

**Curriculum topics:**

- Solar Heating
- Radiant Energy
- Apparent Motion of Sun
- Reflectivity

**Subjects:**

**Physical Science,  
Earth/Space Science**

**Grade range: 3 – 12**

**Who we are:**

Resource Area for Teaching (RAFT) helps educators transform the learning experience through affordable “hands-on” activities that engage students and inspire the joy and discovery of learning.

For more ideas and to see RAFT Locations

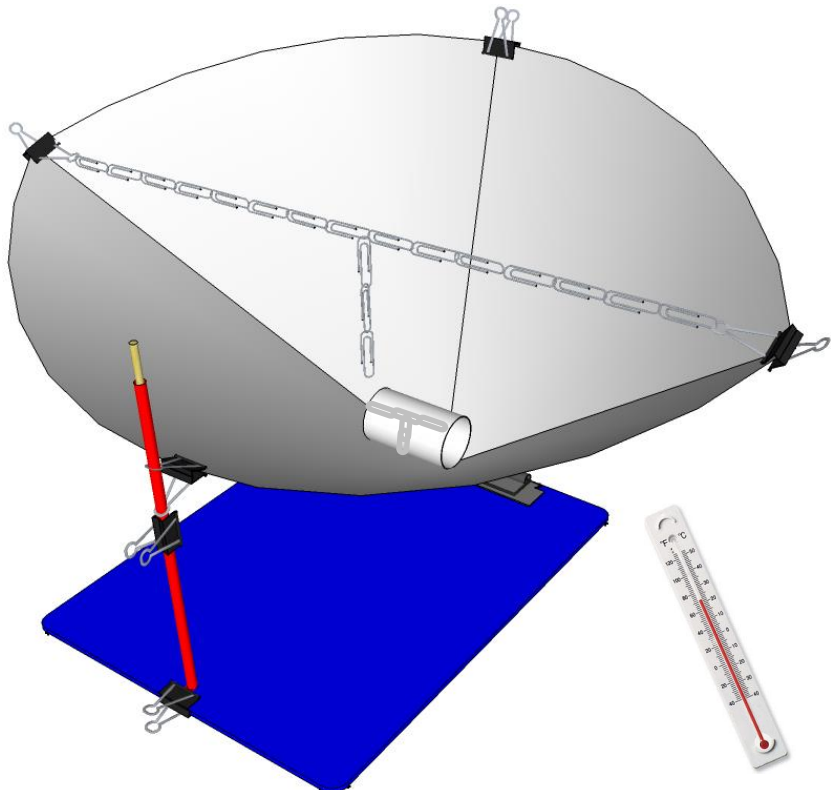
[www.raft.net/visit-raft-locations](http://www.raft.net/visit-raft-locations)

# SOLAR COLLECTOR

Explore renewable energy from the Sun



The Sun provides a daily source of free and non-polluting energy that can be collected and converted. Concentrate sunlight using a reflective collector and explore heating and “cooking” foods and other materials.



# Materials required

Per Solar Collector:

- Reflective insulation, ~50 cm x 81.5 cm (16" x 32")
- Adhesive Velcro® pads, with both hooks and loops, ~ 2.5 cm x 2.5 cm (1" x 1"), 3
- Clipboard, ~23 cm x 31.5 cm (9" x 12.5"), 2.5 cm (1") capacity, wire loop to hold papers
- Large (fat) straw, ~20.5 cm (8") long
- Chopstick, bamboo
- Binder clips, small, 1.9 cm (¾"), 6
- Paperclips, small, ~20
- Paper, white, ½ sheet – taped to make a cylinder
- Thermometer, suitable for liquids up to 100°C (212°F)
- Water, crayon shavings, or small precooked food sample (such as chocolate or a beverage) in a heat resistant container
- Optional: Shower cap or oven bag

**Caution – The Solar Collector and the items heated, including the container and its contents, and metal components may get very hot during operation. Use gloves or oven mitts when moving hot items. For hot liquids use liquid-proof gloves or mitts.**

## How to build it

- 1 Fold the reflective sheet in half, and then unfold. Peel the backing off of one side of each of three Velcro® pads and evenly space them along the edge A half of the reflective sheet. Leave some space between the pads and the center line of the sheet (stay away from the middle). See figure 1.

