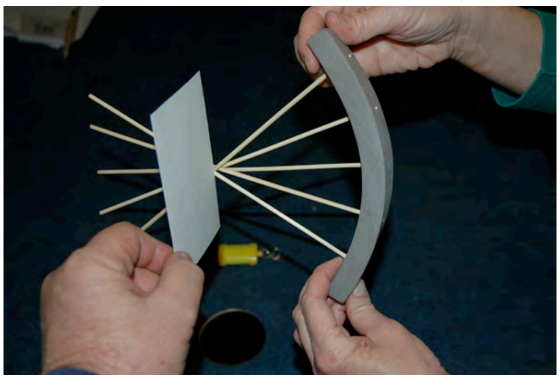
Night Sky Network
Astronomy Clubs bringing the wonders of the universe to the public

It's all Done with Mirrors

How telescopes use mirrors to focus light from distant objects

About the Activity

These simple demonstrations are a great way to illustrate the path of light as it reflects off of mirrors and how this is used in telescopes.



Topics Covered

- How does a telescope work?
- Why is the image upside down?
- How do mirrors focus and concentrate light?

Participants

Adults, teens, families with children 5 years and up. If a school/youth group, ages 7 and up. From one to twenty participants.

Materials Needed

- Spoon
- Foam strips (see Helpful Hints for more information)
- Template for foam strips, included here
- 10 – skewer sticks
- Scissors
- Concave mirror (see Helpful Hints)
- Small flashlight
- Index card or piece of white paper

Location and Timing

This demonstration can be used before a star party, in a classroom, or in an auditorium.

- **Why is the image upside down?** 1 – 3 minutes
- **How mirrors reflect light?** 3-5 minutes

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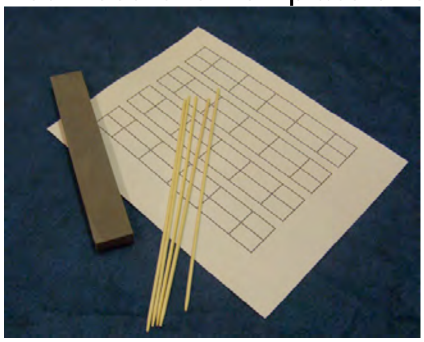
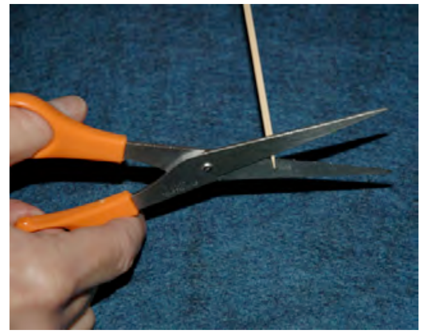
Materials Preparation:

1. To make the foam and sticks:

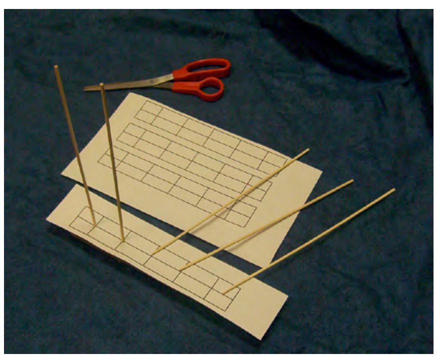
a) You need the Template sheet, skewer sticks, and foam strips.

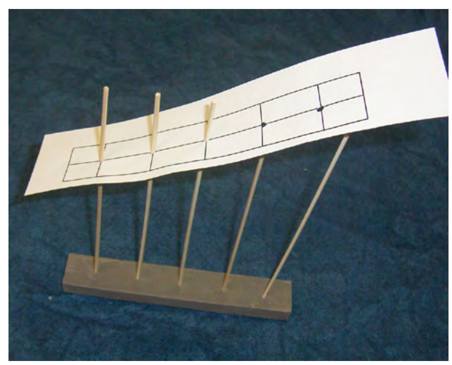




b) Trim about 1/4 inch off the sharp end of each skewer stick.

c) Place one foam strip template on one of the foam strips and insert the skewer sticks into foam strip at the marks – try to make them as vertical and parallel as possible.





