

Topics: Solar Heating,
Radiant Energy

Materials List

- ✓ Aluminum foil or reflective Mylar
- ✓ Clear tape
- ✓ Binder clips, medium, 14
- ✓ Paperclips
- ✓ String
- ✓ 9 binders with similar cover sizes
- ✓ CD or equal
- ✓ Straw, 3 mm (1/8") diameter
- ✓ Paper/sharp cutter
- ✓ Small dark cooking pot or black can
- ✓ Support for the pot (see **To Do and Notice** step 6)
- ✓ Water or food sample (without a food safety issue!)
- ✓ Oven cooking bag

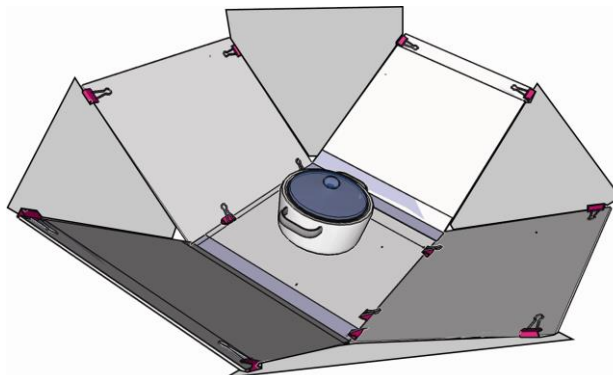
This activity can be used to teach:

Next Generation Science:

- Energy transferred/ converted (Physical Science, Grade 4, 3-2, 3-4; High School, 3-3)
- Thermal energy (Middle School, Physical Science 3-3)
- Eval./Reduce Human Impacts (Earth/Space Sci., Middle School, 3-3; High School, 3-2, 3-4; Life Science, High School, 2-7)

Binder Cover Solar Collector

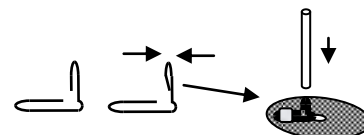
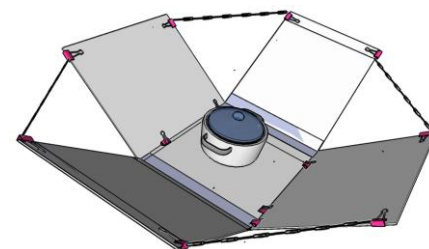
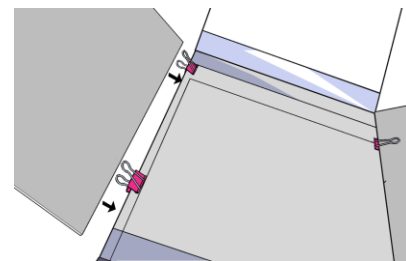
A Renewable Energy Device



Explore heating with sunlight using an easy to make and store solar collector.

Assembly

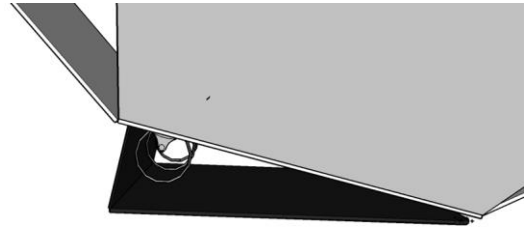
1. Cut the covers from the spines of 5 binders using a paper cutter or other sharp cutting tool. Cut as close as possible to the spine so as to maintain a sealed edge.
2. If the cover is accidentally cut into then use tape to seal the cut edge.
3. Save the binder covers and discard (or repurpose) the spines with the rings.
4. Cut foil or Mylar pieces big enough to cover one side of each of 9 binder covers.
5. Attach the foil or Mylar by taping with clear tape or, if view binders (which have clear pockets on the outside covers) were used, by inserting into the pockets.
6. Place 3 binder covers in a row with the reflective sides upward and the longer edges aligned to each other. Leave a small gap between the binder covers to make bending and folding easier. Attach the covers together using clear tape.
7. Attach 2 binder clips to each un-taped side of the central binder cover as shown. Leave the handles of each binder clip in the "up" position.
8. Set a binder cover into the space between the clip handles as shown. Repeat for the other side of the central binder cover. **Alternately** the covers could be taped together, but then the collector would not be as foldable or storable.
9. Connect the handles of a pair of binder clips together with a paperclip chain of 10 paperclips or an equal length of string. Make 5 pairs. One pair is saved for later use in step 4 of **To Do and Notice**.
10. Attach 4 sets of the connected binder clips to the 4 outer binder covers as shown to the right.
11. Insert the 4 remaining binder covers into the triangular shaped gaps, as shown at the top of the page. Adjust the length of the paperclip chain (or string if used) as needed.
12. To make a pointer, bend up the narrower loop of a paperclip to a 90° angle. Pinch the narrow loop slightly to make narrower. Tape the wide loop of the paperclip to the non-reflective side of a CD, or similar flat object. Pinch and insert a small diameter straw over the upright narrowed paperclip loop.



