Get Energized! STEM Kit Use Instructions

Note: This kit is intended for students 4th grade and higher in a supervised classroom setting. It is strongly recommended that instructors try the kit themselves before using it with students. This kit covers the scientific practices of Developing & Using Models; Analyzing & Interpreting Data; Using Mathematics & Computational Thinking; Constructing Explanations & Designing Solutions; and Engaging in Evidence Based Reasoning.
(https://www.nap.edu/read/13165/chapter/7#50)

Unpacking Instructions

One classroom set of 15 kits is inside one large green case. Also included is a teacher's kit (not blue) with extra supplies in case they are needed.

Kit Contents

Each individual kit should contain:

- 100 mL Beaker
- Circular Papers (4 – made w/watercolor paper)
- Digital Scale
- Empty Jar
- Jar of Rock Salt
- LED Flashlight
- Multimeter w/Cables
- Pipette
- Red LED (2 volt, 20 mA rating)
- Tweezers
- Weigh Boat
- Yellow Magnet
- Blue Cloth Bag Containing:
  - Two ½" stainless steel washers
  - Two ½" zinc washers
  - Two ½" aluminum washers
  - Two ½" copper washers
- Red Cloth Bag Containing:
  - Two ½" copper washers (1 labeled SOLAR A and 1 labeled SOLAR B)
- Blank Data Table Templates (1 per student)
- Get Energized! Booklet

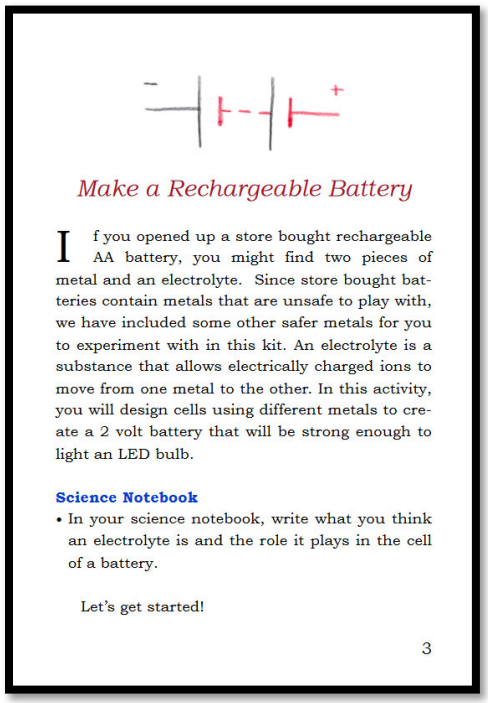
Room Setup

1. Arrange tables and chairs so students can work in pairs.

2. Make sure to have the following supplies on hand:
   - Water
   - Paper Towels
   - Water-Color Paper and Scissors (only if new circular papers are needed)
   - Markers/Pens (for writing on paper towels)
   - Science Notebook
   - Tape (for taping templates into Science Notebooks)
3. Have each pair of students obtain a kit, a paper towel for their workspace and a beaker full of water (roughly 50 mL).

Begin Lesson

1. Students should start by opening their science notebooks to a new page. Notebooks should be labeled "Get Energized!" with the date and the name of their lab partner.
2. They should then open the kit and take out the Get Energized! Booklet and begin reading on page 3.



Make a Rechargeable Battery

If you opened up a store bought rechargeable AA battery, you might find two pieces of metal and an electrolyte. Since store bought batteries contain metals that are unsafe to play with, we have included some other safer metals for you to experiment with in this kit. An electrolyte is a substance that allows electrically charged ions to move from one metal to the other. In this activity, you will design cells using different metals to create a 2 volt battery that will be strong enough to light an LED bulb.

Science Notebook

- In your science notebook, write what you think an electrolyte is and the role it plays in the cell of a battery.

Let's get started!

