HUDSON
RIVER
MUSEUM

Parker Solar Probe Paper Model

Ages: 10+ (through adult)

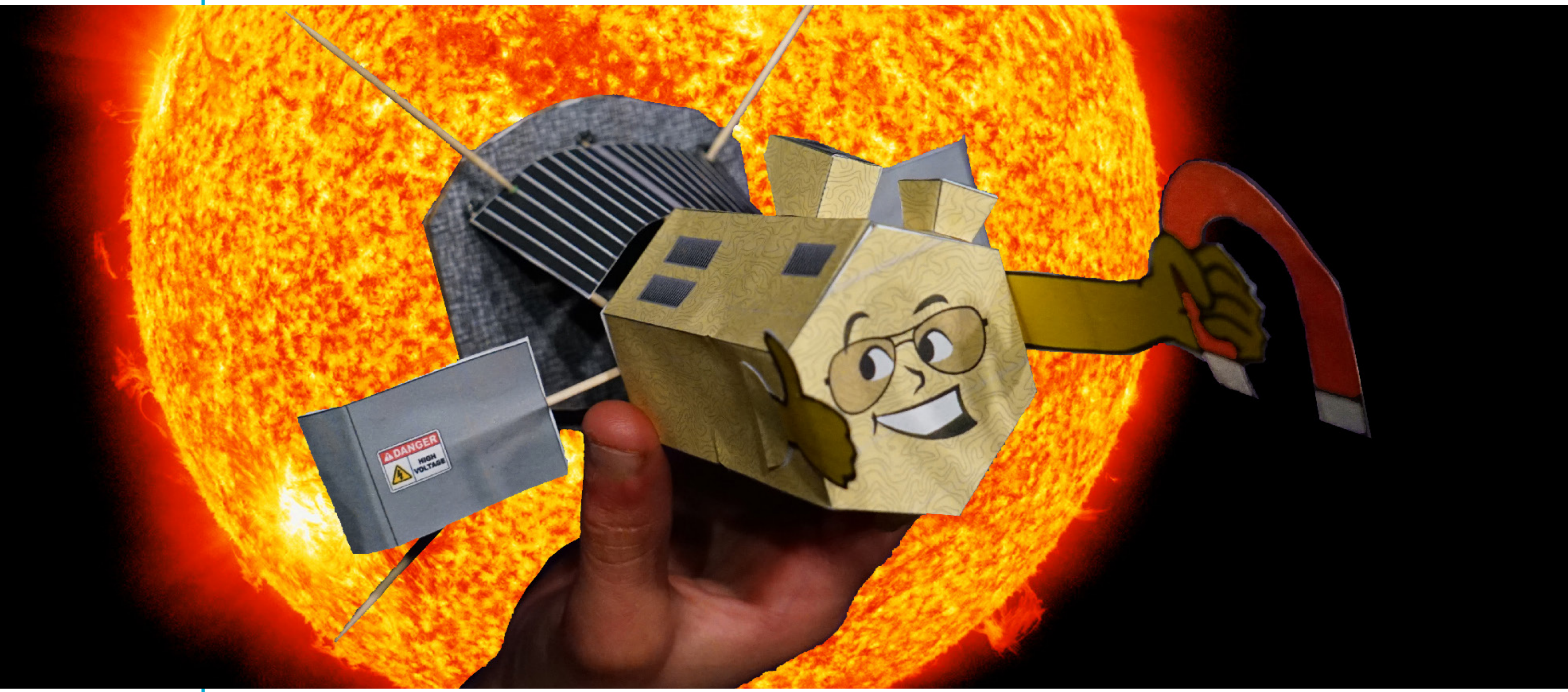
Duration: 1+ hour

Materials and tools needed:

- Printer (color or monochrome)
- 2 sheets of 8.5 x 11" copy paper or cardstock (preferably the latter)
- 12–14 toothpicks (round or flat)
- Cardboard (single- or double-layered and at least a 5 x 5" square)
- White glue or glue stick
- Scissors or X-Acto® knife (preferably the latter)
- Heavy sewing needle, T-pin, large safety pin, compass point, etc.