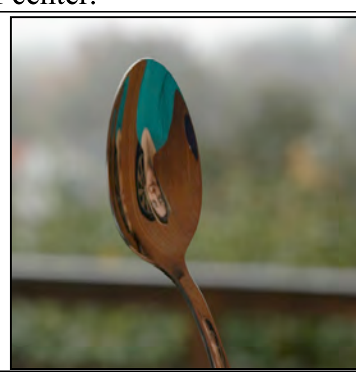
d) Remove the template.

e) **Loose sticks?** If the sticks in the foam get loose after several uses, you can either:

- glue them into the holes by wiping the end of each stick over a glue stick (see photo to the right)
- or move each stick just to the right or left and make a new hole. This option will only work for 3 or 4 relocations of the stick before you'll need a new piece of foam.

Detailed Activity Description

Why is it upside down?

Leader's Role	**Participants' Roles (Anticipated)**
Key message for your visitors to take home: Many telescopes invert the image. This is an effect of a curved mirror.	
Presentation Tip: The only time you probably get this question is when you are looking at the Moon or at a terrestrial object.	
Question from visitor: The Moon doesn't look right. It looks upside down. To Do: Hand the visitor the spoon and, if it is too dark to otherwise see their reflection, shine a red light indirectly toward their face. To Say: Hold this spoon a couple feet from your face. 	
Alternate way, using telescope: If it is still daylight and you have a reflector telescope, ask them to stand about 5 to 8 feet in front of the telescope and look down the barrel – they may have to look off center.	
To Say: How do you look? Why is your image upside-down? 	Upside-down! Shrugs

<table>
<tr>
<td>To Do:
Hold up foam and sticks.

<u>To Say:</u>
This telescope has a curved mirror in it to collect the light. When you look in a flat mirror, the light comes straight back out at you. The top spoke is where your forehead is and the bottom spoke is where your chin is. But a spoon is curved -- so is the telescope mirror."

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<tr>
<td>To do:
Curve the foam strip.

"NOW where is your forehead and where is your chin?"</td>
<td>Reversed!</td>
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<tr>
<td>That's the difference between astronomical telescopes and spotting scopes you might use to find birds. You could put one more mirror or lens in the path of the light in the telescope to turn the image right side up again, but with each additional element (lens or mirror), some light is lost. For astronomers it's more important not to lose that dim light than it is to have it the image "right" side up.</td>
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Leader's Role	**Participants' Roles (Anticipated)**

Extending the Activity:
The telescope also flips the image right for left. The back of the spoon shows you right side up, but a little elongated.

Presentation Tip: Many visitors might notice when looking in the spoon that when they raise their right hand, the opposite hand of their upside down reflection is raised.

Question from visitor:
Wait a second – when I raise my hand, the opposite hand is raised in my reflection.

To Do:

Hold foam and sticks horizontally.

Hand the foam and sticks to the visitor and ask them to figure it out or talk them through it while they bend the foam.
To Say:
Once again, when you look in a flat mirror, the light comes straight back out at you. Here's your right hand and here's your left.
But a spoon is curved -- so is the telescope mirror."

To Do:

Curve the foam strip.

"NOW where is your right hand?"

Question from visitor:
Hey – look at yourself on the other side of the spoon – I'm right side up!

To Do:

Hand the foam & sticks to the visitor.
To Say:
Can you curve the foam strip to show me how the spoon is curved on that side?

So why are you right side up?