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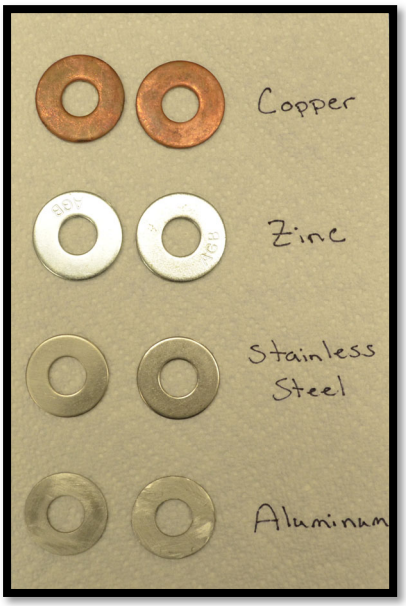
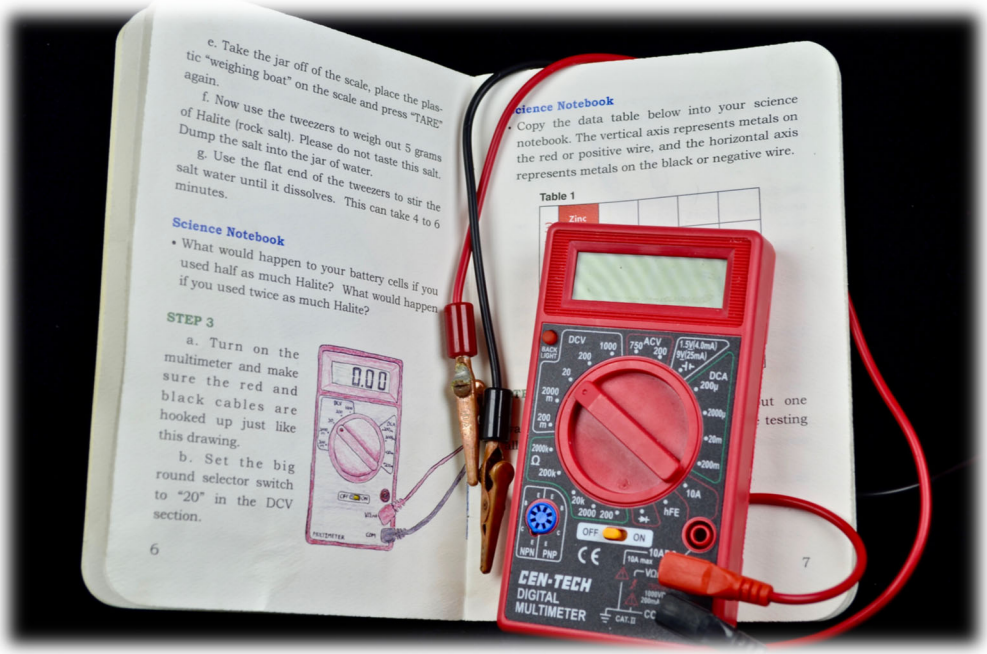
3. The words 'Science Notebook', accompanied by a pencil icon, are located throughout the booklet, which indicates that the students should **stop and respond** to the prompt in their notebooks.
4. Blank data table templates that are supplied in the kit can be used by the students and taped into their science notebooks in the appropriate place. Extra copies of the templates can be downloaded from the EOC website at: https://www.cns-eoc.colostate.edu/stem-kits/get-energized/
5. Pairs of students should be allowed to proceed at their own pace. Make sure to encourage students to read the text rather than just looking at the pictures.
6. Walk around the classroom and check on students, especially if they are younger. Clarify any parts that the students do not understand.