Introduction:

For the first time, astronomers and engineers have sent a probe into the fiery vicinity of the Sun to study what can't be studied from Earth. Make a model of this daredevil robotic mission to the edge of the star of our solar system!

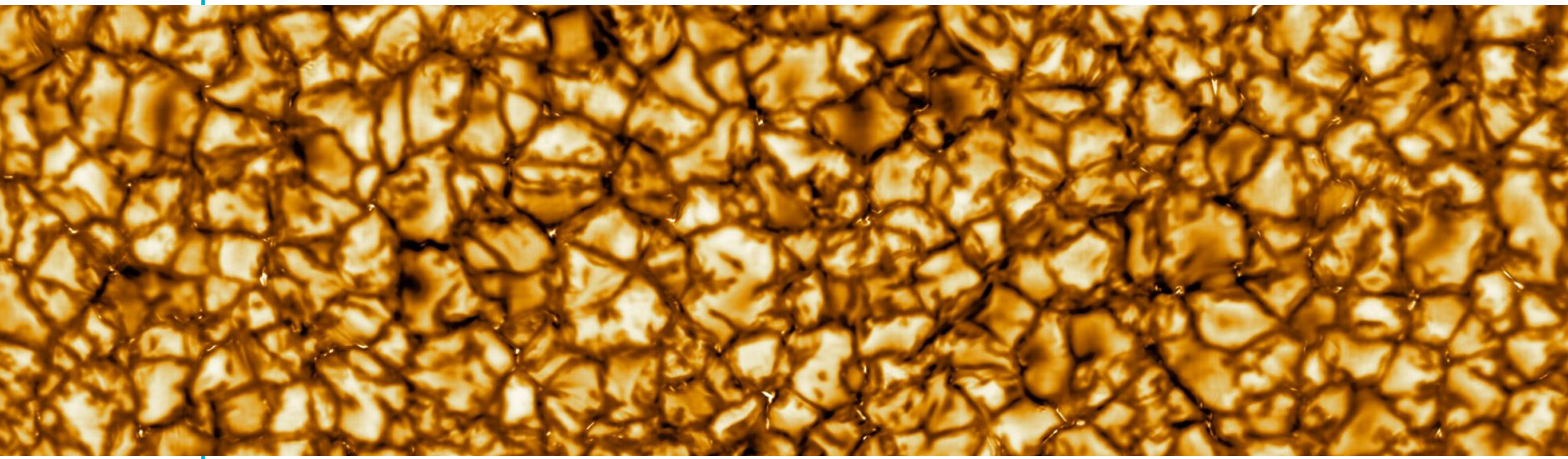


Why study the Sun with a heat-resistant robot?

You would think it would be simple to study the Sun. It's easy to see, and easy to find in the sky, right? But looking at the Sun from tens of millions of miles away can only tell you so much. In order to understand what's going on in and around the Sun, you have to get close. You have to measure the electrical and magnetic fields around it, take samples of the superheated material it throws off, and get pictures of what's in space around it—from angles we can't reach as long as we are stuck on Earth.

The Sun does more than just keep us warm and provide energy for plants and solar panels, it also produces intense bursts of ions and charged particles, which sometimes reach Earth. While life on our planet has evolved to take these events largely in stride, the components of our technological infrastructure—weather and communications satellites, electrical transmission lines, radio broadcasting—are much more fragile. In 1859, a solar storm actually caused electrical equipment on Earth to melt, and telegraph operators' equipment caught fire. In 1989, it happened again, knocking out power across much of Québec, Canada. These days, we're also concerned about astronauts in Earth orbit and other astronauts who might one day have to deal with a solar storm while en route to Mars or the Moon.

In order to understand how bad these events can get, what are the warning signs, and how to protect against them, NASA launched the Parker Solar Probe in 2018. The Parker is designed to go far closer to the Sun than any previous mission. It will get so close that the intensity of solar radiation will be up to 475 times stronger than what we experience on Earth—and the Sun-facing side of its heat shield will reach temperatures of close to 2,500 degrees Fahrenheit. At that distance, the Sun will look HUGE—the size of a saucer held at arm's length.



The surface of the Sun, by the Inouye Solar TelescopeNSO/AURA/NSF.

Model-Making Tips

Before we jump in, here are some model-making tips to keep in mind.

- Make sure the surface you work on is clean and is easy to clean up, so if you do leave some glue or marker or a scratch, it won't be a problem!
- If you are using heavyweight paper like cardstock, check the instructions on your printer to make sure you are feeding the paper properly.
- If you are using an inkjet printer, let the printouts sit for at least five minutes to dry. If you try to work with the paper when it is still wet, it will tear much more easily.
- Don't cut out all the pieces at once. Cut out one piece at a time, and assemble that piece, with the photos as a guide. Then move on to the next piece.
- To make folds easier and neater, try scoring the line of the fold with your hole-poking pin, the back of the knife, or even your fingernail. Scoring means dragging something sharp over the line of the fold as if you are cutting it, but not pushing down hard enough to actually cut the paper. [Photo 0]
- While the X-Acto® knife is generally the tool of choice, don't worry if you don't have or can't use one. Scissors will work fine and can be better for circles and curves.
- Don't slather parts with glue. That just makes the paper soggy! A thin coating, on one surface, is usually plenty. If it's difficult to control the amount of glue by applying it directly out of the bottle, try putting glue in a dish and applying it with a cotton swab or a brush.
- After each step, put the part you just assembled to the side to dry. Five minutes is more than enough time. If you assemble the parts in the order listed below, then by the time you move on to the next step, the previous part should be ready to work with.

Step 1

Print out the two sheets with the parts of the Parker Solar Probe (included in this PDF) and start by building the body of the Spacecraft Bus.

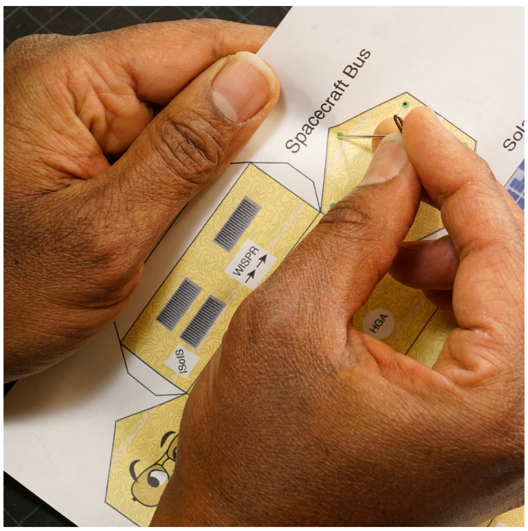
a. Before cutting the Spacecraft Bus out of the paper, find the six green dots at the hexagonal base. With the large pin or needle, poke a hole through each dot.

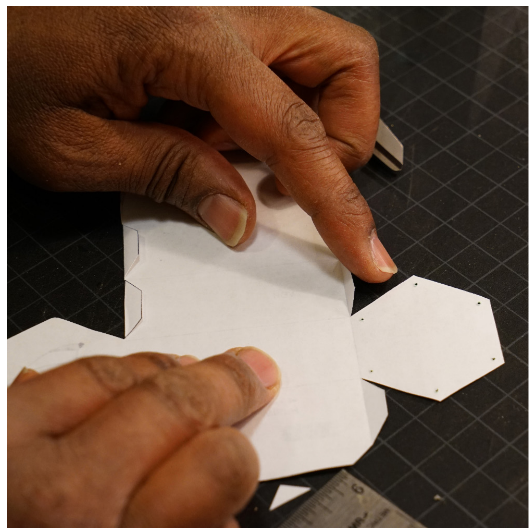
b. Then, cut out the Spacecraft Bus and fold the glue tabs inward.