How Mirrors Focus Light

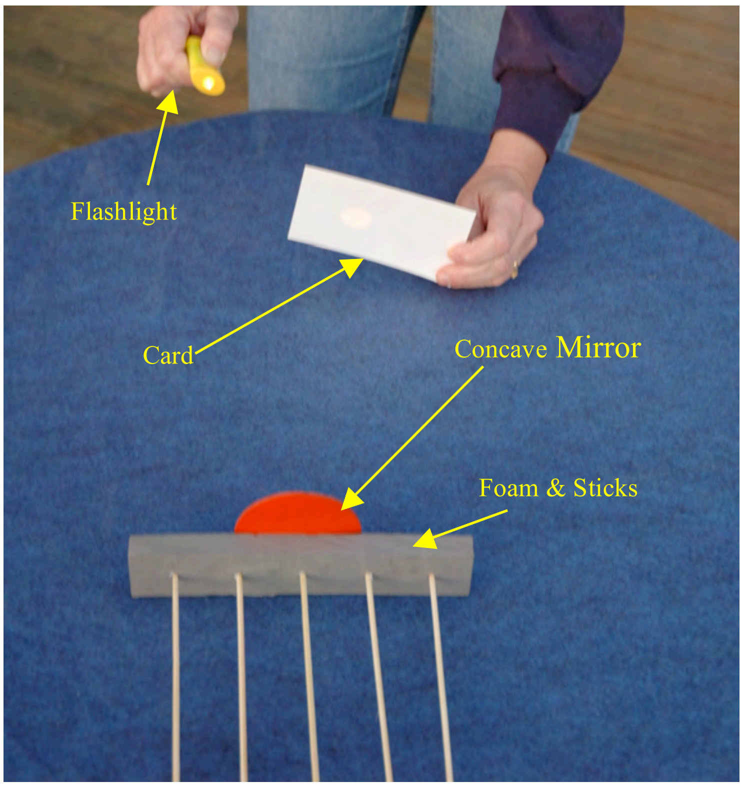
To show actual light path compared to foam and sticks.

To Say:

Now we're going to demonstrate directly how a curved mirror concentrates the light.

To Do:

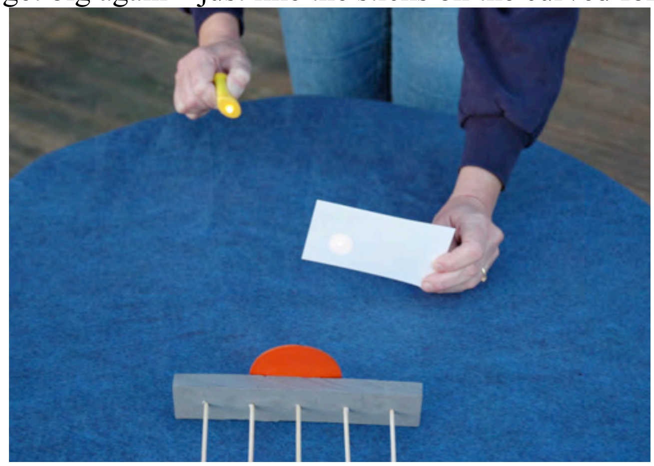
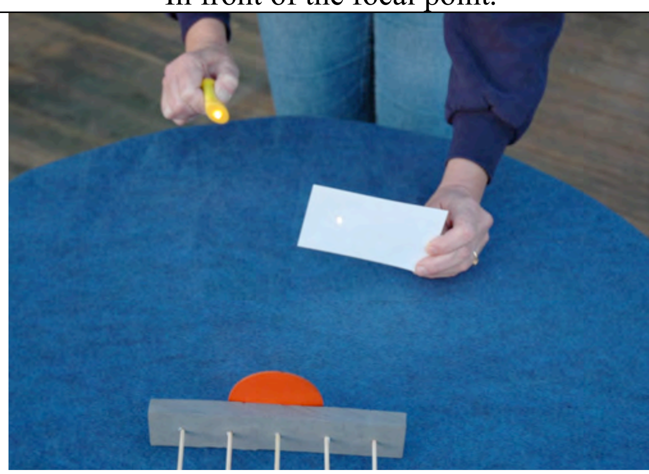
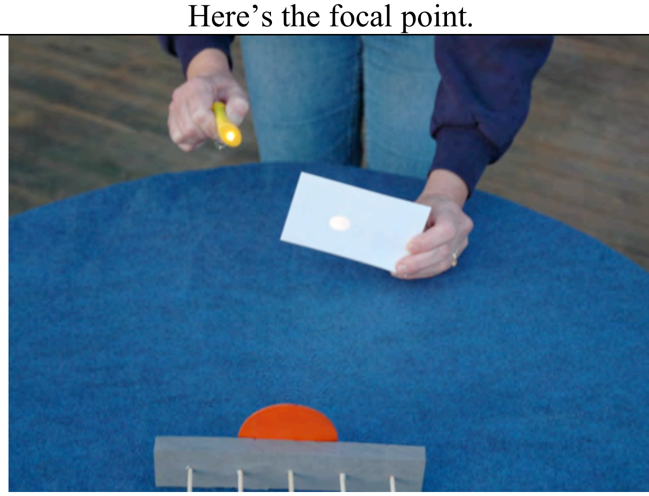
Lay the foam and sticks on a table and lean the concave mirror against it. (In the photo below, you are seeing the back of the concave mirror leaning on the foam).

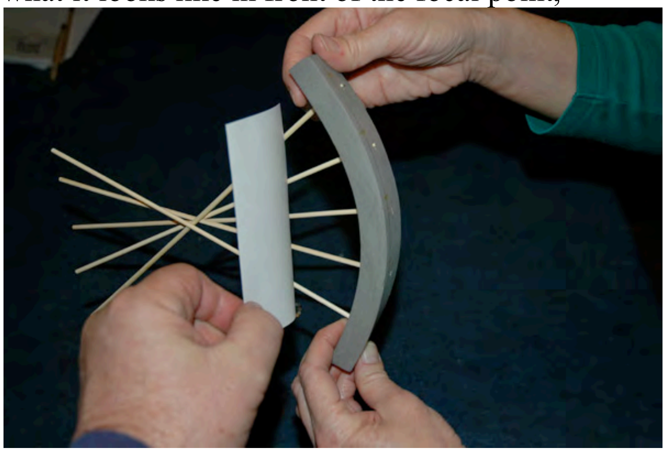
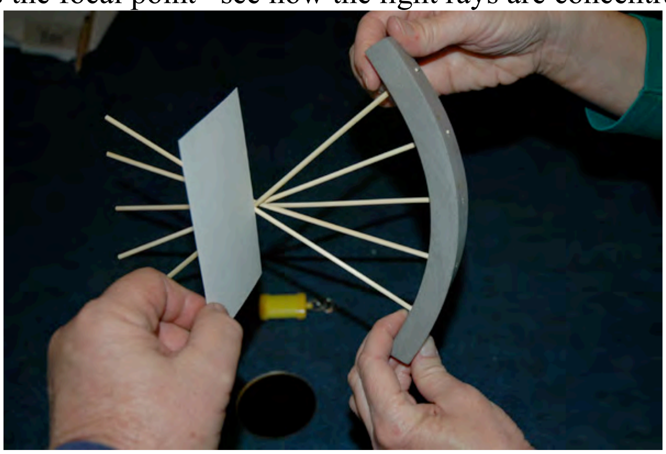
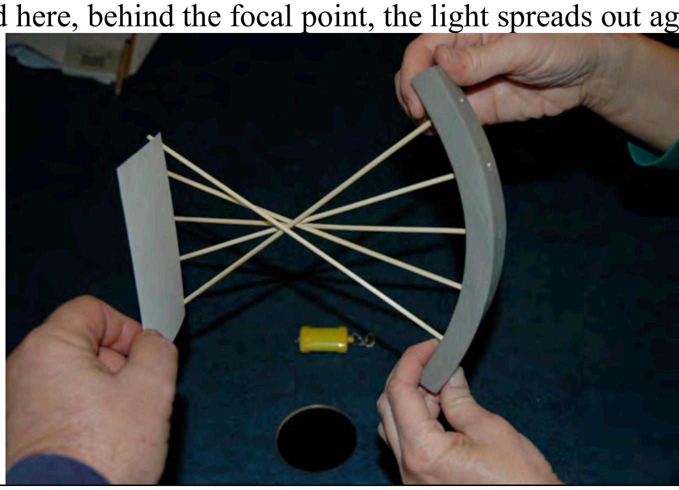