Part 1: Make a Rechargeable Battery

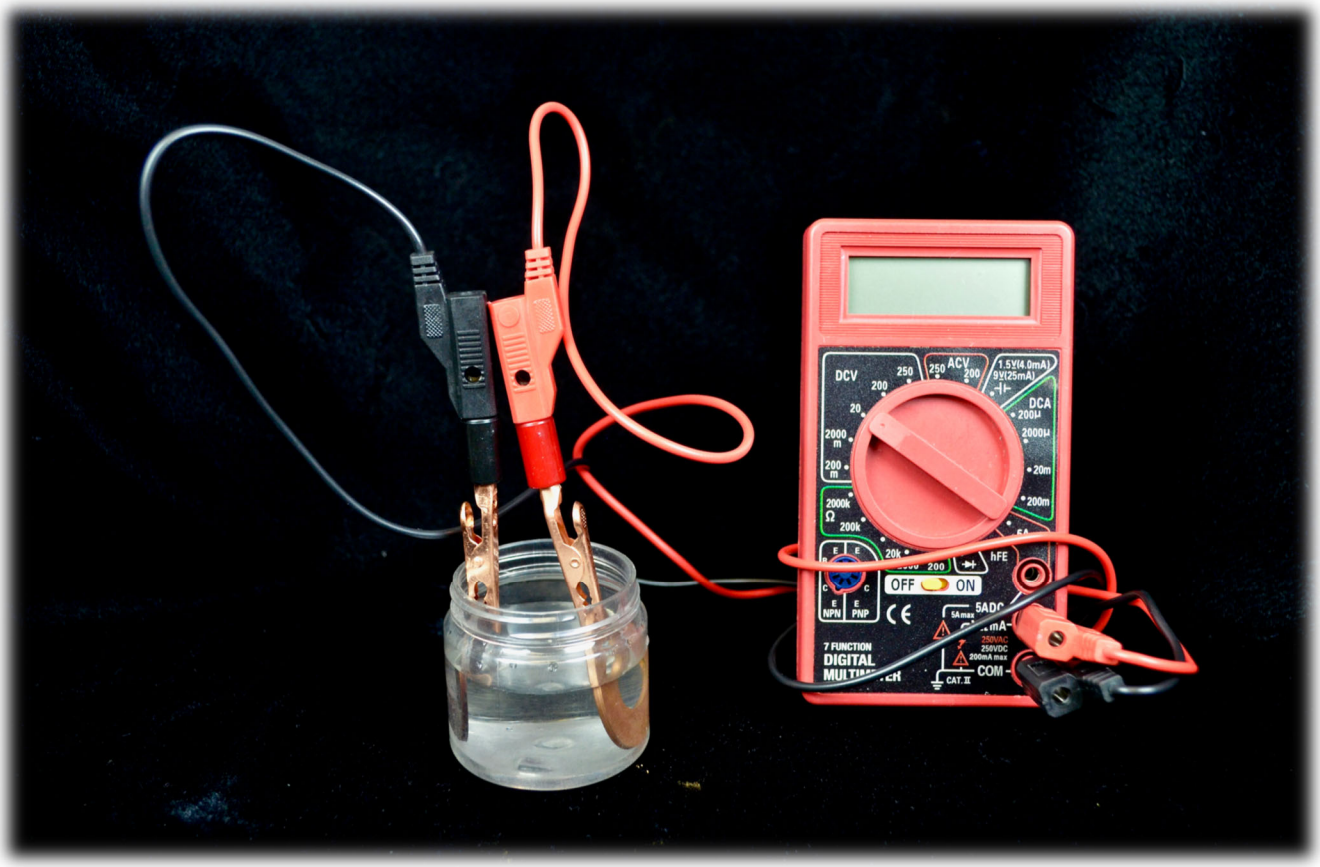
1. Part 1 uses only the washers in the blue bag. Make sure students label their paper towel correctly and accurately identify the correct metals using the yellow magnet and the balance (page 4).



2. The cables for the multimeter should be plugged in correctly – there are 3 plugs available. The red cable should be plugged into the middle hole and black cable should be plugged into the bottom hole. The setting should be on 20 in the DCV section (page 6).



3. Make sure the students are submersing the washers into the electrolyte correctly – the washers should not touch (page 8).



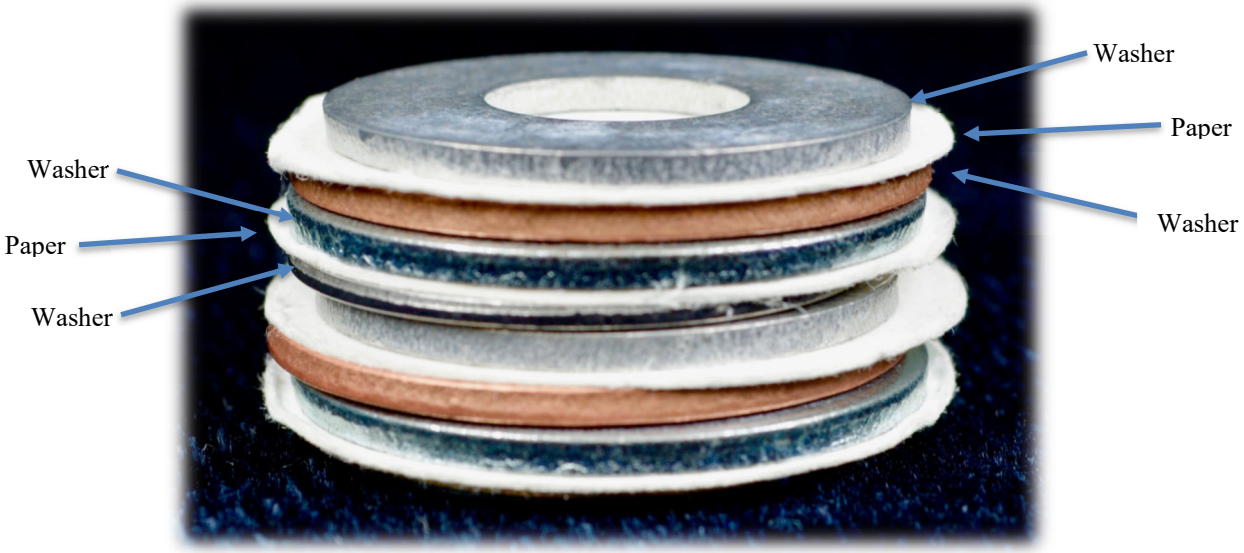
General Idea of How Students Data Table Should Look:

Red Alligator Clip (+)					
	Zinc	-0.78	-0.71	-0.22	-0.01
	Aluminum	-0.59	-0.45	-0.01	0.24
	Copper	-0.08	0.01	0.49	0.70
	Stainless Steel	0.01	0.08	0.54	0.78
		Stainless Steel	Copper	Aluminum	Zinc
		Black Alligator Clip (–)			

Key:

- **Numbers Should be Around Zero**
- **Numbers Should be Positive**
- **Numbers Should be Negative**

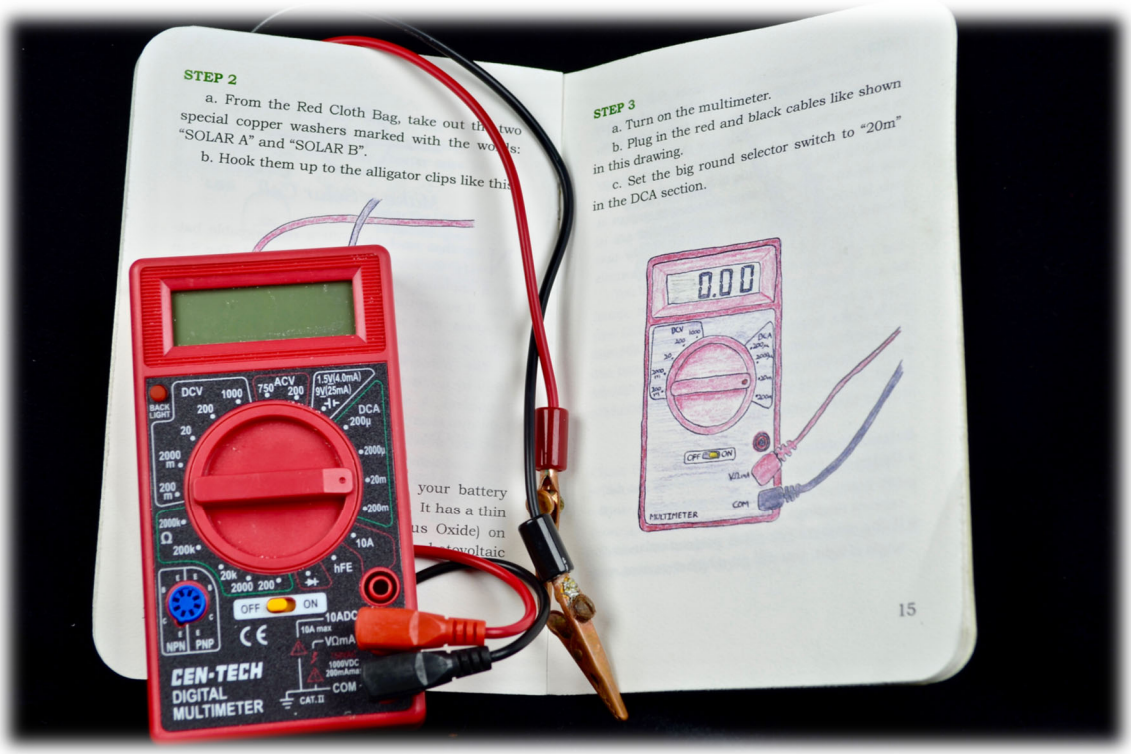
4. When students are making their cells, make sure they are created in the correct format (page9):
   - One cell = washer, paper, washer
   - Multiple Cells = washer, paper, washer; washer, paper, washer; washer, paper, etc. until all washers and papers are used up.
   - Tip: Make sure that student's papers aren't drooping over and touching other cells!