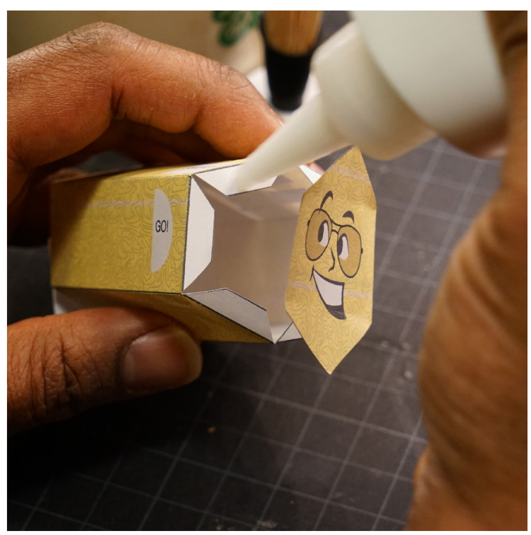
c. Fold into a hexagonal tube and glue the large glue tab to the inside.

d. Fold the small glue tabs inward and glue down the hexagonal ends.

e. Set aside to dry.



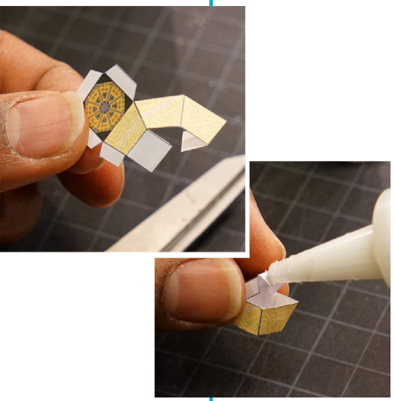
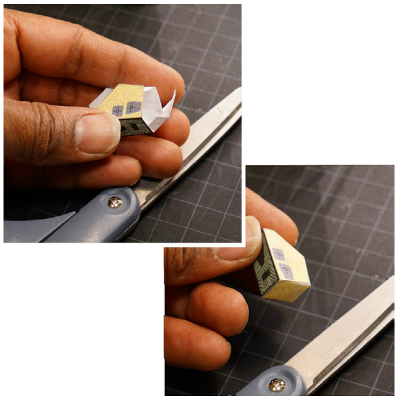