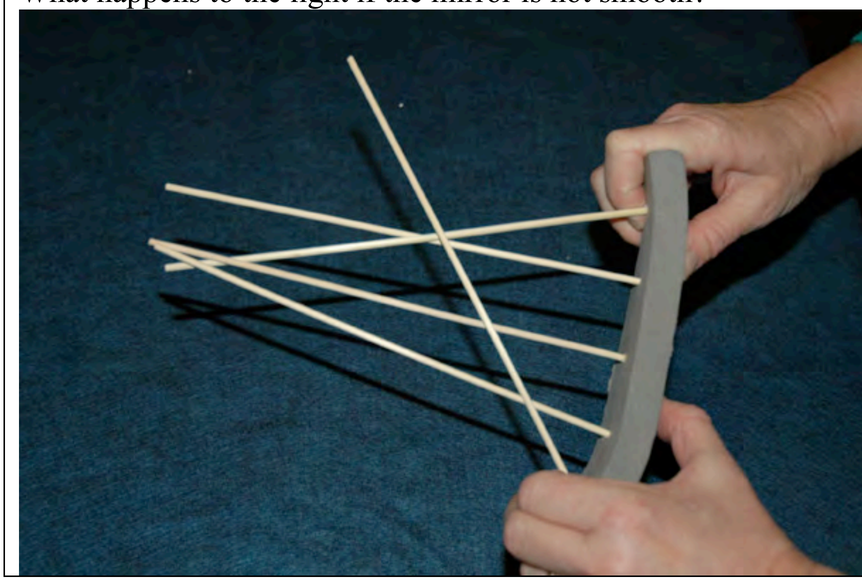
Reflect a light, like a single bulb flashlight, into the concave mirror and direct the reflection onto a light-colored card.

The light must be at least a foot (12 inches or 30 cm) from the mirror.

The focal length of the mirror provided is between 15 – 20 cm (6 – 8 inches). The distance between the card and the mirror when the light is concentrated to a point is the focal length of the mirror.

To Say: Let's watch the light get concentrated. *To Do:* Move the card close to the mirror. Then start moving it farther away from your mirror – watch the light circle start large, then concentrate to a point, then get big again – just like the sticks on the curved form.  In front of the focal point.	Participants watch or help.
 Here's the focal point.	
 And then the circle of light gets big again in back of the focal point.	

Leader's Role	**Participants' Roles (Anticipated)**
To Say: Let's see what's happening with the light using our foam strip model. Here's what it looks like in front of the focal point,  here's the focal point –see how the light rays are concentrated –  and here, behind the focal point, the light spreads out again. 	Participants watch or help.

