

Solar Cell in a Drinking Straw

Instructions: Make a photoelectrochemical cell in a straw using drinking draws and raspberries! A 45-60 minute activity.

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Introduction

In this experiment you will be making a solar cell in a drinking straw. You will be using the good light-absorbing properties of raspberry juice to capture electricity from sunlight, using some nice straightforward chemistry. Enjoy!

Equipment List

test tube rack	aluminium foil
3 test tubes	tweezers
a screw	dish of raspberries
clear drinking straw	glass rod
25cm length of solder wire	bright light (1 between 2 pairs)
6cm of blue plastic-coated copper wire stripped at both ends	small bottle of methylated spirits
matches	small vials of:
tealight candle	- copper sulphate,
heatproof mat	- ferrous sulphate, zinc
25 ml measuring cylinder	- sulphate, sodium
tissue	- hydroxide pellets
scissors	- ammonia solution
conical flask	spoon-spatula
2 x 1ml plastic pipettes	pestle and mortar
retort stand	multimeter with probes
food bag tie / string	2 x crocodile clip wires

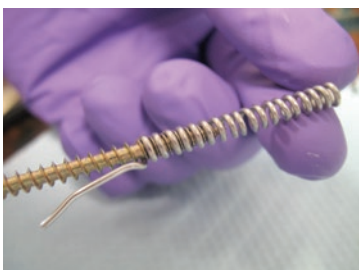
Method

1. Bend the straw at its flexible hinge to make a U-shape.
2. Cut the longer arm to the same length as the shorter arm with a pair of scissors. You should now have a symmetrical U-shape and a long straight bit of straw.
3. Cut the long straight bit of straw into 3 equal parts by cutting at a 45° angle using scissors. These will then be used as scoops for the next steps. Keep everything for later.



Making the working electrode

4. Cut off a 1cm long piece of solder wire from the 25cm you have been provided with using the scissors. Keep it for the next stage.
5. Wrap the rest of the solder wire in between the grooves of the screw thread to make a coil that is about the same length as one of the arms of the U-shaped straw. **Leave at least 2cm of wire not coiled to use as a handle.**



6. Twist the screw round to get it out of the coil when you have finished (as if you are unscrewing it). You might need a little help from a screwdriver.

7. Make sure the coil fits into the straw **easily**. If it doesn't, stretching the coil lengthways slightly will make it thinner.

8. Measure out 10ml of methylated spirit into a measuring cylinder. Pour it into one of the test tubes.

9. Add into this test tube 1 heaped spoonful of zinc sulphate powder using a spoon-spatula and the 1cm length of solder wire you cut earlier.

10. Use a plastic pipette to add in 2ml of ammonia solution.

11. Roll up a small bit of aluminium foil into a ball of about 1cm in diameter and drop into the test tube.

12. Finally put in the solder wire coil, so that it is fully submerged **except for the uncoiled handle**. Leave for 10 minutes.

13. While you are waiting, measure out another 10ml methylated spirit using the measuring cylinder. Pour this into a clean test tube.

14. Add 1 heaped spoonful of zinc sulphate powder and clean the spoon with a tissue. Then add about 4 or 5 sodium hydroxide pellets.

15. Next, take the dish containing raspberries and mash them up using a glass rod or spoon-spatula. Pour into your third clean test tube.

16. After 10 minutes are up, take out the coil using tweezers and gently wipe with a tissue to remove any large lumps of solid on it. Then put the coil into the second test tube and leave for 1 minute. Take out the coil, wipe with a tissue and wrap gently in a small piece of foil.

17. Place a tealight candle on a heatproof mat and light it with a match. Hold the foil-wrapped coil with the tweezers and wave it slowly side-to-side about 5cm over the flame for no longer than a minute. **If smoke appears before this, the solder is about to melt so remove it from the heat early**. Allow to cool.

18. Unwrap the coil and put it into the test tube containing raspberry juice, **leaving the handle above the level of the juice**. Leave it here while you assemble the cell.



