SLINKY® EXPERIMENT #147:

SOLAR ENERGY™

Build Your Own Portable Solar Energy Laboratory!

WARNING: CHOKING HAZARD - Small Parts. Not for Children under 3 years.

fun & fact manual

AGES 8 AND UP
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WHAT’S IN YOUR KIT?

- Graduation Card
- Thermometer
- Test-Tube
- Heat Absorber Bag
- Piece of Rubber
- Test-Tube Holder
- Test-Tube Stand
- Reflector
- Magnifying Glass
- Cardboard Bracket
WARNING:
Adult supervision is required for activities using the solar furnace/parabolic reflector in this kit. It collects and focuses sunlight very efficiently and will generate a great deal of heat.

Do not leave the reflector unattended, even if it is not currently in the sunlight. Remember, the sun travels throughout the day, and the reflector could be in the light in a few hours! Put the reflector away and under cover when not in use!

Several experiments involve cooking with the solar furnace. Do not eat or drink anything prepared this way, as the furnace may not have been cleaned properly between experiments!

The polished reflective coating on the reflector is very thin. Be careful not to scratch it! Handle it by the edges to avoid getting fingerprints on it. If it becomes dusty and you need to clean it, use a very soft cloth.

Finally, never focus the reflector on a living thing!

INTRODUCTION
The energy we use today is usually obtained from fuels, such as oil, natural gas or coal. Those three fuels are called fossil fuels because they are formed deep in the earth from once-living matter. The process takes huge amounts of both pressure (from the weight of the earth around and over it) and time (millions of years.)

Life on Earth hasn’t been around forever, so we usually say that fossil fuels are a finite energy source. That means that even though the planet is always making more, it does so too slowly to help us. There is a limited supply, and once we use it up, we can’t get more. We are using up our inheritance quickly and leaving nothing for the future. Some experts say that at the rate we are going, by sometime in the 21st century, we may have used up the two trillion barrels of crude oil created since life began billions of years ago. Incredible, considering that human beings only began really using the stuff less than 150 years ago.
For that reason, the science of energy usually takes two directions. One path concentrates on trying to find and make use of more of those buried fossil fuels. For example, scientists and engineers can use satellites to try to better detect hidden deposits of fossil fuels; or design cars that go further on the same amount of gasoline. The other path tries to develop sources of energy that are not fossil fuels. For example, power generated by wind or water, or nuclear power.

This kit is designed to let you experiment with one alternate energy source—the power of the sun.

**SOLAR ENERGY**

It has been estimated that if every bit of the sunlight that falls on the earth in a single day could somehow be converted to useful energy forms, it would satisfy the energy needs of the world for 50 years. On the local level, enough sunlight falls on the roof of the average suburban home to supply three times as much energy as that home consumes. The energy is there—our challenge is to find ways to make use of it.

Think about it for a minute. Indirectly, our current system is already largely based on solar energy. The energy of the sun is used by green plants for photosynthesis. Other life forms eat those plants or other plant-eaters. All of these life forms then can become fossil fuels millions of years after they lived.

Nature may be able to make use of solar energy, but can we? It certainly has a lot going for it compared to other energy sources. Unlike fossil fuels or nuclear power, no pollution is created. Solar energy is available in most of the world, and best of all, it is **renewable**. No matter how much solar energy we use today, the sun will rise tomorrow to be used again.
ACTIVITY 1: YOUR THERMOMETER

To begin, let’s look at your thermometer. You’ve probably seen lots of thermometers before. There are many different types—the one enclosed in your kit is the most common type. It contains a bulb of liquid at one end and a long thin bore which runs up the center of the glass rod. When the liquid in the bulb gets warmer, it expands and moves up the bore. When it is cooled, it moves down.

Our thermometer is not graduated. That doesn’t mean that it failed school—it has no numbers on it. For most of your experiments, you are interested in whether the temperature goes up or down, not in knowing the exact temperature.

You will find a small piece of rubber with the thermometer. First, bend the rubber in half. With a pair of scissors, carefully cut two slits about 1/4 inch (.6 cm) apart and about the same length (see figure). Slide the thermometer through the slits (see figure). By sliding this rubber marker up or down the thermometer tube, you can mark the first temperature measured and see whether it rises or falls. The marker is made of rubber so that you can soak it in water when necessary. This system will work for many of your experiments.