To Do and Notice

Be aware of the following safety issues:

- Protect the eyes with sunglasses when using the binder cover solar collector with sunlight.
 - Select a food (e.g., tea, cocoa, marshmallow, precooked hot dog) that is safe to eat warmed but not cooked.
 - Use appropriate caution when handling or tasting hot liquids or foods!
1. Place the solar collector on a flat surface in a sunny area. If the weather is or may become windy, place in an area where the wind is blocked and/or place suitably stable, heavy objects around the collector.
 2. Place the CD/straw pointer on top of the flat central binder cover (the base) of the solar collector.
 3. Turn the collector until the shadow of the straw is directly above or below the base of the straw. Change the angle of collector by raising one side of the collector toward the Sun using an uncut binder, as shown, until the shadow of the straw is as short as possible. Use additional binders or other objects to adjust the angle of the collector.
 4. The highest side binder cover will tip inward at some point. To secure the cover in place connect one clip of the 5th binder clip pair to the top of the highest side cover and the other clip to a 10th binder cover that has been inserted under the base. Adjust the length of paperclips (or string) between the binder clips, as needed, to keep the side binder cover from tipping inward.
 5. Place 1 or more binders on the central binder cover oriented so as to create a level surface.
 6. Place a support on the center of the collector that will elevate the pot 2-3 cm (~1"). The support could be a wire rack, block of wood or other relatively insulating object with a flat top that will support the pot.
 7. Fill a dark pot with an appropriate liquid or food. **Avoid choices that might involve food safety issues!**
 8. Enclose the pot in an oven bag, close the bag, and place both on the support, selected in step 6.
 9. Check the solar collector at set intervals. Use an appropriate thermometer, briefly touch the container, or carefully taste the item to gauge the degree of heating. Remove the pot when the contents are hot enough.



The Science Behind the Activity

The Sun provides a daily source of free and non-polluting energy that can be collected and converted. Light rays can travel through a transparent material (air, clear plastic), be reflected (by foil or reflective Mylar), and/or be absorbed (by dark and/or dense materials – the dark cooking pot). Solar collectors can have flat or a curved-sided reflector(s). Curved-sided solar collectors do not need to track the Sun's movement as closely as flat-sided collectors. Parabolic and cylindrical collectors will focus sunlight to a single point or line, which can become extremely hot. A flat panel collector creates a more diffuse area of concentrated sunlight. The binder covers do not become very warm because the foil, or Mylar, reflects the sunlight. The pot containing the food becomes warmer because of the extra sunlight that is reflected from the foil and strikes the pot. Heat can be lost to the surrounding air so having the pot enclosed in a transparent oven bag will decrease the rate of heat loss, increase the rate of heating and maximize temperature that can be reached.

Taking it Further

Experiment with one or more of the following questions:

How would moving the solar collector during the day to stay aimed at the Sun change the rate and degree of heating? How can the angle of the side panels be adjusted to better reflect sunlight toward the pot? Would attaching reflective material to the outside of a view binder cover work better than inserting the material into the cover's pocket?

Web Resources (Visit www.raft.net/raft-idea?isid=504 for more resources!)

Many useful links on solar collectors and related topics can be found at - <http://www.solarcooking.org>.