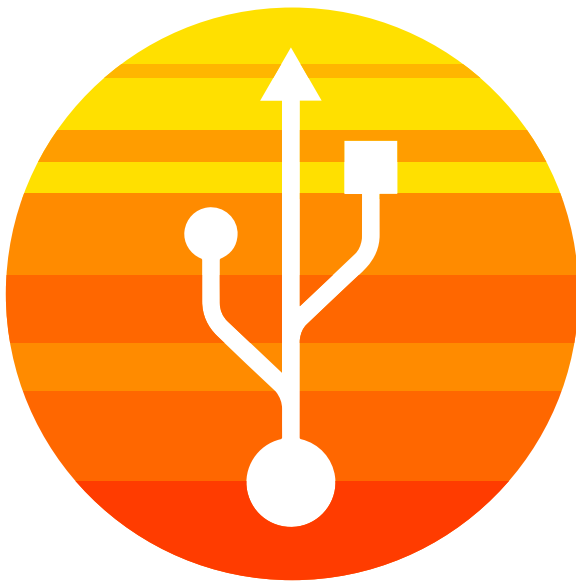


Solar USB Charger



Design and construct a solar USB charger while learning solar science and building career skills

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Lesson 3 Overview

Estimate Time:

90 minutes (Two 45-minute periods) Additional instruction is necessary if students are designing and building their own cases

Objectives: Students will be able to:

- Build a solar USB
- Demonstrate the skills to solder safely

Handouts:

- 3.1 Building Your Solar USB Charger

Prep Time:

- Allow 1 month to request and receive solar USB charger kits
- 1 hour to review lesson and print materials

Materials:

- PowerPoint presentation and projector
- Internet access
- Solar USB Charger Kits (1 per student)
- Soldering Iron (1 per group of 3-4 students)
- Solder (1 per group of 3-4 students)
- Safety Glasses (1 per student)

Resources:

- Soldering Safety Video (3:04):
https://www.youtube.com/watch?v=3ht_Jmf_aCNM
- How to Solder Video (3:04):
https://www.youtube.com/watch?v=Qps9w_oUGkI
- Soldering Safety Handout:
<https://ehs.stonybrook.edu/programs/lab-oratory-safety/laboratory-equipment/soldering>

Lesson 3: Building a Solar USB Charger

This lesson provides students with step-by-step instructions for how to build a solar USB charger. Students will learn how to solder wires together to build their charger.

KEY WORDS

Soldering: the process of joining wires together using a metal filler (solder) to create a smooth path for electrical current to travel through

Solder: metal filler used to join wires together

PREPARATION

- Students should have an understanding of the components of the solar USB charger they are going to build. Review material from Lesson 2 to ensure students understand the project.
- Prior to this lesson, order enough kits for each student. The solar USB charger kit used in this lesson can be purchased using the materials included in the materials matrix at the beginning of the unit.
- In this lesson, students will be required to solder together different components of the circuit. It is very important that students know how to solder safely before building their solar USB charger.

- Activity 1 is designed to help students understand how to solder safely by giving them an opportunity to practice soldering wires. If students are already familiar with soldering, Activity 1 can be skipped. In order to complete Activity 1, each student will need a short piece of wire they can use to practice soldering.
- In addition to the Solar USB Charger kits required for each student, you will need a soldering iron and solder for each group of about 3-4 students. There is information on where to purchase these materials on page 6 of the curriculum.

ACTIVITY 1: SOLDERING SAFETY



Soldering is the process of joining wires together using a metal filler (solder) to create a smooth path for electrical current to travel through. Watch one or both of the videos below about how to solder.

- Soldering Safety Video (3:04): https://www.youtube.com/watch?v=3ht_JmfaCNM
- How to Solder Video (3:04): <https://www.youtube.com/watch?v=Qps9woUGkvl>
- Review soldering safety and how to solder with students. Review this soldering safety handout with students.
 - <https://ehs.stonybrook.edu/programs/laboratory-safety/laboratory-equipment/soldering>
- Provide each student with a short piece of wire that they can use to practice soldering. Have students work in small groups to practice soldering. Have two students work together to solder their piece of wire together. The rest of the group should observe and check that the students are following all of the safety procedures covered in the video.
- Safety Tips:
 - Wear safety goggles.
 - Solder under a fume hood if available.
 - Do not touch the tip of the soldering gun.
 - Always leave the soldering gun in a stand when not in use.
- Soldering Tips:
 - Be patient. It will take time for the soldering gun to heat the wire enough to melt the solder.
 - Remember to place the soldering gun on one side of the wires you are soldering together. Then, move the solder over the wires on the other side until the heated wire melts the solder and covers the wires.