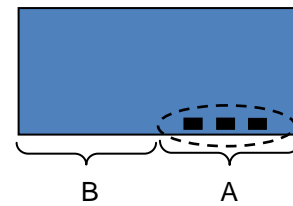


Figure 1

- 2 Remove the backing from the unattached side of the Velcro® pads.

- 3 Fold up the two lower corners of the sheet to form a triangle so that edge A overlaps edge B as shown. Press down on the overlap to firmly stick edges A and B together with the Velcro® to form a cone. See figures 2 and 3.

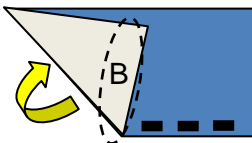


Figure 2

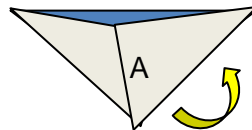


Figure 3

- 4 Flatten the tip of the cone and slide it under the clipboard clamp as shown, seam side up. Secure the overlapped edge at the top with a binder clip. See figure 4.

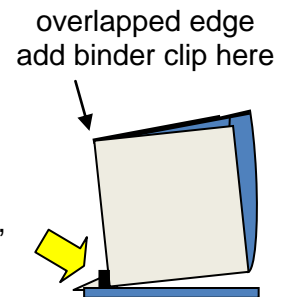


Figure 4

- 5 Fold over about 1 cm (~½") of the large straw as shown in figure 5. Use a binder clip to attach the flattened end of the straw to the clipboard base. The straw should be clamped at the front: on the short edge of the base opposite from where the cone is attached. See figures 6 and 7.



Figure 5

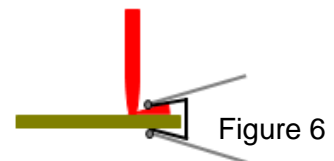


Figure 6

- 6 Attach a binder clip to the front edge of the cone as shown in figure 7.

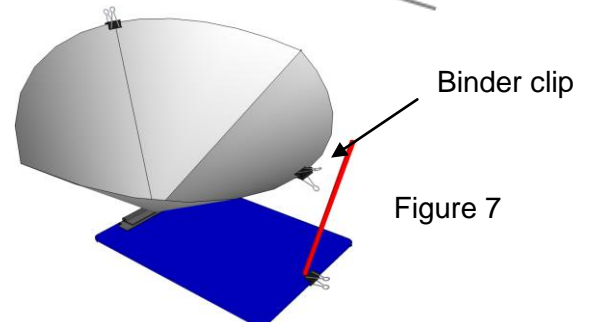


Figure 7

- 7** First slide the straw into the clip attached to the cone. Then, run the stick through the handles of the clip, and then insert the stick **pointed end down** into the straw. Push the handles down over the end of the straw. See figures 8 and 9.

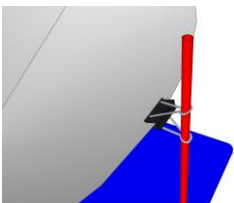


Figure 8

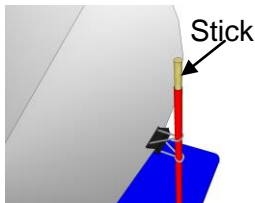


Figure 9

- 8** Add a binder clip in the midpoint of the straw as shown in figure 10. This keeps the stick from sliding in the straw. The binder clip will also be used later when adjusting the cone angle.