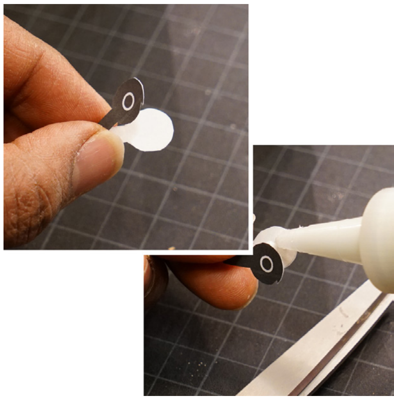


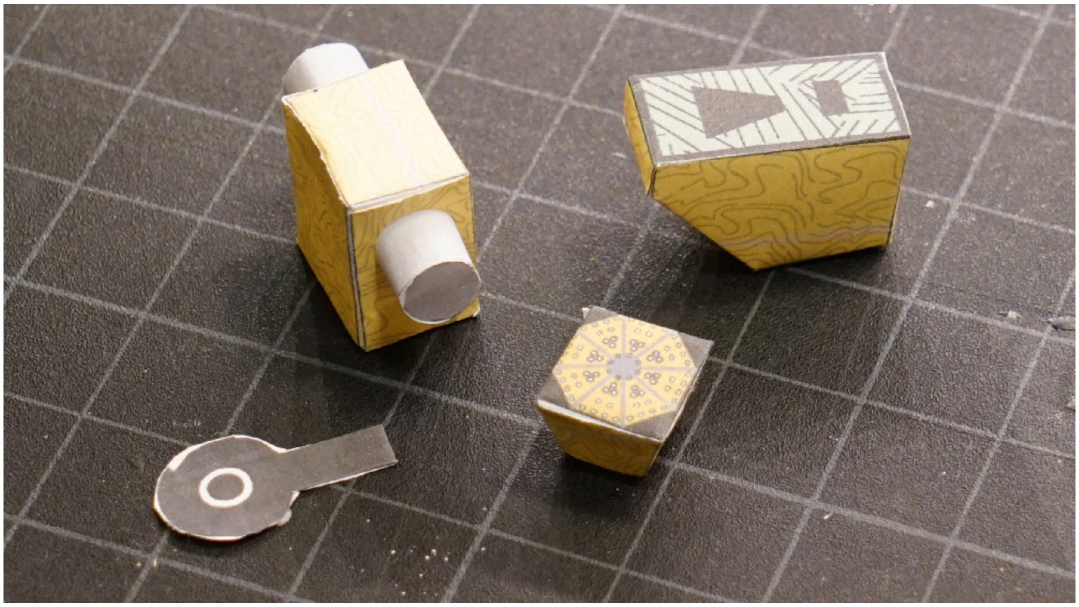
Step 2

Build the Integrated Science Investigation of the Sun (ISoIS), Wide-field Imager for Solar Probe (WISPR), Solar Wind Electrons, Alpha particles, and Protons (SWEAP), and Forward-Facing Solar Wind Ion Sensor instruments.

a. Cut the four instruments out of the paper.
b. Fold the tabs and glue them down as illustrated in the accompanying photos.
c. The two gray strips with glue tabs on the SWEAP instrument are formed into cylinders and glued on top of the white circles. The grey circles cap the cylinders on the SWEAP instrument.
d. Set aside to dry.

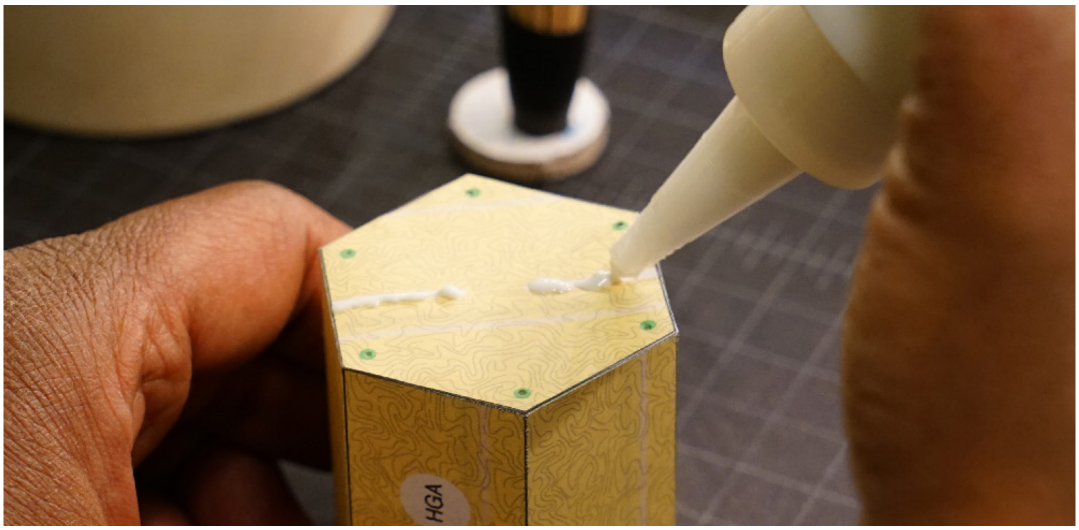




Step 3

Apply the toothpicks to the Spacecraft Bus.

a. Place the Spacecraft Bus face-down on your work surface.
b. Apply glue to the white lines.
c. Glue two toothpicks to the white lines. They should just cover the lines and stick out past the sides.
d. Set aside to dry.