Make two slits in piece of rubber with scissors as shown
ACTIVITY 2: GRADUATE YOUR THERMOMETER

The liquid in most thermometers is mercury, or, as in this one, colored alcohol. This liquid expands when heated, and contracts when cooled. This is useful to us because it does so linearly. That means that it expands or contracts exactly the same amount for any given rise or fall in temperature. Whether changing by the two degrees between 32 and 34 or between 66 and 68, the liquid will rise or fall by the same amount.

Scientists generally use either KELVIN, or, more often, the CENTIGRADE (also called CELSIUS) temperature scales, and so will we. However, if you are more familiar with the Farenheit scale, you may wish to convert the numbers we are about to use. For your convenience, here is a suitable conversion table.

If you dip a thermometer into liquids at 20° Celcius (C), the red column inside will reach a certain height. If you then put the thermometer in a liquid at 30° C (10° C warmer), the red column will rise further. Heat the liquid another 10°C (up to 40°C), and the column will rise exactly the same distance as it did from 20°C to 30°. The change in the column is linear, and that enables us to graduate our thermometer.
Examine your thermometer tube carefully. You will notice a small mark (like a horizontal scratch) about 2/3 up the glass rod. The liquid inside will reach that particular mark at exactly 20°C.

Now, put some ice cubes into a cup and leave them out for several minutes. When they start to melt, swirl the water continuously around the ice cubes. The temperature of this water is exactly 0°C.

Dip your thermometer into the ice water and where the red column comes to rest, mark it with a fine pointed felt-tip marker or small piece of tape. This is your 0°C mark.

Measure the distance the column has fallen from 20°C to 0°C. This distance, divided by 20, is the amount the thermometer will rise or fall for every 1°C change in temperature. However, you will not be able to mark the thermometer with that many small marks in a precise way. Here is a way to get reasonably accurate measurements.

Use a ruler to measure out the distance between 20°C and 0°C. Make another mark the same distance above 20°C to show 40°C. Make another mark halfway between 40°C and 20°C, to show the 30°C mark. Similarly, a mark halfway between 20°C and 0°C will represent 10°C. You now have marks every 10°C in the range of likely weather conditions you will normally see. You will be able to estimate the temperature to within a few degrees when it is partway between the marks. If you like, you can use the same methods to mark the entire thermometer.

The graduation card enclosed may be useful, but, being made from paper, it can’t be placed in water. Keeping in mind which of your marks represent which temperatures, you can hold the thermometer up to the graduated card to get a fairly accurate reading. Just line up your 20°C and 0°C marks on the thermometer with the same marks on the card. Remember to hold the thermometer by top end, not the bulb, so that your own body heat doesn’t affect the reading!
ACTIVITY 3: CONVERTING SUNLIGHT INTO HEAT

The simplest and lowest technology approach to solar power is just putting things out in the sunlight to heat up. Energy efficient houses have been designed to do just that. Let’s try to find out how effective that can be.

Take three transparent cups. They may be either glass or plastic, but they should be of the same size and material. Place one on a dark sheet of paper and two on a white paper. Stand the three cups outdoors in bright sunlight. Pour an equal amount of cold water into each—about half a cupful should be enough. Measure the temperature of the water in each with the thermometer. Now, cover one of the cups standing on white paper with a sheet of clean glass, a transparent saucer, or even a plastic bag.

Measure the temperature of the water in each cup after 10 minutes, half-an-hour and, if possible, after 1 hour. What differences did you find?

In order to make sense of the results, you must know that:
a) A dark background generally absorbs more heat than a light background.
b) Glass or plastic absorbs a small quantity of the sun’s rays.
c) Covering the cup slows or stops the evaporation of water.
d) When water evaporates, some heat is lost since it is used to facilitate the evaporation. This is why we sweat—it cools us down!

ACTIVITY 4: SUNLIGHT SHINING THROUGH A WINDOW

Repeat Activity 3, but this time perform it on a table in a room with the window closed. In other words, you will test sunlight which has passed through glass windows.

Before you start, try to guess what the results should be. Even the scientist who developed these experiments was not sure what the result would be until he tried it!
ACTIVITY 5: THE HEAT FROM AN ELECTRIC BULB

What would you expect to find if, instead of sunlight, you were to use the light of a lamp? Try it and see.