Part 2: Make a Solar Cell

1. Make sure that students do not pour out their electrolyte solution until they very, very end! It will be used when students get to make a solar cell.
2. Students should have a red cloth bag containing Solar A and B washers. Make sure they are not mixed up with the blue cloth bag washers!

3. Make sure that the red alligator clip is plugged into the middle hole on the multimeter. The black alligator clip should be plugged in directly below the red one. The setting for the multimeter should now be set to 20m in the DCA section (page 15).



4. When using light sources, let students use sunlight or flashlight. If flashlight is used, make sure students shine light **under** the water. Let them try different distances, angles, and light sources!

Clean Up

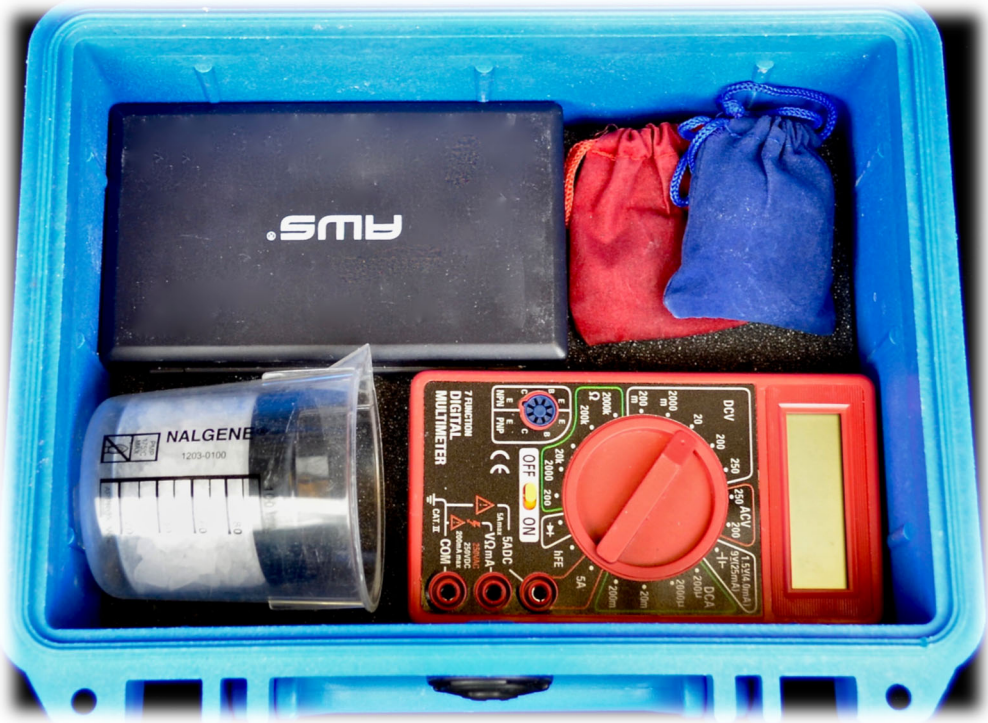
1. The multimeter needs to be turned off and the alligator clip cables should be unplugged and neatly coiled.
2. The digital balance and flashlight also need to be turned off.
3. The electrolyte solution is safe to be poured down the sink drain.
4. The electrolyte jar and ALL washers must be rinsed **thoroughly** and completely dried with a paper towel or soft cloth.

   If the washers are not cleaned and dried properly before being put back into the bags, they will corrode, sticking together and be ruined.

5. All washers need to be placed into the appropriate bag (Solar A & Solar B copper washers go in the red bag – all others go in the blue bag).
6. Put the jar of salt inside of the dried, empty 100 mL beaker. Place the LED light, magnet and 4 circle papers into the empty jar with the weigh boat on top. **All items should be dry first!**

Packing Instructions

Step 1: Place the digital scale, multimeter, the red and blue cloth bags, and the 100 mL beaker with jar of salt rock in it into the case as shown.



Step 2: Put the flashlight on top of scale along with the jar with the magnet, LED & paper circles in it. The tweezers and pipette can be placed on top of the multimeter. The red and black cables should be gently wrapped up and put over the red and blue cloth bags.

