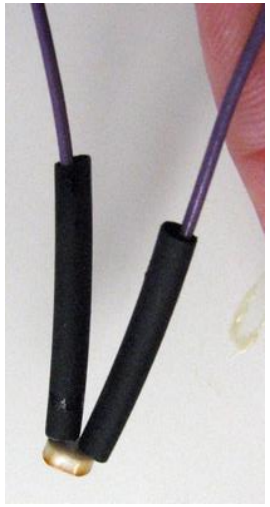
wires after joining

Adding Insulation (If Desired)

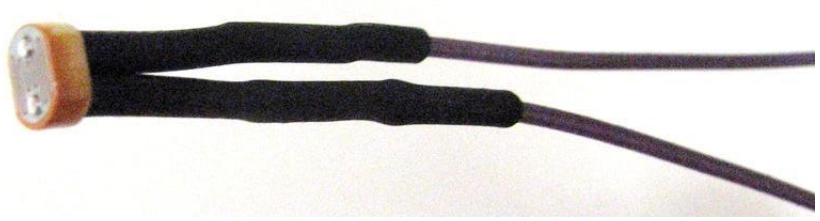
1. Slip heat shrink over the wires to be insulated; you need to put the heat shrink on before you solder the joint together when the jointed parts preclude sliding on the insulation.



slide into position



2. Apply heat with the heat gun, heating until the insulation shrinks into place.



Adding Insulation (If Desired)

3. It is often snazzy to tightly twist the wire together for a more tidy and organized wiring layout. To do this, insert the loose ends of the wires into the chuck of a drill, running the drill until the wire is tightly wound (to suit your taste). When drilling, pinch the wires at the base of the photoresistor together to keep the drill from breaking the wires off the photoresistor.

4. Trim the loose ends to even them up or to make them the correct length, and strip off about ¼ inch of insulation for use with a breadboard.

Prevention of Burns and Fire

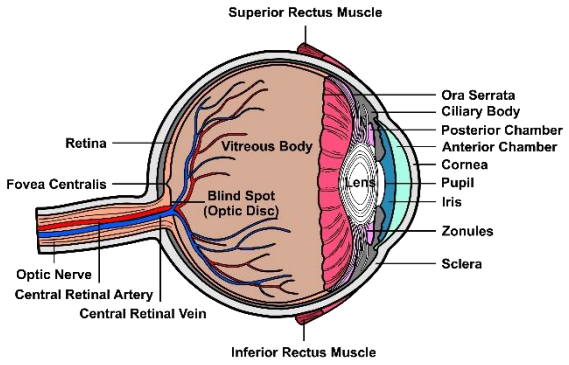
- don’t touch the tip of the soldering iron (could be as high as 400^{o}C or 750^{o}F)
- hold parts to be soldered with a “helping hands” device or with a clamp (a vise works)
- never touch a bare metal part being soldered (heat will quickly conduct to your fingers)
- the soldering stand and other items that have been in contact with the soldering iron will become hot enough to burn you
- always return the soldering iron to the stand
- turn off the soldering iron when you are finished
- the heat gun can also cause burns – keep skin away from air stream and exit port

Use Common Sense

- no horseplay in the lab
- don’t solder on flammable work surfaces
- don’t solder around flammable substances (gasoline, hairspray, . . .)
- let your instructor know if you think something is not safe
- know the location of the fire extinguisher and first-aid kit
- let your instructor know if you are injured

Protect Your Eyes

- always wear safety glasses when soldering – solder can “spit”
- always wear safety glasses when watching somebody else solder
- be careful of others around you when soldering; it would be easy to turn and touch somebody with the soldering iron



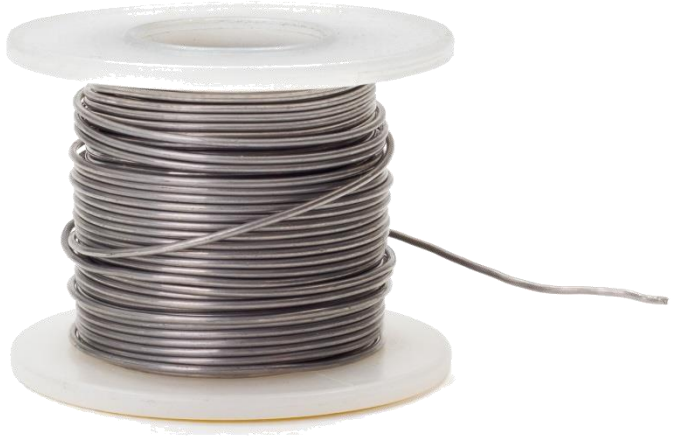
Solder and Flux

- most solders contain lead; we recommend that you use lead-free solder
- lead is a toxic substance
- lead can be absorbed through your skin, or you can draw lead into your body by breathing the fumes given off by soldering
- solder in a well-ventilated space; avoid soldering in a small, closed space, regardless of what type of solder you are using
- most of the smoke that comes from soldering is due to the flux; these fumes are also unhealthy
- wash your hands after soldering
- read the warning labels on the solder and flux before use