Step 4

Assemble the High Gain Antenna (Front and Back) and Support.

a. Cut out and roll the support into a cone that is open on both ends. Glue the tab into place.

b. Cut out and form the back and front into two flattened cones. Glue the tabs into place for each.

c. Glue the back and front together around the edges, to make the assembled Antenna, which has a “UFO” shape.

d. Glue the Antenna to the small open end of the support, so the small open end on the support covers the white circle on the Antenna.

e. Set aside to dry.




Step 5

Assemble the Solar Arrays and attach to the Spacecraft Bus.

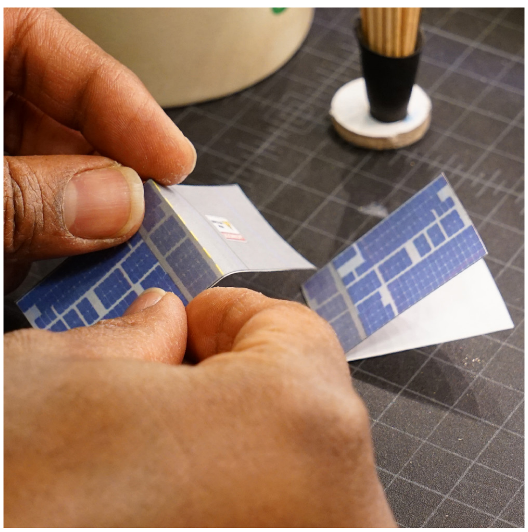
a. Cut out and fold each Solar Array along the dashed line.

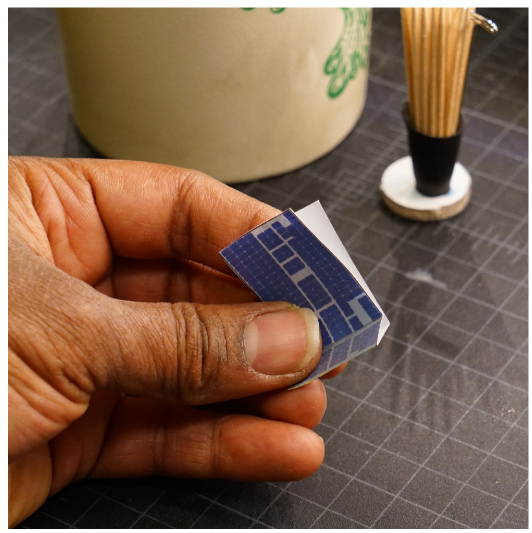
b. Bend the gray end section of the Solar Arrays upward slightly.

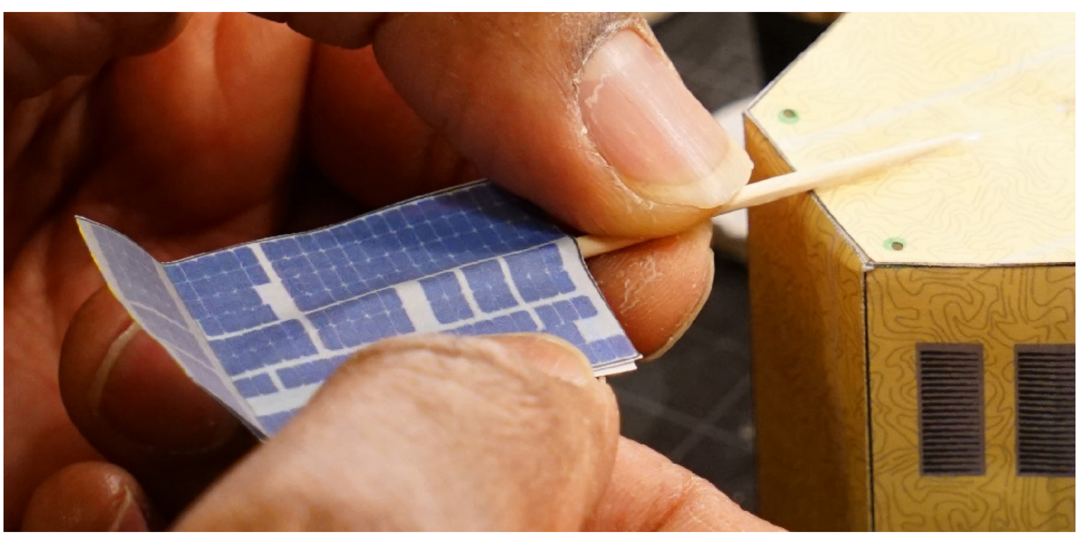
c. Unfold the Solar Arrays and apply light glue to the unprinted side.

