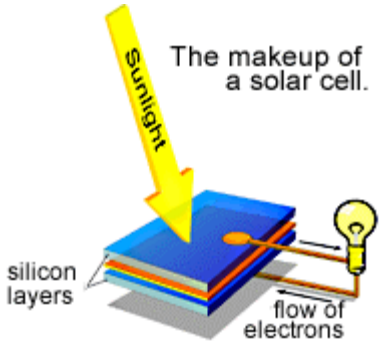
Background

Not only is the sun a source of heat and light, it's a source of electricity too! Solar cells, also called photovoltaic cells, are used to convert sunlight to electricity. Solar cells are used to provide electricity all kinds of equipment, from calculators and watches to roadside emergency phones and recreational vehicles.


Solar panels are becoming common on many homes.

Solar cells are most commonly made from silicon, the same material used to make computer chips. Silicon is one of the Earth's most common elements, and is a major component of sand and many kinds of rocks. A solar cell is built like a sandwich, with two layers of silicon separated by a thin layer of insulating material. All three layers work together to convert sunlight into electricity.

When sunlight falls onto the solar cell, it produces a small electric charge. Like a battery, the charge is positive on one side of the cell, and negative on the other. A wire connects the two sides of the cell, allowing electricity to flow. This flow, or current, of electricity can be used to power a small light bulb, turn an electric motor, or recharge a battery.



Solar cells are often used in locations where there isn't any electricity and where electricity is needed in small amounts. In such cases, solar cells are usually connected to batteries, allowing electricity to be stored for use during times when the sun isn't shining.

A single solar cell is able to produce only a small amount of electricity. But solar cells can be connected together on a multi-cell panel to produce larger amounts of electricity. As with batteries, the more cells that are connected to one another, the greater the current of electricity that can be produced.[1] Solar panels can produce enough electricity to power satellites, recreational vehicles, and equipment for other applications where electricity is used in large amounts.

For this project, you will be using the electricity from solar panels to power a small car. Your challenge will be to build a solar car that travels as fast and straight as possible.


A completed solar car.

Build It!

These step-by-step instructions provide you with a plan for making a basic solar car. If you can think of ways to improve the design of your car, try them out. Experiment with the materials.

[1] Solar cells connected in series (in a long chain, positive to negative, etc.) will increase the voltage of the panel. Solar cells connected in parallel (all their positive terminals to one wire, and all their negative terminals to another wire) will increase the current, or amperage of the panel. In most large commercial panels, the individual cells are connected both ways, with rows of cells in series to raise the voltage of the panel, and then those rows connected to each other in parallel, to raise the amperage.

Substitute parts to try to make the car lighter and faster. Keep a record of your design improvements as you go.

Materials

The tools and materials for making a solar car.

Order a Solar Car Kit:

SunWind Solar Industries
1-866-248-5350 (toll-free)
Web site: http://www.sunwind.ca/

The Solar Car Kit should contain the following materials:

- 2 solar panels, with contacts
- 2 wooden axles
- 4 screw eyes
- 5 wheels (2 large, 3 small)
- 4 black rubber tires
- 2 elastic bands
- 1 motor shaft pulley
- 1 alligator clip test lead
- 2 cm clear vinyl tubing
- 1 electric hobby motor
- 1 self-adhesive motor clip
- 1 brass paper fastener
- Fine sandpaper
- 1 piece of foam board (24 cm by 7 cm)

Tools and Other Materials

Gather together the following tools and materials:

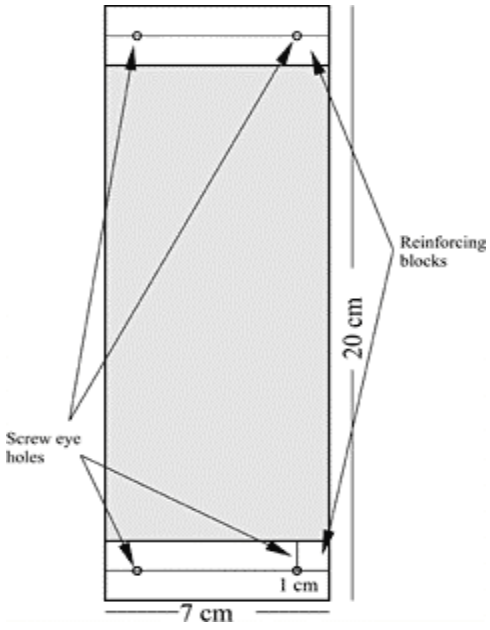
- Hot glue gun with glue sticks
- Scissors
- Retractable utility knife
- Metal ruler
- Pliers
- Roll of clear tape

A. Construct the Body

1. Using the utility knife, cut the foam board into three pieces — one measuring 20 cm by 7 cm, and two measuring 2 cm by 7 cm. Use the metal ruler to guide your cuts.