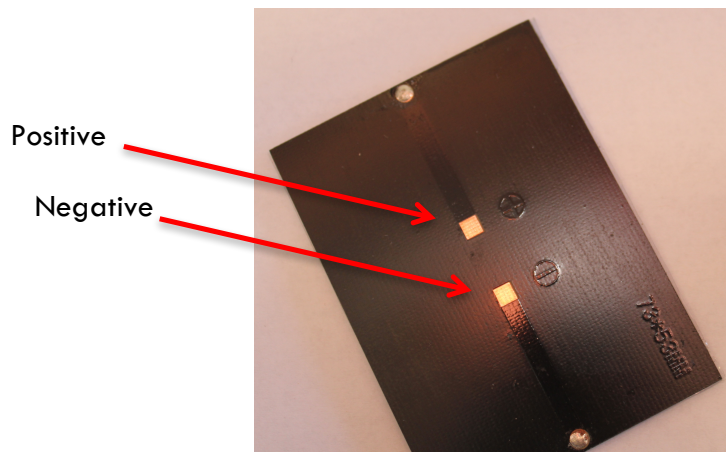
- With some soldering guns, only one side of the tip of the gun will heat up and be able to melt the solder, so make sure you position the soldering gun correctly before attempting to use the solder or it will not melt.
- If you make a mistake, you can use the hot soldering gun to melt the solder and pull the wires apart.
- If your soldering gun has a buildup of melted solder, use a damp sponge to clean it off before attempting to solder another component. You can also use flux to clean your soldering iron and prevent oxidation, which can negatively impact solder joints.

➤ **Soldering Alternative**

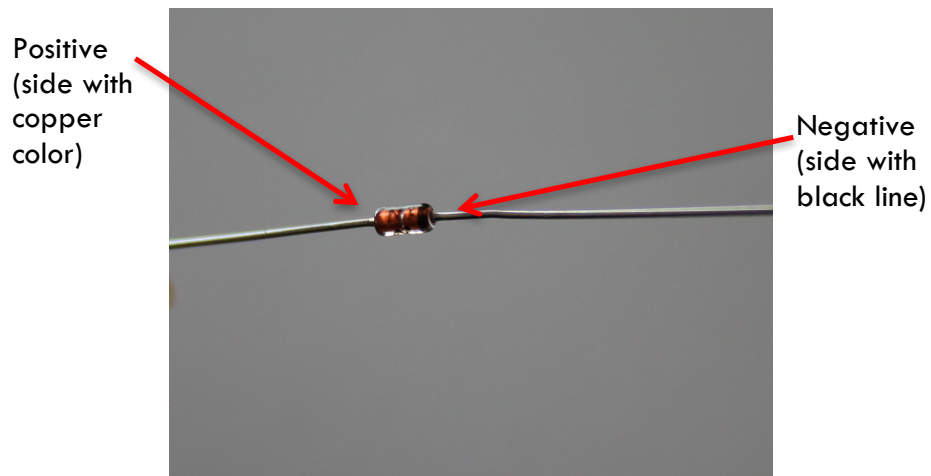