d. With the Spacecraft Bus still face-down on your work surface, sandwich the end of each toothpick between the halves of the Solar Arrays and the top of the Spacecraft Bus, as shown. Leave about 1 inch of toothpick uncovered between them. The side of the Solar Arrays with the blue solar cells should face up, with the ends bending upward. You can double-up on toothpicks, so the panels aren't as wobbly.

e. Set aside to dry.







Step 6

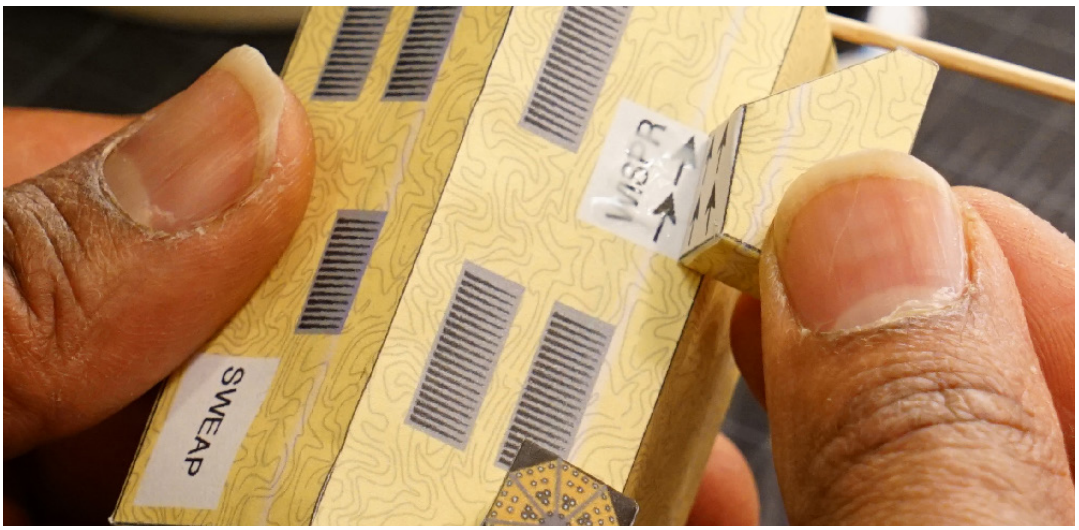
Attach the ISoIS, WISPR, and High Gain Antenna instruments to the Spacecraft Bus.

a. Glue the assembled ISoIS and WISPR over the labeled white squares on the Spacecraft Bus.

b. Make sure the arrows on the base of ISoIS and in the white box on the Spacecraft Bus are pointing in the same direction.

c. Glue the High Gain Antenna Mount's larger open end to the labeled circle.

d. Set aside to dry.



Steps 7 & 8

Assemble the Magnetometer Arm and All Systems Go!

a. Cut out each piece and fold in half along the fold line.