ACTIVITY 6: BLACK WATER

Given what you’ve already seen, if you were to dye the water in the glasses a dark color, would you expect to obtain a higher temperature?

Could this idea be put to practical use? Perhaps you could test it.

A dark colored food coloring would work well. If you have no food coloring, you could use ink to darken the water. Drip some water into the top of a dried-out-felt-tipped pen and collect the water as it comes out at the bottom. As an extra bonus, the pen may write again!

ACTIVITY 7: SOLAR HEATER

Find a small cardboard or plastic carton that is just slightly larger then the “heat absorber bag” enclosed in this kit.

Fill the bag with cold water through the water inlet marked “A” in the following diagram. This is best done with a straw or an eye dropper, if you have one.

Fit the heat absorber bag in the mouth of the cardboard carton, with the clear side facing out and the back, black side of the bag facing into the carton. You may have to tape it in place. Leave inlet A unblocked.

Put this “solar heater” where it is facing the sun. As the day goes on, turn it to keep it facing the sun directly.
Measure the temperature every hour by carefully inserting your thermometer into Inlet A. Take the temperature at both the top of the bag (near the inlet) and the bottom. What happens?

Warmer water, like warmer air, rises. As the sun heats the water, the warmer water rises to the top of the bag, and the cooler water sinks down.

A commercial hot water tank is very similar to your bag. A water tank is placed above the heater and a pipe from the bottom of the tank is connected to inlet A and from the top of the tank to outlet B.

As the water is heated, it rises through outlet B and up the pipe to the top of the tank. As water rises from the heater to the tank, it pulls in colder water from the bottom of the tank through inlet A to be heated.

Does the water get warm enough to use around the house? How large of a solar heater would you have to have to be useful in everyday life.

**ACTIVITY 8: SOLAR HEATER AND REFLECTED LIGHT**

Perform Activity 7 again, exactly as you did before, but this time take a mirror and stand it at a distance and angle from the solar heater in such a way that the mirror reflects additional sunlight onto the solar heater. One way to do this would be to keep
the mirror lower than the heater and angled up to face it.

The heater will now absorb the direct sunlight as it did before, and, in addition, it will receive extra reflected energy from the mirror. How much additional heat can you obtain this way? Would this be a practical way to make a larger-scale solar heater more efficient?

ACTIVITY 9: THE SOLAR POND

At the Southern tip of Israel, near the town of Eilat, is a small lake. At first glance, there seems to be nothing remarkable about the lake. The water is warm and salty and not particularly clean. However, this lake attracts scientists from all over the world because it is a “solar pond”, and if current research proves successful, this small lake may make a major contribution towards solving the world’s energy shortage.

If the sun shines on a pool of water, the top layer becomes slightly hotter as warmer water usually rises to the top. But hot water evaporates faster than cold, and when water evaporates, it uses up heat.

In an ordinary pool, the sun shines on the water-adding heat. When the water evaporates, it loses heat. Eventually, a balance is reached where any additional heat causes additional evaporation and the pool stays a constant temperature.

The solar pond in Eilat is different. Because of an underground salt-water well, the water at the bottom is much more salty than at the top. Salty water, however, is heavier than fresh water. It does not rise to the top to float over the fresh water, even when warm.

In this pool, bathing is now strictly prohibited. Swimmers, diving to the bottom of that lake, were badly scalded before the scientific facts relating to this pool were known. Today, scientists are investigating the possibility of building human-made solar pools in order to make use of this solar energy trapped in the salt water layer.
You can test this idea. Find a colored bowl (not white). Fill it up one-third of the way with water and stir in as much salt as will dissolve. If you have some ink or dark food coloring, color this salt solution.

You may want to do this next part in the sunlight, where you will need to leave the bowl when you are done. Carefully and slowly, add another one-third bowl of fresh water. Pour it very slowly down one side of the bowl, using a spoon to direct the flow. It is important to prevent the two liquids from mixing. If the fresh and salt water mix, don’t panic! Stop pouring, and tip out some of the mixed water. Add more salt until you have salt water again, and try again.

Let your solar pond stand in the sun for some time and then measure the temperature at the top, the middle, and the bottom of the bowl.