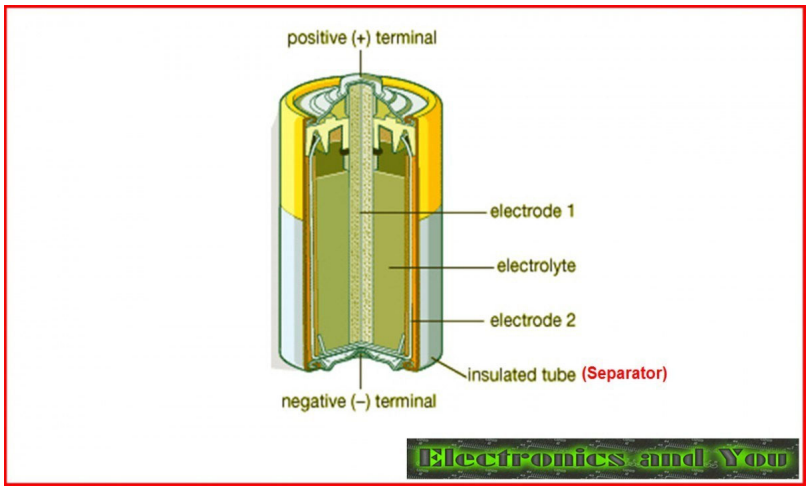
Step 3: Lastly, place the Get Energized! booklet on top and carefully close the lid without pinching any of the items. **CAUTION:** ***Do not force the case shut – it should close with ease!***

Class Discussion Questions

Note: The questions provided below are guide questions that students can discuss as a class in order to determine what they learned/took away from the kit.

Part 1: Make a Rechargeable Battery

1. What is an electrolyte and what role does it play in a battery?
   An electrolyte is a catalyst that makes a battery conductive – promoting the movement of ions between metals. In our battery, the electrolyte is salt – in real batteries, it is usually an acid.



2. What metals did you find were the best at creating high voltage? The worst?
   Typically, the best combination of metals is Copper (+) and Zinc (-). The worst tend to be Aluminum (+) and Stainless Steel (-).
3. How do you think the electrolyte created would vary in voltage if there were an increased concentration of halite? Decreased?
   An increased concentration of halite may increase the voltage to a certain point and a decrease might decrease the voltage. This would make a great science fair research project for a student to determine the optimal concentration of halite for this experiment.
4. Do you think the results would change if the halite did not fully dissolve in the solution prior to the experiment? Explain.
   If the halite were not fully dissolved, this would create a weak electrolyte and might affect the voltage readings at the beginning of the experiment.
5. What combination of cells produced the highest voltage? Why are some metals better at conducting electricity than others?
   This will vary among the students, but typically Copper and Zinc and Stainless Steel and Aluminum will make the best overall combinations to get the LED to light up. Some metals have a higher resistivity (how strongly it resists or conducts electric current), which makes them less conductive. Lower resistivity leads to higher conductivity.
6. What strategy did you use in order to determine the best combination of cells?
   Students hopefully referred back to the data they collected into their table to determine the best combinations, but some will simply do trial and error.
7. What happens if one of the cells is put in the stack upside down?
   If one of the cells is put in the stack upside down, it will subtract from the overall voltage total instead of add to it.

8. How could you get the LED light to shine brighter? Dimmer?
   Students could try a different electrolyte solution or trying different battery combinations. This would also make a good science fair question for a student.

Part 2: Make a Solar Cell

1. How do you think sunlight is converted into electricity?
   The black oxide on Solar A is a photovoltaic semiconductor. This means that light can be used to move electrons away from the Cu_2O nuclei. "Electron Holes" are created when the electrons move away from the nuclei. These electrons form negative ions in the electrolyte. Solar B begins to gain too many electrons, so they start to flow back to Solar A (through the multimeter) to fill the holes. Electricity is just moving electrons. Here we have a simple way to move electrons with just light.
2. What angles were most effective at producing a higher current? Explain.
   The best angle is when the light is perpendicular (90°) to the washers because this is when the most light is absorbed into the system.
3. Why are solar panels on buildings tilted?
   So they are as close to perpendicular to the sun as possible.

Part 3: Recharging the Battery

1. How many washer solar cells do you think you would need to recharge your washer-cell battery?
   In full sun, the Solar A/B cell generates 1 milliamp of current. A typical battery charger gives 80 milliamps of current. So we would need around 80 washers and the sun.

Teacher Feedback Survey:

http://dat.cns-eoc.colostate.edu/STEMkits/stem_kit_survey.php

Thank You!