2. Glue the two smaller foam board pieces to the large foam board piece as shown in the illustration below.

3. Using a ruler, carefully mark the positions of the screw eyes on the two smaller pieces as shown in the illustration below.



Dimensions of the foam board pieces for the body of the solar car.

4. Turn the screw eyes into the foam board pieces. Be sure the screw eyes penetrate both layers of foam board.

Turn the screw eyes firmly into the foam board.

5. Slip an axle through the screw eyes to check their alignment. The axle should be parallel to the end of the foam board. If necessary, adjust the screw eyes.

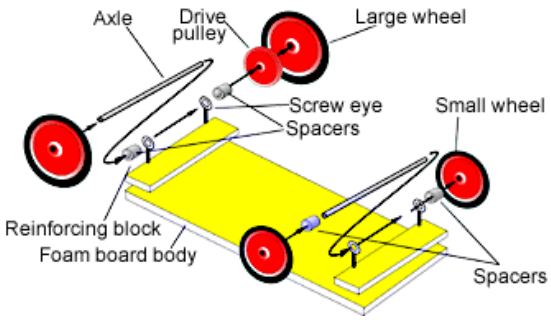
B. Mount the Wheels

1. Slip a rubber tire onto each of the two large wheels, and two of the small wheels. The smallest wheel will be used later.

2. With scissors, cut the vinyl tubing into small sections approximately 5 mm in length. These will be used as spacers on the car's axles (see diagram).

3. Test the fit of the wheels and axles. The wheels should grip the axles firmly. If the wheels cannot be pressed onto the axles, try sanding the ends of the axles to reduce their thickness slightly, and check again for fit.

If necessary, sand the end of the axle to obtain a good fit with the wheel.



Mount the axles and wheels of the solar car.

4. Assemble the rear axle as shown in the illustration. Do this by slipping the axle through the screw eyes, then adding the spacers followed by the drive pulley (the third small wheel) and wheels. You may need to sand the axle a little to allow the drive pulley to slide on.

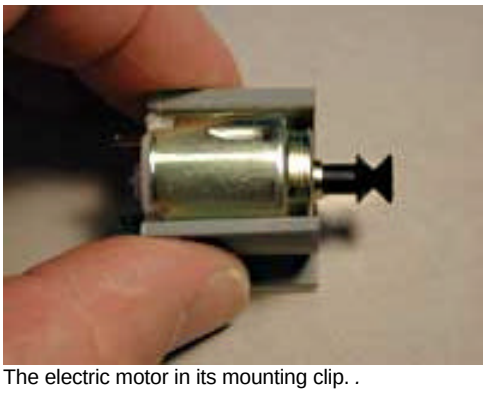
The rear axle with its drive pulley.

5. Add the front axle with its wheels and spacers, as shown in the illustration.

6. At this point, check your car to see how well it rolls. Put the car on the floor and give it a gentle push. Make sure it rolls easily and in a fairly straight line. Adjust the axles slightly to get a better alignment, if necessary. If the screw eyes seem loose, carefully place a drop of hot glue where the screw eyes come through the foam board to hold them in position.

C. Mount the Motor

1. Push the small black pulley onto the shaft of the motor, as shown on the next page. Slip the motor into its clip.



The electric motor in its mounting clip. .

2. Stretch the elastic band over the rear wheel and place it on the axle-mounted drive pulley.

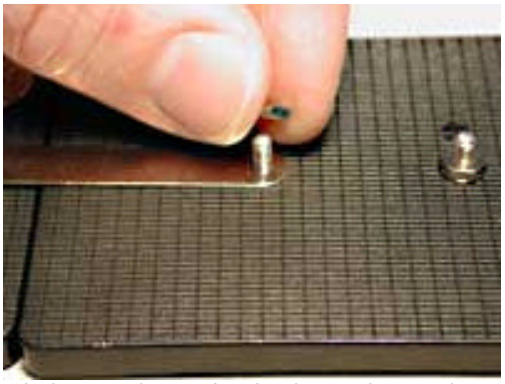
3. Position the motor so that the elastic band makes good contact with both pulleys without being stretched more than 5 mm. Once you know where the motor should fit, mark that location on the foam board with a pencil. Remove the backing from the self-adhesive motor clip, and press the clip and motor onto the foam board in the position that you marked.

Position the motor on the car body.