Solders and Temperatures

lead-free solder: One popular lead-free solder has a composition of 96% tin and 4% silver and melts at 221°C or 430°F (part number 65-026 at radio shack). Tips for lead-free soldering, modified from http://www.emsnow.com/npps/story.cfm?id=18862, are provided below:

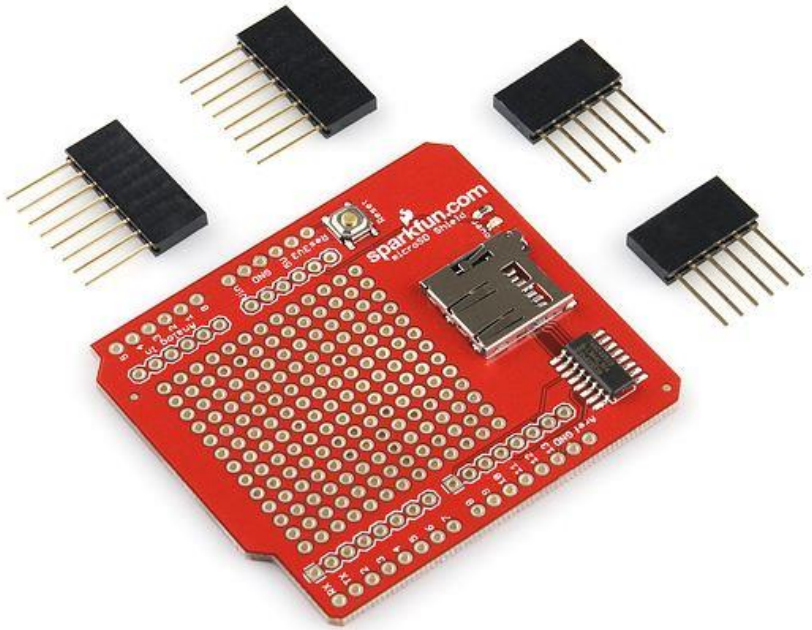
- Insure the tips are designed for lead-free soldering
- Insure the soldering temperature is set to 700-800°F
- Insure the flux content in the wire is a least 2% wt/wt
- Use the correct tip for the job
- Insure the parts are easily solderable with the chosen flux
- Avoid prolonged contact times
- Avoid needless reworking of the joint
- Avoid the use of additional liquid flux



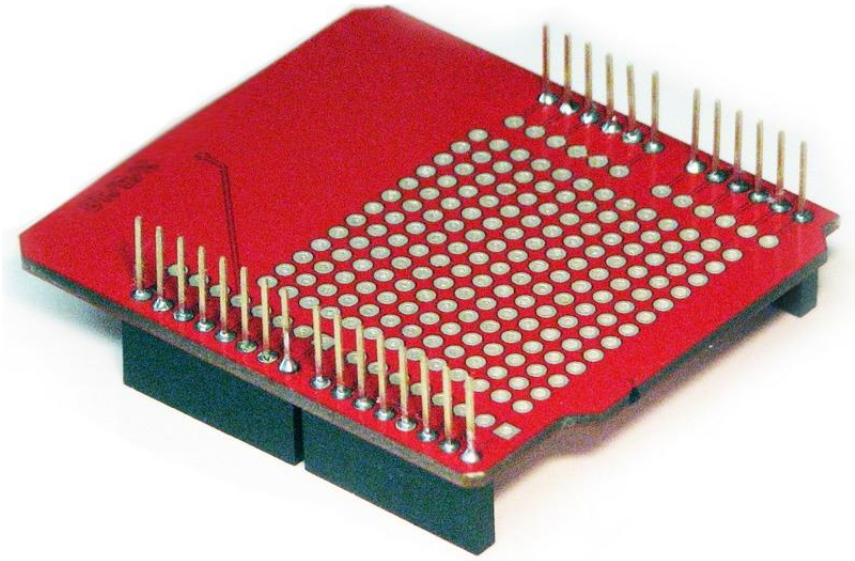
solder containing lead: A common tin/lead solder has a composition of 60% tin and 40% lead and melts at 188°C or 370°F. Lead-based solders melt at a lower temperature and are often considered to be more forgiving (easier to solder and better reliability) than lead-free solders. However, lead-based solders are being phased out due to environmental and health concerns.

Tips for Through-Hole Soldering

For through-hole soldering, pins are inserted through the holes in a printed circuit board and then soldered into place.