**ACTIVITY 10: AN IMAGINARY SOLAR SUPER-FURNACE**

Remember Activity 8? You used a mirror to reflect extra light directly onto your solar heater to increase its effectiveness. What if we could gather all of the sunlight from a rather large area and reflect it onto a rather small one? The purpose of our solar furnace is exactly
that. To understand it, you will first have to do some heavy thinking.

The key to our solar furnace will be a **parabolic reflector**. A parabolic reflector is one which reflects parallel rays-of light in this case-gathered all along its surface onto a single point or line. The reflector in this kit may have reminded you of a television satellite dish, a device designed to gather your TV signal efficiently in much the same way.

![Diagram of a parabolic reflector](image)

A **calorie** is a unit of energy. In this case, it is not the calories you think about in your food (although they are related). Here, it is the amount of energy needed to raise the temperature of 1 gram of water by 1 degree Celsius.

The parabolic reflector in this kit has a reflective surface area of about 72 square centimeters. Let’s say it receives 1 calorie per square cm. The maximum amount of heat available at the focal point of the reflector will be 72 calories per minute (all of the energy that hits the reflector in that minute). In theory, we could raise the temperature of 1 gram of water by 72°C in one minute. That’s enough to go from just above the freezing point (0°C) to the boiling point (100°C) in about a minute and a half!

Granted, one gram of water isn’t very much. It’s a cube of water about one centimeter on a side. On the other hand, our reflector isn’t all that big either. Think what you could do with one the size of an
umbrella! Unfortunately, reality must intrude on this thought experiment. One of the biggest problems facing anyone working with energy is that no system is completely, 100%, efficient at generating and transporting energy. We will get far less spectacular results with our reflector than are possible in theory.

NOTE: To convert centimeters into inches, remember that one inch equals 2.54 centimeters and one cm equals 0.394 inches. For temperature conversions, refer to the conversion table in Activity 2.

ACTIVITY 11: ASSEMBLING THE SOLAR REFLECTOR

Take the parabolic reflector and attach the lower half of it to part A of the cardboard bracket. This can be done with staples, paper clips, or tape. If you have none of these things, carefully make a slit in the cardboard flap on Part A and insert the lower part of the reflector into the slit.

Part B of the cardboard bracket has 5 slits. Insert the top of the reflector into one of these slits. You want the reflector to be at the angle facing the sun that will gather the most energy. Therefore, you should use slit No. 1 if the sun is low in the sky, or slit No. 5 if you perform these experiments towards noon and the sun is high in the sky. Whether you use slit No. 1, 2, 3, 4 or 5 depends on the position of the sun—-you will have to experiment before you decide which to use. Once you have decided, turn the assembled reflector to face the sun.
Next, take the wire test-tube holder (part C) and insert this into the two holes of the stand (part D). Insert the test-tube into the assembled test-tube holder. Finally, slip the tongue of the cardboard stand (D) into the slits provided in the base of the bracket (part A). Move the stand right and left until you think that the focal point of the reflected sunlight is within the test-tube.

The drawing of the assembled solar furnace should make these assembly instructions clear. Note that you need the test-tube holder for some of the experiments, but not all. The cardboard bracket is useful for every experiment with the parabolic reflector.

**NOTE:** On a windy day, place some stones or any other suitable weight into the bracket under the reflector, to prevent it from being blown away!
ACTIVITY 12: FOCAL POINT

The focal point of a perfectly shaped parabolic reflector of this type should be about 2.5 inches (6 cm) above the deepest point on the reflector. However, the reflector is made of thin, metal-coated plastic. It is likely to bend slightly. Even the slightest distortion can change the position of the focal point. (F.P.)

Place your solar furnace in the sunlight. Remove the test-tube and its holder. Get a small sheet of blank white paper and slowly move it towards the reflector. As the sheet approaches the focal point, you will begin to see a circular bright spot on it. The closer you get, the smaller the spot becomes. At the focal point, it is quite small. Our solar furnace will be the most effective here, at the focal point.

What happens as you move the paper closer to the reflector than its focal point?

ACTIVITY 13: BURNING A FEATHER

Find a small, dark, bird feather and bring it to the focal point of the reflector. As you near this point, the feather may start to shrivel and smoke. It is easy to burn a dark feather. If you can find a white one, try the same experiment. What happens?