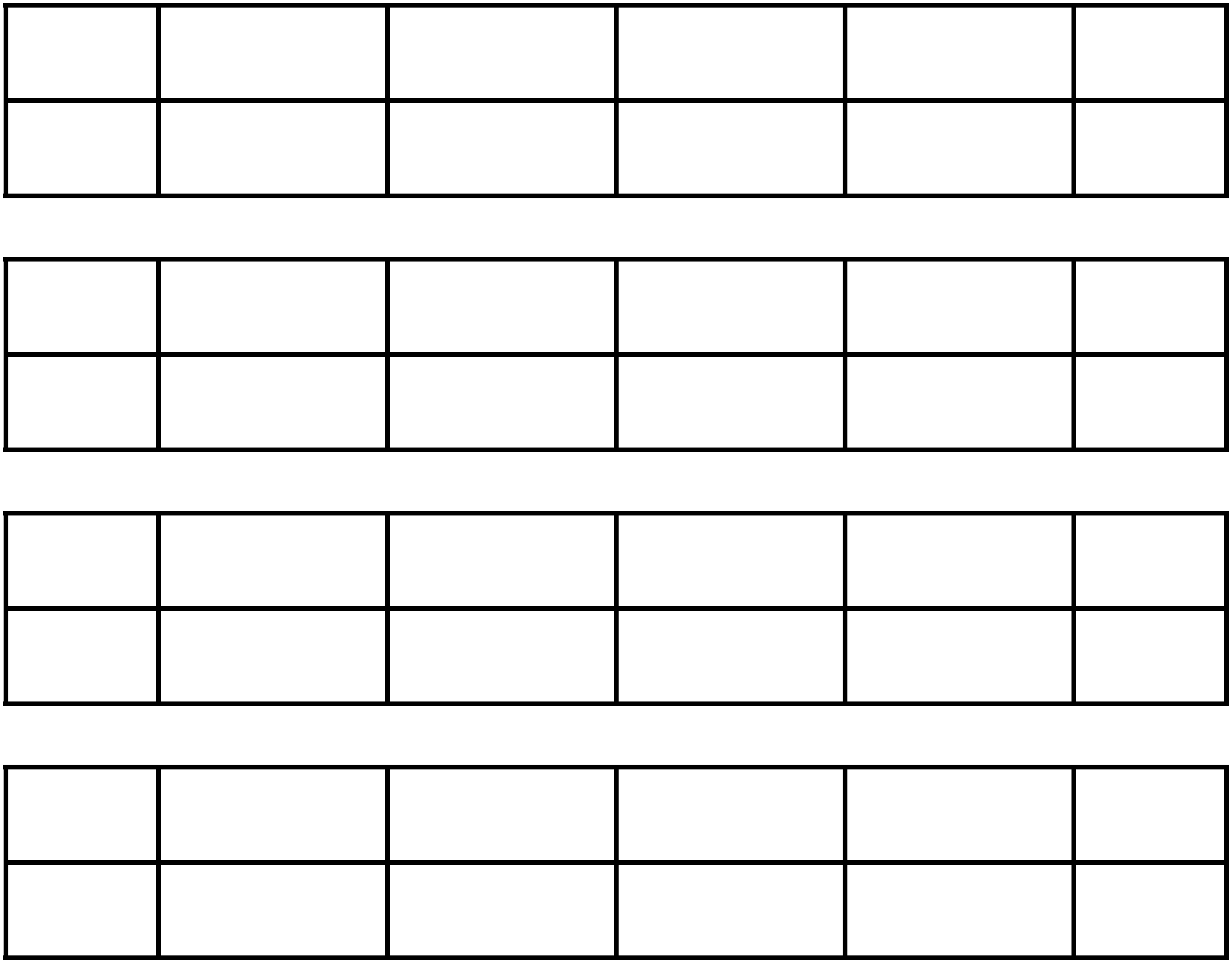
To extend the activity: **To show why you need an extremely smooth mirror.** *To Do:* Using the foam and sticks, bend the foam so the sticks come to a focal point. *To Say:* This is how the light comes together to a point with a well-made mirror. *To Do:* Push the foam so there is a small bump in the curved surface. *To Say:* What happens to the light if the mirror is not smooth? 	It goes in all directions. You don't get a focal point. It's not concentrating the light properly.

Helpful Hints

1. **Foam strips:** You can use any fairly dense soft foam (like the material some computers come packed in) or you can order the material at: http://www.oneoceankayaks.com/ - the material is "Minicel Foam". Order the 5/8" thickness. A 20"x24" sheet will make 48 strips that are 1-1/4" x 8". You can use a utility knife to cut the foam.

2. **Concave Mirror:** Available in 3 sizes from science supply companies like http://www.schoolmasters.com (Search for "Concave mirror")

3. **Loose sticks?** If the sticks in the foam get loose after several uses, you can either a) glue them into the holes by wiping the end of each stick over a glue stick or b) move each stick just to the right or left and make a new hole. The second option will only work for 3 or 4 relocations of the stick before you'll need a new piece of foam.



FOAM STRIP TEMPLATES