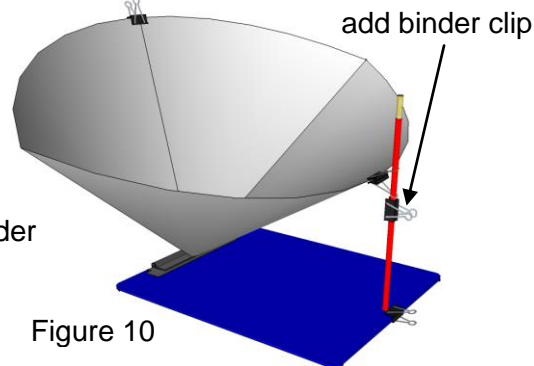


Figure 10

- 9** Make a paperclip chain of 3 paperclips and a longer 45 cm (17") chain. Attach the small chain to the center of the longer chain so that it dangles. Hook each end of the long chain to the handle of a binder clip. Attach a binder clip to the left and right corners of the cone. Change the size of the longer chain if needed. See figure 11 below.

## To do and notice

**Caution – Wear sun glasses or equivalent when positioning and using Solar Collector.**

- 1** **Position the Solar Collector.** Place the Solar Collector on a flat surface – aimed at the Sun. Place the paper cylinder in the Collector, positioned horizontally.

- 2** Remove the middle binder clip from the straw. Raise or lower the top binder clip on the straw until the long paperclip chain's shadow crosses the center of the cylinder. Reattach the clip to hold the cone at the new angle. See figure 11.

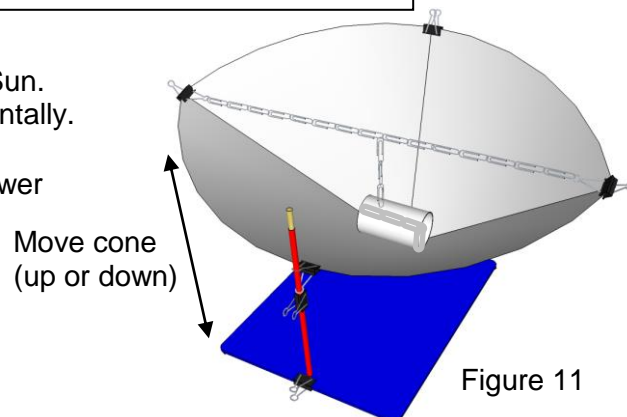


Figure 11

- 3** Rotate the whole Collector so that the shadow of the short paperclip chain is centered (left to right) on the cylinder. See figure 12. Note: As the sun moves across the sky the collector will need to be repositioned for maximum heating.

*Tip: If the area is windy, tape the clipboard to the ground or weight it down.*

Move entire collector  
(left or right)

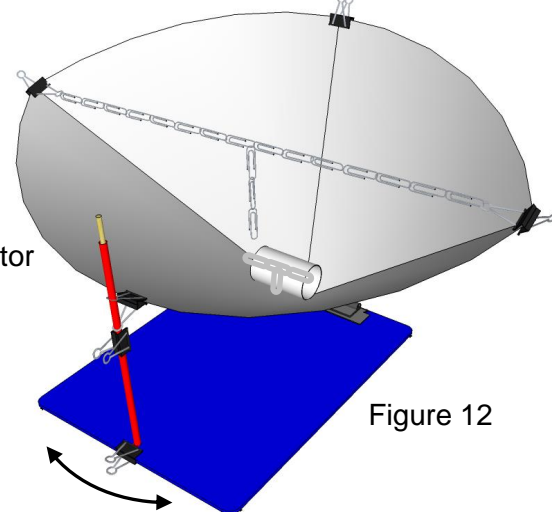


Figure 12

- 4** **Heat something inside the Collector.** Remove paper cylinder. Place heat resistant container with sample, inside the Collector. Collect data with the thermometer, checking the temperature every 15 minutes. If the sky is clear and the cone is pointed at the sun, the material will heat up quickly! Optional: Place the container being heated inside a clear plastic bag (such as an oven bag). The warm air that is trapped will increase the speed of reaching a high temperature as well as increase the maximum temperature that is reached.