ACTIVITY 14: SINGEING A PIECE OF RUBBER

Try the same experiment with the dark piece of rubber you are using with your thermometer. As you approach the focal point of the parabolic reflector with the piece of rubber, the rubber begins to smoke and smell.
ACTIVITY 15: BACK TO ACTIVITY 3
Fill the test-tube halfway with cold water and attach it to the test-tube holder. Measure the temperature of the water and then place the holder and test-tube into the solar furnace in direct sunlight for 5 minutes. How big was the rise in temperature?

ACTIVITY 16: ACTIVITY 6 AGAIN
Repeat the previous experiment. This time, however, add a few drops of ink to the water (see Activity 6). How big is the rise in temperature now?

ACTIVITY 17: BOILING WATER IN THE SOLAR FURNACE
Put your setup from the previous experiment back into the sunlight. Does the water come to a boil if you leave it there long enough? How long does it take? Do you think that it can be done in less than favorable conditions, like winter?

ACTIVITY 18: BREWING TEA
Clean out your test-tube thoroughly with soap and water. Place a few tea leaves (less than 1/4 teaspoonful) into the test-tube and add enough water to fill it halfway. Fit this into the solar furnace and see how long it takes to brew yourself a “cup of tea”. Don’t drink the tea, just in case you haven’t cleaned the test-tube well enough!

ACTIVITY 19: MELTING WAX
Insert a small candle (like a birthday candle) into the test-tube and fit it into your solar furnace. Does the candle melt? How long does it take? Did you use a dark or light colored candle? Given what you have found in other experiments, do you think it might make a difference?
WARNING: With this experiment, you have probably dirtied the test-tube with melted wax. This will be difficult to clean! You need soap, hot water, and a test-tube cleaner. You can make your own test-tube cleaner by wrapping a little steel wool around a pencil (see diagram).

ACTIVITY 20: FRYING AN EGG WHITE
For this experiment, you will need an uncooked egg. You will need to separate the white from the yolk. Here’s one way to do that. When you crack the shell, separate it into two halves and pour the egg back and forth between the halves, over a bowl. As you pour, the white should slide out over the shell and down into the bowl, eventually leaving you with just yolk in one of the shell halves. Keep the yolk for the next experiment, and pour some of the white into the test-tube. Set it up in your solar furnace. Can you cook the egg white? How long does it take? Remember not to eat the results!

ACTIVITY 21: FRYING THE YOLK
Now it’s yolk’s turn to be fried. Does cooking the yolk take more or less time than cooking the egg white?

ACTIVITY 22: ADDITIONAL LIGHT
The solar reflector collects all of the sunlight that falls on it and concentrates it at the focal point. As with your solar heater, the amount of energy available is limited by how much it can collect and how efficient it is at using energy.
What would happen if you made more sunlight available to the reflector by means of an ordinary mirror, or even several mirrors? Can you increase the heat at the focal point significantly?

**ACTIVITY 23: THE FOCAL POINT OF YOUR LENS**

The lens enclosed in your kit is a 20 mm diameter double convex converging lens with a focal point of 35 mm. What does all of that mean? Well, the most important part is that it is a **converging lens**. That means that light shining through it is focused to a single point. In this case, that focal point is 35 millimeters (almost an inch and a half) away.

Hold your lens right over any letter E in this booklet. Slowly pull it away from the page. As you increase the distance from the lens to the letter E, the letter seems to grow and grow until a point is reached past which, the image blurs! This is the Focal Point. Try to measure whether it really is 35 mm.
ACTIVITY 24: WHY A LENS?
A converging lens focuses all the energy received on its surface on a considerably smaller area.

Our lens has a surface area of approximately 300 square millimeters. In perfect conditions, if we focus the lens on a 1 mm square area, that area should receive 300 times the energy per mm. If our lens receives from the sun 1 calorie of radiant energy per mm, the Focal Point of our lens should receive 300 calories per mm.

As in our previous experiments with the solar furnace, the total energy available to us remains the same, we are just finding a way to make a more concentrated use of it!