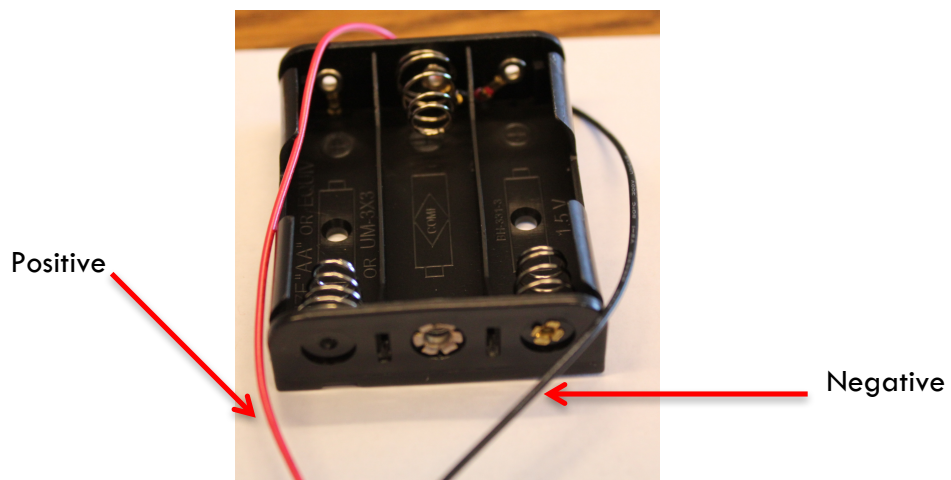
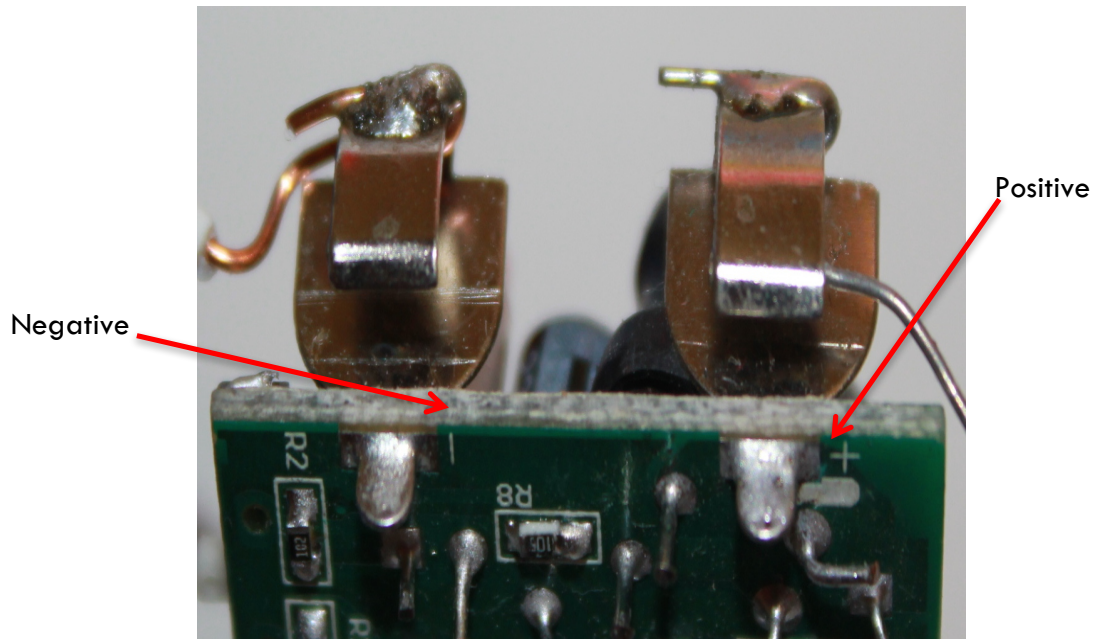
- If you do not want to use soldering irons for this project you can use alligator clips to attach all the components together. This may require a higher upfront cost to purchase the alligator clips/leads, but it will also allow you to take apart and reuse all of the solar USB components.
- Keep in mind that these kits do not have pre-soldered solar panels, so it would be a good idea to purchase at least 1 soldering iron in order to solder wire onto all of the solar panels before students start the project. This can also come in handy if one of the components breaks or needs reinforcement.