## Curriculum Standards:

Energy can be transferred from place to place and converted from one form to another

(Next Generation Science Standards: Grade 4, Physical Science 3-2 & 3-4; High School, Physical Science 3-3)

Energy, natural resources, & the environment

(Next Generation Science Standards, Grade 4, Earth & Space Science 3-1)

Thermal energy transfer

(Next Generation Science Standards: Middle School, Physical Science 3-3)

Evaluating & Reducing Human Impacts

(Next Generation Science Standards: Middle School, Earth & Space Science 3-3; High School, Life Science 2-7, Earth & Space Science 3-2 & 3-4)

Science & Engineering Practices

(Next Generation Science Standards: Grades 3 – 12)

Additional standards at: <http://www.raft.net/raft-idea?isid=675>

# The science behind the activity

Light rays travel through some materials (air, clear plastic), reflect off other materials (foil), and can be absorbed by dark or dense materials (food, container). Energy from absorbed light rays can be converted into chemical energy (photosynthesis), electrical energy (solar cells), or thermal energy (heating water, air, food). Solar collectors can have flat or curved reflectors. Curved sided solar collectors do not need to track the Sun's movement as closely as flat-sided collectors. Parabolic and cylindrical collectors focus sunlight to a single point or line, which can become dangerously hot. A cone or funnel collector creates a more diffuse area of concentrated sunlight. The item being heated can still become mouth burning hot! This version could reach temperatures over 80 °C (176+° F). The sides of the collector do not become very warm because the foil reflects the sunlight. The food container becomes warmer because additional sunlight is reflected from the foil and strikes the container.

## Learn more

- Isolate a sample to be heated, on a foam block. What happens?
- Try a variety of containers: for example, put food into a clear mason jar versus one painted black. Also try different kinds of black coloring on the containers, such as glossy black versus matte black. Which container gets hottest?
- Try different orientations toward the Sun. Which orientation creates the hottest temperature?
- If the location is windy, try putting the collector into a wind shelter. Does this make a difference?
- Add additional reflectors to increase the power of the sunlight.

**Related activities:** See RAFT Idea Sheets:

***Auto Sunshade Solar Collector -***

[www.raft.net/ideas/Auto Sunshade Solar Collector.pdf](http://www.raft.net/ideas/Auto%20Sunshade%20Solar%20Collector.pdf)

***Binder Cover Solar Collector -***

[http://www.raft.net/ideas/Binder Cover Solar Collector.pdf](http://www.raft.net/ideas/Binder%20Cover%20Solar%20Collector.pdf)

***Reason for the Seasons -***

[http://www.raft.net/ideas/Reason for the Seasons.pdf](http://www.raft.net/ideas/Reason%20for%20the%20Seasons.pdf)

***Shadow Play -***

[http://www.raft.net/ideas/Shadow Play.pdf](http://www.raft.net/ideas/Shadow%20Play.pdf)

***Solar Cone Cooker -***

[http://www.raft.net/ideas/Solar Cone Cooker.pdf](http://www.raft.net/ideas/Solar%20Cone%20Cooke.pdf)

***Time for Shadows -***

[http://www.raft.net/ideas/Time for Shadows.pdf](http://www.raft.net/ideas/Time%20for%20Shadows.pdf)

***View Binder Sundial -***

[http://www.raft.net/ideas/View Binder Sundial.pdf](http://www.raft.net/ideas/View%20Binder%20Sundial.pdf)

## Resources

Visit [www.raft.net/raft-idea?isid=675](http://www.raft.net/raft-idea?isid=675) for “how-to” video demos & more ideas! See these websites for more information on the following topics:

- **Comprehensive site on solar collectors.** Illustrated plans, news, photos of solar collectors and people using them around the world, and many useful links – [www.solarcooking.org](http://www.solarcooking.org)