ACTIVITY 25: CONCENTRATING HEAT WITH YOUR LENS
In a normally-lit room, place the bulb of your thermometer at the Focal Point of the lens. Note the temperature at the start of the experiment and again after 5 minutes. Was there any noticeable change?

Now take your lens and thermometer outside into direct sunlight. Again, place the bulb of the thermometer into the Focal Point of the lens. Note the temperature at the start of experiment and see how long it takes your thermometer to almost reach the top (120°F). Be sure to remove the thermometer before it gets to that temperature.

ACTIVITY 26: CHARRING PAPER

SAFETY NOTE: This activity should be done with adult supervision.

Place your lens in bright sunlight, with a blank white piece of paper at its focal point. Can you char (blacken) the paper?
If the sun is bright enough, you may be able to char it? It will char easiest right on the edge of the paper.

The white paper reflects most of the sunlight and solar heat. Even though the solar heat is concentrated at a small point, the paper barely, if at all, reaches its burning point.

Replace the white piece of paper with a dark colored, matte (not shiny) paper. Does it char easier? Be careful not to actually set it afire! The dark colored paper absorbs most of the energy, and easily reaches its burning point.

**ACTIVITY 27: THE SHADOW OF THE LENS**

Try to locate a small bottle cap about the same size as your lens. Fill the cap with water and place it in direct sunlight for 10 minutes. Measure and record the water temperature at the start and end of the time period.

Now start again with an equal amount of water in your bottle cap and the water at the same starting temperature as before. This time place the water at the focal point of your lens. Compare the temperature of the water after 10 minutes with the results of your previous try-they should be very similar.

The lens concentrates the sunlight it gathers onto a small area of the water. The surrounding water will be in the “shadow” of the lens. That means that the surrounding body of water doesn’t directly receive the energy that is being concentrated by the lens. The total amount of heat received remains the same.
The method works very well when you need any part of an object to reach a high temperature. Once the paper reaches its burning point, it can burn on its own. The lens is much useful for heating water!

**ACTIVITY 28: THE SUN TRAP**

For this experiment and the next two, you need fairly large pieces of cardboard (like empty cereal boxes) or stiff drawing paper. The carton must be stiff, but still bendable, as you will be rolling it later. You also need some glue, aluminum foil, a ruler, and scissors.

What to do:

Cut (or glue together) your thin carton board or stiff drawing paper to about 50 cm x 30 cm (20 in x 12 in). cover a table with a piece of newspaper to protect it. Place the carton on the newspaper. Cover one face of the board evenly with glue. Use a paintbrush or thick paper towels to spread it evenly, if necessary. Get a piece of aluminim foil of the same size (50 cm x 30 cm) as the board (you may need to use more than one piece.) Foil usually has a shiny side and a non-shiny side. Glue the foil to the board, shiny side up. Work carefully and slowly, smoothing out any bubbles and wrinkles. You have made a crude cardboard mirror!

Allow the glue to dry for at least half-an-hour. In the meantime, you can see how well your mirror works! Take it outdoors and use it to reflect sunlight onto the wall of a house. How reflective is it? When the glue is dry, you can try bending the mirror a little. What happens?

When the glue is completely dry, roll the carton into a funnel, as illustrated. The shiny side (the one with the aluminum foil) must be inside the funnel. The top opening should be approximately 20 cm (8.5 inches) across, and the bottom about 2 1/2 cm (1 inch). Seal the funnel into its current shape with adhesive tape, glue, or staples. Your “solar trap” is ready.
Go outside into the sunlight. If anybody asks you what you are doing, you can answer sweetly, “I’m trying to trap some sunlight!” People may think that you have lost your mind, but, in fact, you are quite scientifically correct!

Insert your index finger into the small hole of the funnel and, standing in sunlight, slowly turn around in a circle, making a complete circuit. You will find there is a point where your finger feels much hotter than at any other. At that point, of course, you are facing the sun.

Now, keeping your finger in the hole, lower and elevate your arm. There comes a point where you will take your finger out quickly! There is no danger that you will burn your finger but it will get uncomfortably hot.

If you insert a candle into the opening, instead of your finger, it will melt like butter!

**ACTIVITY 29: HOME-MADE SOLAR REFLECTOR**

On a piece of carton you will need to mark a circle 32 cm (about 12 inches) across. The precise way to do it as follows:

Get a length of string and two pencils. Tie a loop in each end of the string wide enough to fit around a pencil. You want to have 16 cm (about 6 inches) of string free between the two loops. Fit a pencil into each loop. Use the first pencil to poke a hole in the center of the board and leave the pencil stuck in the board. You may need to secure this pencil in an upright position. Now use the second pencil to draw a circle around the first pencil. If you make sure that the loop moves freely, not letting the string just wind around the pencil, you should come out with a pretty good circle.

The less accurate, but faster, way to do this is the find an object that is already a circle of the right size and trace around it. You might want to try a pot lid, or a record album. Either way, when you have finished drawing your circle, use the scissors to cut it out.
Glue some aluminum foil onto the circle, just as you did when making the solar trap (shiny side up). Trim away excess foil from around the circle.

Next you want to divide the circle into four equal pieces, like dividing a cake or a pizza pie. Use your pencil to draw the divisions first! Draw a line on the foil covered side, dividing the circle in half down the middle. Then draw another line that cuts the halves in half again (see diagram).

Now punch a hole at the center of the disc. You may already have done this if you used the pencil and string method to make the circle. In that case you just need to poke through the foil with the pencil to clear the hole. If you didn’t use the pencil and string method, use the pencil now to make the hole.

Cut along the lines you have drawn. Start from the outsides of the circle and go towards the hole in the center. IMPORTANT: Stop cutting when you are about 2.5 cm (1 inch) away from the center! You don’t want to cut all the way to the hole!

Use your ruler and pencil to measure and mark on the foil side a point 2 cm (slightly less than 1 inch) to the right and to the left of each of the four slits you have made in the circle. Pinch the board to either side of each slit together so that the sides meet each other at the points you marked. Fasten the two edges together with glue, tape, or staples. Repeat this with each slit. You should end up with a bowl shape that looks a lot like your solar reflector, with an extra hole in the center.
Pinch the two sides of the slits together

Go out into the sunlight and try it out. Compare it with the solar reflector that comes with this kit. Yours is much larger, but not as reflective. Which one seems to work better? You may want to try repeating some of your earlier experiments with your new reflector to compare the results.

**ACTIVITY 30: FURTHER EXPERIMENTS**

These are suggestions for what could be a whole series of further experiments. How far you go depends on how interested you are in learning more about solar energy.

You could make two more solar traps (see figure), one half the size you’ve already made, the other twice the size. How do you think they would work, compared to the original?

Similarly, you could make a bigger and a smaller solar reflector and compare them. Of course, the larger the reflecting surface, the more energy can be collected and concentrated.

However, it is not only the amount of surface area that matters. The angle of reflection is also important. What do you think would happen if you changed the angle of the sides of the solar trap? You could do that by rolling the funnel tighter or more loosely. Try it and see what happens.
Consider your homemade solar reflector. Pinching the edges of each slit more or less makes the bowl deeper or shallower. What effect do you think this would have? Try it!

FURTHER RESEARCH

Solar energy, and the science of energy in general, is a fascinating subject. You may find that the more you learn, the more you want to know. For example, this kit has explored only one avenue of solar power. All of the devices in this kit use the sun’s energy directly, to create heat. You have almost certainly seen solar powered calculators and other devices. They have a characteristic strip of dark panels which generate electricity when enough light shines on them.

Imagine how useful it would be to collect solar energy where it is plentiful and there is room for huge collectors (like in the desert). If we could convert it to electricity, we could run it through power lines to where it can be used. There is a big limit on the devices we have built in this kit- how do you get the heat energy from place to place? You can use pipes to carry heated water, like the pipes in your home. However, if you have ever accidentally touched a hot water pipe, you know that it is hot! The pipe loses heat to the air around it, and that means it is not a very efficient way of moving energy. The farther it moves, the more you lose.

There are, of course, problems with solar cells. If that were not true, they would be used in many more places than just in calculators! If you are interested, start by looking up solar energy in a current encyclopedia or on the internet. You may even want to see what your library has on the subject. Remember, this is an area of science that affects you directly. Imagine a world where electricity and heat are very expensive and/or hard to get. What would life be like without light bulbs, television, radio, computers, stoves, and all the other comforts of modern life that depend on power? If we don’t keep coming up with new energy supplies, the world may have to find out!