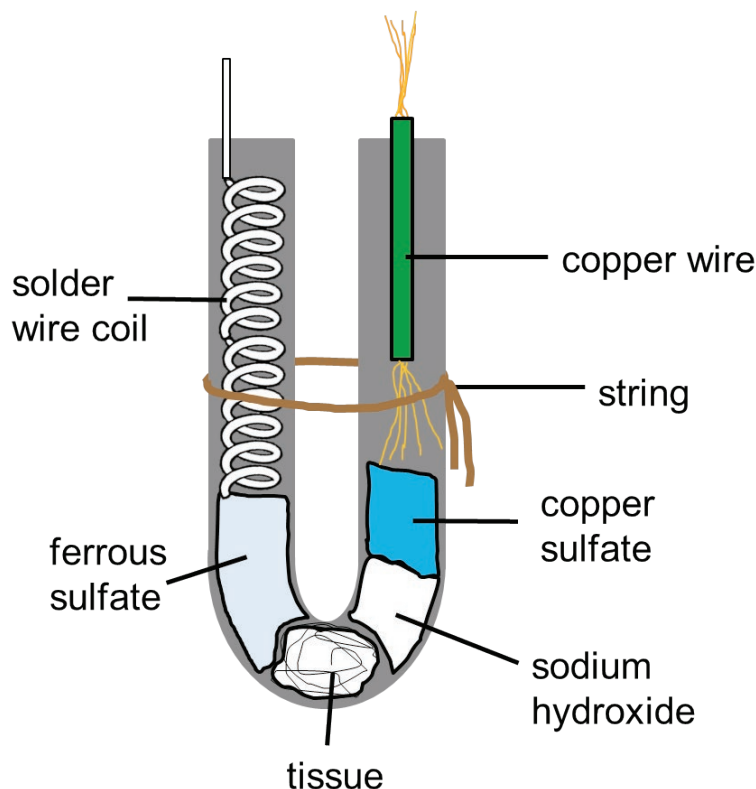
Assembling the cell

18. Push a small bit of tissue about the size of the end of your thumb into the hinge of the U-shaped straw. Use the screw to push it into place.

19. Put a few pellets of sodium hydroxide into the mortar and grind it up using the pestle into small pieces that will fit into the straw. (**WARNING** sodium hydroxide can be harmful and burn the skin) Use a straw scoop to put 1 or 2 scoops of sodium hydroxide into one arm of the straw so that it takes up about 0.5 cm.

20. Use another scoop to put about 3 scoopfuls (or 1cm) of copper sulphate into the straw on top of the sodium hydroxide.

21. Use the third clean scoop to put about 3 scoopfuls (or 1cm) of ferrous sulphate into the OTHER arm.
22. Attach the cell to a retort stand by letting the hinge rest on the base and loosely tying it with a food bag tie (or string) to the pole as shown in the diagram.
23. Remove the coil from the raspberry juice and wipe off the gunk with a tissue. Push the coil into the arm containing the **ferrous sulphate**.
24. Put one end of the blue plastic-coated copper wire into the arm containing the **sodium hydroxide and copper sulphate**.



25. Put some tap water into your conical flask.
26. Filling up the COIL arm first, use a pipette to add the water into both arms of the straw cell.
27. Attach one end of a crocodile clip wire to the solder coil handle and attach the other end to one of the multimeter probes.
28. Take the other crocodile clip wire and attach one end to the copper wire and the other end to the other multimeter probe.

Measurement

29. Measure the **voltage** of the cell by turning the dial on the multimeter to **2000mV**. If you do not get a reading check for air bubbles in the straw. The water needs to be all through the straw for it to work. Squeeze the straw gently to get rid of air bubbles.
30. Measure the **current** in the cell by turning the dial to **2000 μ A**.

31. Now shine a bright light onto the cell and see if the current changes. Take the bright light away again and what happens? Switch the multimeter back to measure the voltage. Has that changed?

One single cell is not enough to power very much, but if we attach up cells in a series circuit we might be able to increase our output. Team up with a few neighbouring pairs and create a series circuit containing both cells. Measure the combined voltages and currents using a multimeter. Can it power an LCD display calculator?

Disposal

- Wash up your mortar and pestle, spoon-spatulas, tweezers, test tubes, conical flask, raspberry dish and glass rod with plenty of water at the sink. Throw your rubbish in the bin (plastic pipettes, tissue etc)
- Make sure your retort stand is packed away and all vials have their lids securely on. Place all the equipment back in the trays they came from. The straw cell itself can go in the bin.



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