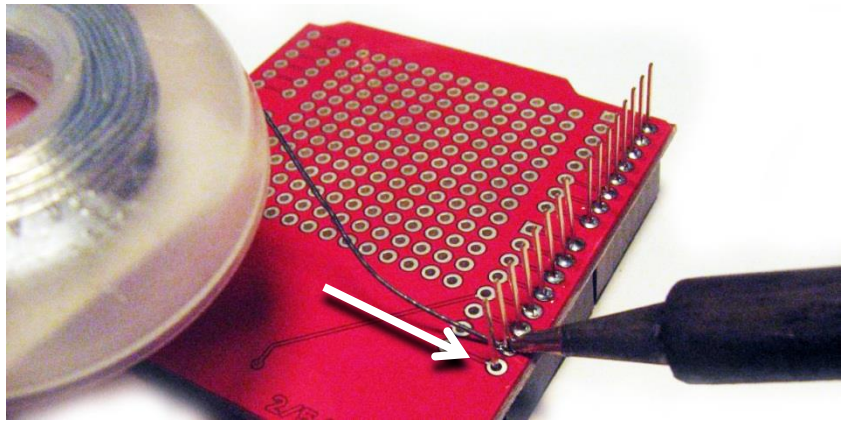
printed circuit board with unsoldered headers



board after soldering headers into place

Tips for Through-Hole Soldering

- Apply flux to the region to be soldered
- Touch the base of the pin with the soldering iron; the tip should contact both the pin AND the metal surrounding the hole
- Position the solder at the base of a pin on the opposite side from the tip
- As the solder melts, feed it into the joint
- Feed in solder until the joint has a concave appearance



feed the solder into the heated joint from the opposite side of tip

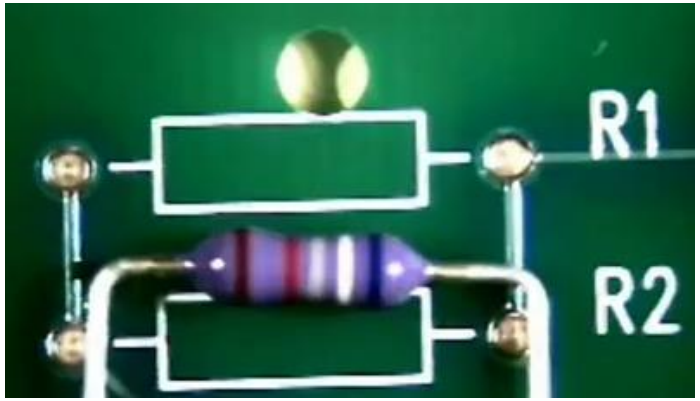
insufficient solder

good

YouTube Videos

There are many videos on YouTube that demonstrate soldering; many of these videos were created by professionals.

Hand Soldering for Through Hole Components (7:06)
http://www.youtube.com/watch?v=x0YxEilyQVY&NR=1



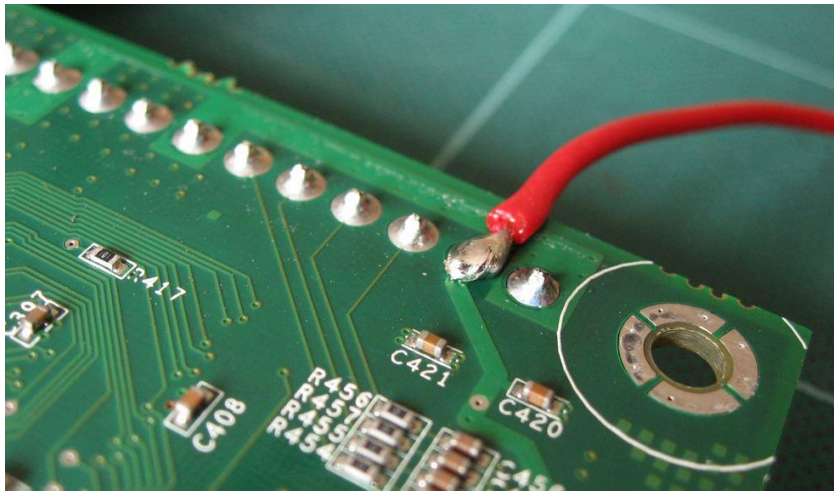
Lead Free Through Hole Soldering Tips | B.E.S.T. Corporation (4:17)
http://www.youtube.com/watch?v=CGnt2vCAjfQ

soldering accessories

heat sink clamp – you can use a clamp like this to protect electronic components from damage during soldering; place clamp between where you are soldering and the component; needle nose pliers also work well

solder sucker – when you make a mistake when soldering onto a printed circuit board, a solder sucker can be used to remove unwanted solder; heat up solder first, and then suck it out

examples of soldering on printed circuit boards



Mathew Newton, wikipedia.com