SETTING THE STAGE: UNPACKING YOUR KIT

- Students should have an understanding of each of the components of the solar USB charger after completing the Components of the Solar USB Activity in Lesson 2. Provide each student with a solar USB charger kit. Remind students that many components are fragile. Ask students to identify each of the components of the kit.
- Ask students to recall the discussion about the positive and negative terminals of each of the components. Ask students if they can identify the positive or negative terminals of the solar panel, the battery, the diode, and the USB charger. Use the images below to identify these terminals for each of the components. The USB unit has a small silver “+” on the positive end.
 - Note the negative side of the diode has a black line around it.



Solar USB Charger
Lesson 3: Building a Solar USB Charger



ACTIVITY 2: BUILDING A SOLAR USB CHARGER

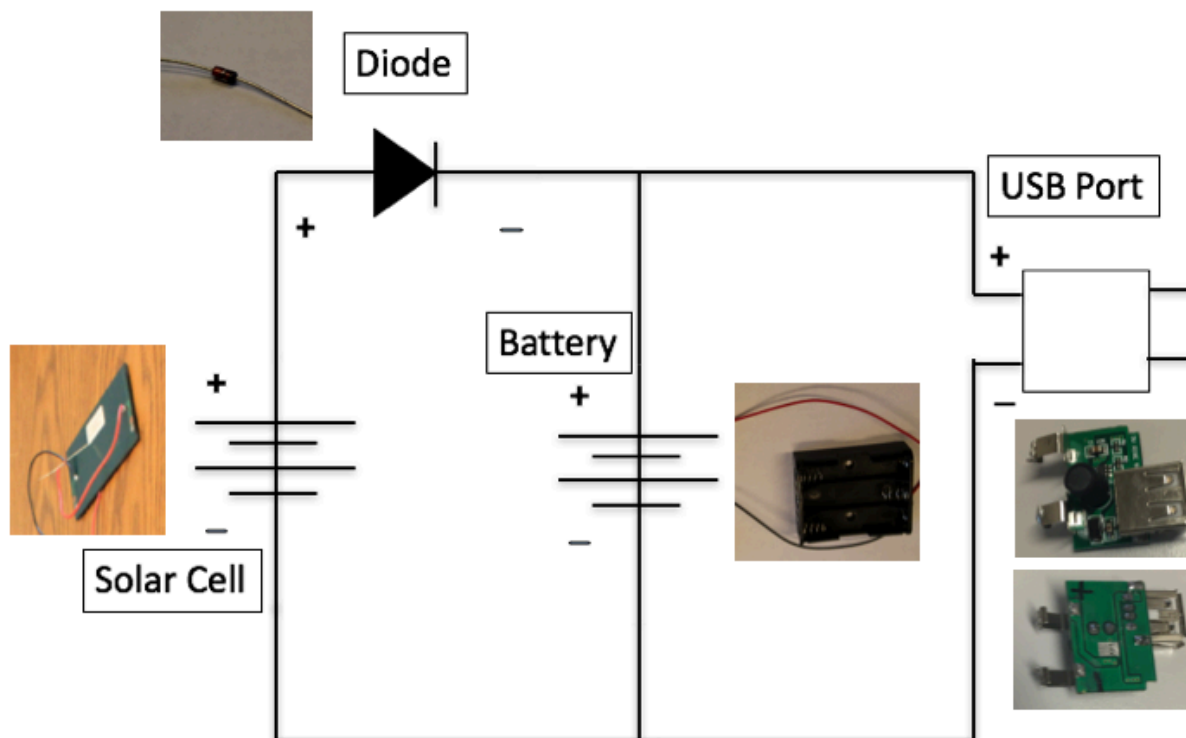
- See the Building a Solar USB Charger Handout for building instructions.

ACTIVITY 3: CREATING A CASE FOR YOUR SOLAR USB CHARGER

- If purchasing the Solar USB Charger kit 2.0 from Brown Dog Gadgets, you may choose to include the wood box used to store the components of the charger. However, if you choose not to purchase the wood boxes, the creation of a case to house the components of the Solar USB Charger is an opportunity for students to use some creativity. The case is important to keep the sensitive electronics away from the environment and making an easy to use USB charging device.
- Do not completely build the case before building your Solar USB Charger. These need to be made simultaneously, so that wires can thread through the correct spot of the case and so that items are positioned in the correct location. Ask students to mark on their circuit diagram which components are inside the box and which components are outside the box.
- There are some factors to consider when thinking of designing a case.
 - **Ease of Use:** Can you easily access the USB connection and toggle switch? If a connection comes loose, can you easily access it for maintenance?
 - **Durability:** Will your case hold up over time?
 - **Case Material:** The charging circuit can heat up and transfer its heat to the case. Metals should be avoided since the circuit would easily transfer heat to the metal. Plastic or wood might be better material.
 - **Repurpose Materials:** Keeping with the theme of sustainability, what materials can be repurposed and used for your solar USB charger?
 - **Solar Cell Orientation:** Does your case give you the ability to create the optimal orientation and tilt for your solar cell?
- Ask students to brainstorm what materials they could find in their home and use to store their solar USB charger.
 - Ideas for case materials: milk carton (paper or plastic), glass container, hallowed out book, scrap wood, spare cardboard box, water bottle, etc.
- When the case is created, use some adhesive such as foam tape or a hot glue gun to keep the components in place.

HANDOUT 3.1: BUILDING A SOLAR USB CHARGER

The circuit diagram for the solar USB charger is below. Refer to this diagram when you are making the connections between different pieces of equipment to ensure components are connected properly.



Soldering Tip:

- Before soldering two wires together, apply solder to the ends of the exposed wire. This will allow you to more easily solder together wires

Step A: Solder the Wires to the Solar Cell

1. Do not remove the clear protective covering on the solar cell at this time.
2. Cut out three, 6 inch lengths of 22-gauge primary wire from the wire spool.
3. Use a wire stripper to cut off about 1/2 inch of the plastic covering at the end of each wire. Twist the exposed metal to prevent fraying and to ensure a secure electrical connection.

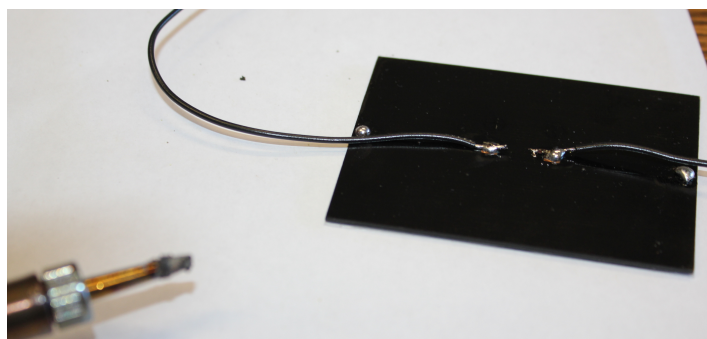


Image 1