D. Prepare the Solar Panels

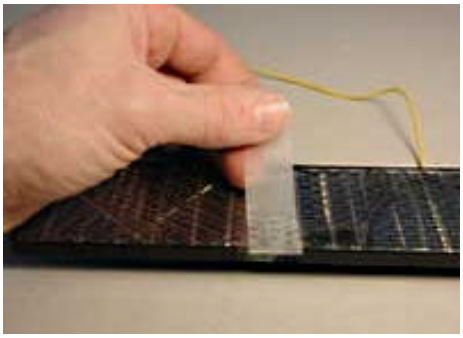
1. On the back of each solar panel you will find a metal connecting bar and two threaded metal contacts. Each contact is equipped with a small washer and a nut. The metal bar and contacts are used to connect the panels together, and to connect wires to the panels. Remove the nuts, washers and metal bars from the connectors and set these aside, being careful not to lose them.

2. Connect the two solar panels using one of the metal connecting bars, as shown below. Be sure the bar connects the positive terminal on one panel to the negative terminal on the other. Secure the connecting bar using washers and nuts, tightening them gently using the pliers (do not over-tighten).



Join the two solar panels using the metal connecting bar.

3. Strengthen the joint between the panels by adding a strip of clear tape on both sides of the panel.

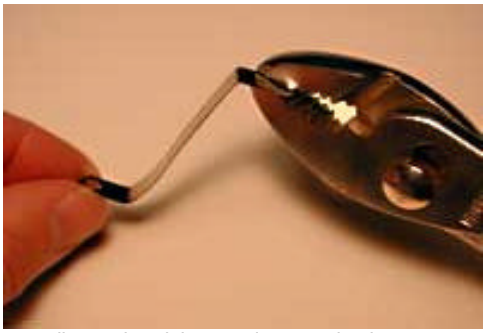


Use clear tape to strengthen the joint between the two panels.

4. Use scissors to cut the alligator clip test lead into two pieces of equal length. Strip about 1 cm of insulation from the two cut ends, and in each case twist the exposed copper wires tightly together.


Strip insulation from the test lead.

5. Using the pliers, carefully bend the spare connecting bar to form an angled support for the solar panels, as shown below.


Use pliers to bend the metal connecting bar.

6. Position the second connecting bar on the threaded metal contact, as shown below. This will be used to help support the panels in a later step.


Connect the wires to the solar panels.

7. Loop the bared ends of each test lead over the threaded contact and screw a nut onto each. Gently tighten each nut using pliers, making sure the wire is well secured.

E. Mount the Panels

1. Use the utility knife to carefully cut a small slot in the large foam board section as shown below.

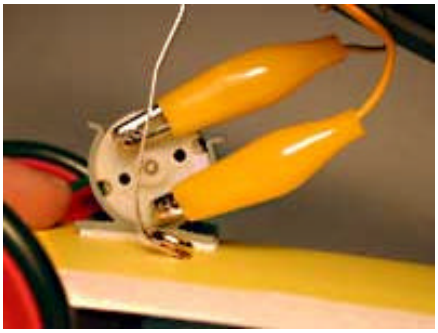

Cut a slot for the paper fastener.

2. Use the brass paper fastener to secure the connecting bar to the foam board. Push the fastener through the hole in the bent connecting bar, and spread the tabs where they poke through the slot in the foam board.


Secure the connecting bar using the brass paper fastener.

3. Arrange the panel and its support so that it sits at an angle on the body of your solar car. Use a small piece of clear tape to fasten the lower end of the panel assembly to the foam board.

4. Use the alligator clips to connect the wires to the terminals on the electric motor. If necessary, tape loose wires to the body of the car to keep them from touching either the ground or moving parts of the car.



Connect the motor to the solar panels.

Test It!

Test your car by placing it in bright sunlight, or under a bright (150 watt or greater) light bulb. The wheels should begin to spin quickly. If the wheels are turning the wrong direction, switch the wires connected to the motor. This will reverse the direction of the motor. You can make small adjustments to the angle of the panels, the alignment of the wheels, and the position of the motor to reduce friction, increase the power from the panels, and improve the speed of your car.

Test your solar car in full sunlight on a smooth surface such as sidewalk.

Acknowledgements

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All images courtesy of The Pembina Institute.

Questions

1. Working under a bright light bulb or in direct sunlight, experiment with the angle of light hitting the solar panels. What angle gives you the fastest rotation of the wheels?
2. How would you modify this car to make the wheels turn faster?
3. How would you modify this design to make a car that could carry or pull a heavier load?
4. How could you modify this design so that your car could run for short periods in complete darkness or low light situations?
5. Sketch a plan for a solar car large enough to carry a human. What technical problems would you have to overcome to build it?

Notes: