HIMALAYAN MAKERS GUILD

ACTIVITY 8 – INTRODUCTION TO SOLDERING

Further Reading: https://learn.adafruit.com/adafruit-guide-excellent-soldering/making-a-good-solder-joint_

LEARNING OUTCOMES

Students will,

1. Solder wires to plated through-hole prototype boards
2. Desolder joints using a solder sucker

This activity should take **~1 hour** to complete:

- 10m introduction to soldering tools and safety
- 10m how to make a solder joint
- 10m soldering demonstration
- 20m soldering and testing
- 10m reflection and discussion

This lesson plan assumes free access to a black-and-white printer and a classroom with a whiteboard, blackboard, or chart-paper. Ensure that the soldering surface is heat resistant (thin sheets of wood fiberboard are an inexpensive option).

MATERIALS AND COSTS PER STUDENT

All of the materials listed here were purchased in Kathmandu in the neighborhood of Bangemudha, just south of the popular tourist area named Thamel, with the exception of the safety glasses which were purchased in the Teku neighborhood. If purchasing equivalent parts directly from China through a website like AliExpress, I would expect the parts to cost twice as much. If purchasing from western vendors such as Amazon, I would expect the parts to cost three times as much.

Cost of Setting Up 10 Soldering Stations					
Item	**Unit Cost**	**Qty.**	**Cost for 10 Stations[1]**	**Expendable[2]**	**Expendable Cost***
Solder tip sponge	0.13	10	1.28	y	1.28
Soldering iron 40W	3.21	10	32.05		0.00
Soldering iron stand	1.47	10	14.74		0.00
Solder	0.96	10	9.62	y	9.62
Extra soldering tip	0.71	10	7.05	y	7.05

1. Currency is CAD, 2017-06-10. Assuming one set of parts per student. ↩
2. Likely to be broken or lost during the activity. ↩

Solder flux	0.38	5	1.92	y	1.92
Solder pump	1.28	5	6.41		0.00
3-plug extension cord w/ switches	2.56	4	10.26		0.00
Flush Cutters	1.54	5	7.69		0.00
Wire stripper (variable)	0.96	5	4.81		0.00
Safety Glasses	0.77	20	15.38		0.00
Total Cost for 10 Stations			**$111.22 CAD**		**$19.87 CAD**

**Depending on use, I would expect $19.87 CAD to be the up-keep cost spent yearly on the soldering stations*

In addition to these tools, the students used a small piece of prototype board (3cm X 3cm) and about 10cm of wire, costing $0.04 CAD and $0.06 CAD respectively per student.

LESSON

Before class: print student handouts; setup the soldering stations; plug in the multi-plug extensions to for all of the soldering irons to be plugged into; cut prototype boards and wires to a size suitable for each student to use.

Outline:

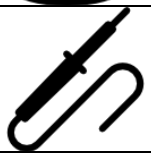
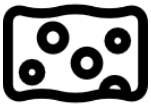
1. What is soldering?
2. Soldering Tools
3. Safety
4. Before You Start
5. Making a Solder Joint
6. Try Soldering

The students can try soldering a resistor into their breadboard that they'll ultimately use in the light circuit.

WHAT IS SOLDERING?

- Soldering is the use of molten metal to make permanent electrical connections.
- Why solder? What's wrong with just using a breadboard like we have so far in the activities? It allows us to make more permanent and reliable circuits that are smaller. Parts easily come out of breadboards, and are limited to the connections on the rows and columns of the breadboard.

SOLDERING TOOLS

	Solder	A soft metal that melts at a low temperature
	Soldering Iron	Used to melt the solder and heat the parts to be soldered
	Flux	A paste/liquid that, when heated, helps the solder flow and bond to other metals
	Soldering Sponge	For cleaning the tip of the iron

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SAFETY

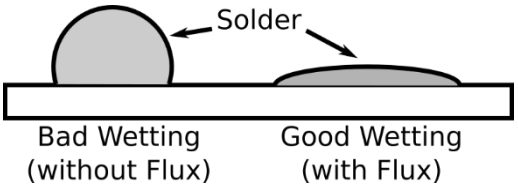
	Wear safety glasses.
	Work in a well ventilated area.
	Only hold the soldering iron while soldering. Otherwise, put it in the soldering iron stand.
	Wash your hands after soldering and do not touch your face while working with solder.

Icons made by Freepik from *www.flaticon.com*, CC-BY-SA-3.0

1. Always wear safety **glasses**. Hot solder or clipped wires can easily fly off of a part you are working on. Even if you are not the one soldering, if you're at the soldering station you need to have safety glasses on
2. Solder fumes can be harmful, so always work in a **well-ventilated** area, preferably with a fume extractor fan.
3. Be careful of the hot soldering iron. Do not do anything but solder while holding the soldering iron. As soon as you're done making the joint, return the iron to the stand.
4. Solder contains lead, which is a dangerous heavy metal. Once it enters your body, it never comes out, and if you accumulate too much it can cause memory damage or infertility. Never touch your face when soldering. Always **wash your hands** immediately after soldering.

BEFORE YOU START

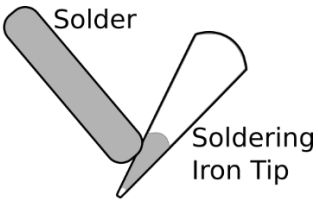
1. Put the wire through the plated hole and secure the parts. If they move while soldering, the joint will not work. They can be secured using clamps, tape, sticky-tack, or just by holding the parts down with your hands. Bending the legs of the part out after putting it through the holes is a good way to prevent it from moving while soldering.
2. If the parts are dirty, or show oxidation (rust), clean them with isopropyl alcohol (usually available at a drug store or pharmacy).
3. Put a small amount of flux on the surfaces to be soldered; flux improves the surface **wetting**, helping the solder flow easily. Note: sometimes solder comes with a flux-core, in which case adding flux before soldering is not necessary.



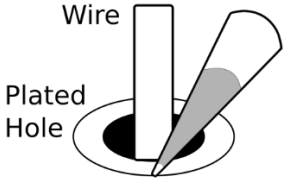
MAKING A SOLDER JOINT

Note that for some students, especially younger ones, all of the details below may not be necessary. The student handout represents a good minimum of information that the students should have before trying soldering.

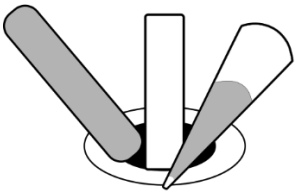
- Three points to keep in mind:
    - Solder moves from cold to hot surfaces
    - Solder moves most easily on "wetted" surfaces, that already have some solder on them. Flux improves wetting. The tip of the iron should be shiny, and the solder should move onto the iron (not ball up on the solder wire).
    - The "sweet spot" of the iron is on the side of the tip, 1-2mm up from the end of the tip. We should use this surface to contact the parts being soldered together



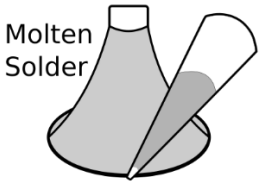
Tin the soldering iron tip by melting solder on it, then wiping off the extra solder onto the sponge. This gives the solder tip good wetting.



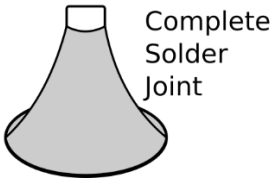
Touch the side of the soldering iron to the joint so that it contacts both the wire and the plated hole.



Apply the solder so that it touches the wire and the plated hole on the side opposite where the iron is touching; hold it there until the solder melts and flows to cover the plate and wire.

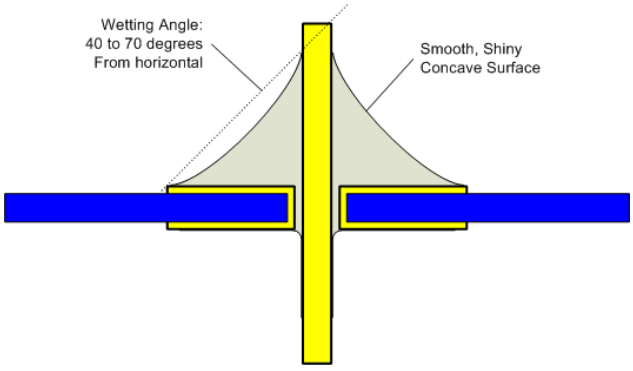


Remove the solder wire from the joint.



Remove the soldering iron from the joint.

1. Tin the tip of the iron (to wet its surface) by melting some solder on it, then wiping the tip clean on the sponge
2. Touch the "sweet spot" of the tip to both the plated hole and the wire.
3. Touch the solder to the wire and plated hole on the side opposite where the iron is touching. When first contacting, it may touch the iron tip too, but once a little solder has melted (a "heat bridge") it should be moved immediately to the side opposite the iron tip so that the solder flows over the plated hole and wire towards the tip.
4. When solder has coated the plated hole and the wire, remove the solder wire from the joint.
5. Remove the soldering iron from the joint. If step 5 happens before step 4, the solder wire will solidify to the joint! The shape of the joint should look like this:



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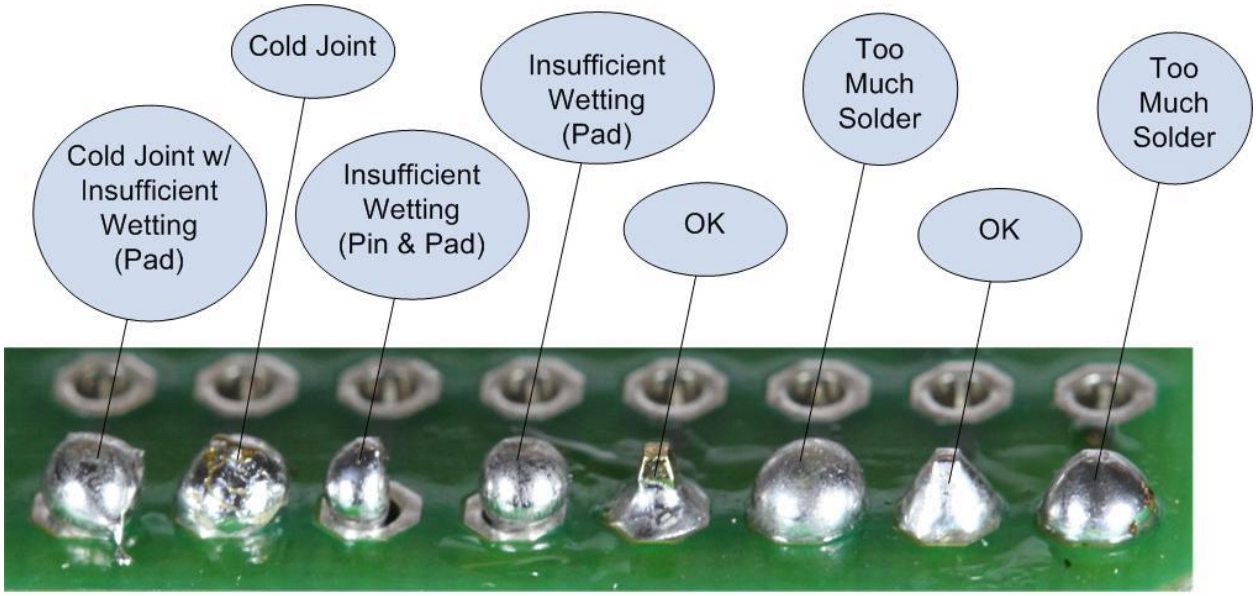
Here are some examples of how the joint should look and common problems:



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To desolder a joint, use the solder sucker. It is like a little vacuum that can be used to suck the molten solder off the joint.

1. Load the solder sucker by depressing the plunger
2. Tin the soldering iron tip
3. Touch the soldering iron to the joint
4. When the solder has melted, keep the soldering iron on the joint and press the tip of the solder sucker against the joint; press the button to activate the solder sucker
5. Remove the soldering iron from the joint

Solder wick can also be used to desolder a joint.

TRY SOLDERING

Demonstrate making a solder joint:

1. use wire strippers to remove insulation from a wire
2. Fold the wire and put it through two holes in the prototype board; the wire needs to stick out through the side with plating on the holes
3. Make the solder joint as shown above
4. trim the wires using the flush-cutters; cut the wire's just a bit above the solder (avoid cutting into the solder joint as it can break the joint)

Have the student sit 1-2 people per soldering station and try making solder joints and desoldering those joints. They between two students, they shouldn't need to use more than 9cm^2 of prototype board. When the students are finished, they should re-tin the tip of their iron and turn it off.

FAQ

- My solder isn't melting on the iron, what's wrong?
  - 1) is the iron plugged in and powered on
  - 2) Is the tip dirty or oxidized? If so, clean it on the sponge and try dipping it in flux before melting the solder on the tip.
  - 3) make sure you're contacting the side of the iron, 1-2mm up from the tip rather than directly on the tip.
  - 4) are you sure that's solder wire and not normal wire that you're using?
- Why isn't the solder sucker working?
  - 1) Is the plunger depressed?
  - 2) are you keeping the soldering iron pressed to the joint so that the solder is melted?
- Why isn't the solder sticking to the board?
  - 1) are you sure you're soldering on the side with the plated holes?
  - 2) are the plated holes clean and did you apply a little bit of flux to the plated hole?

CHALLENGE AND EXPLORE

Evaluate the students' understanding of the learning objectives by asking them to try the following:

- Have the students try testing the conductivity of their complete joints using a multimeter; they should touch the probes to the solder, not the wire
  - Skill: using a multimeter to measure conductivity
- Have the students try soldering wires along the board as illustrated in this video: https://youtu.be/_ypW45Y8VSs
  - Skill: plated-through-hole soldering