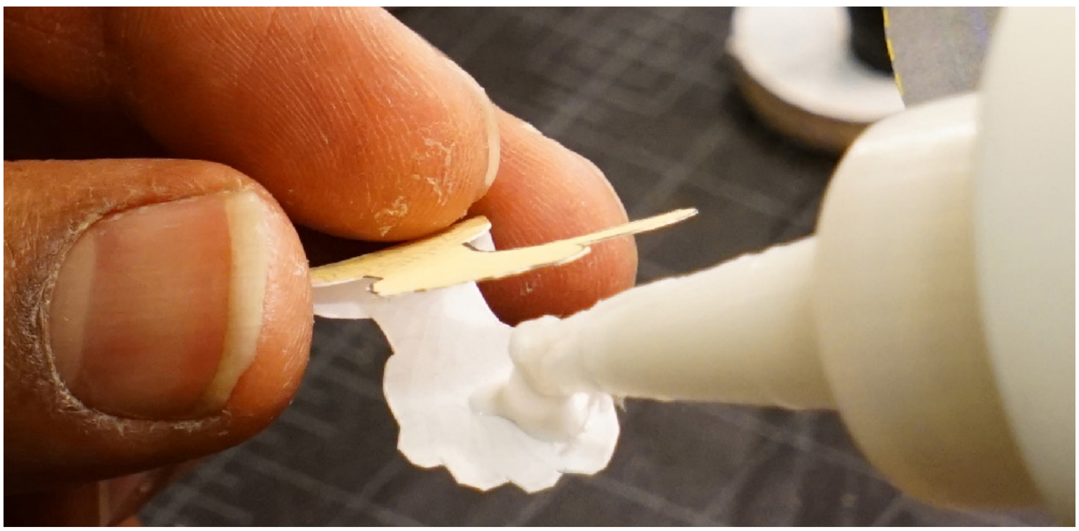
b. Glue the front and back of the Magnetometer Arm together. Repeat for All Systems Go!

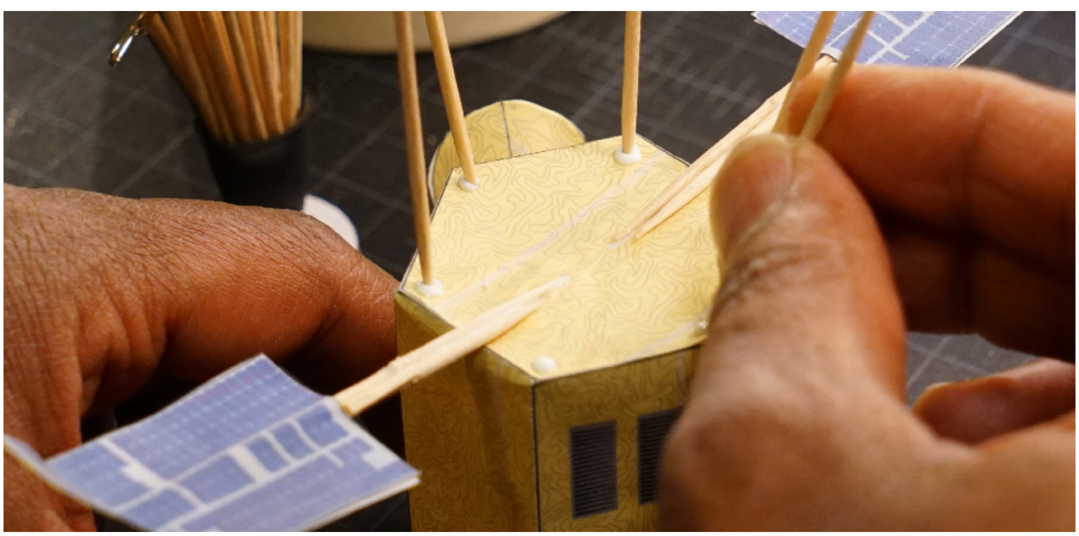
c. Set aside to dry.

Prepare the Spacecraft Bus for the Heat Shield with toothpicks.

a. Dab one end of six toothpicks with glue and poke just the tip into the holes in the Spacecraft Bus. Don't worry if they stick out at funny angles. We'll take care of that in a minute!

b. Set aside to dry.





Step 9

Assemble the Heat Shield.

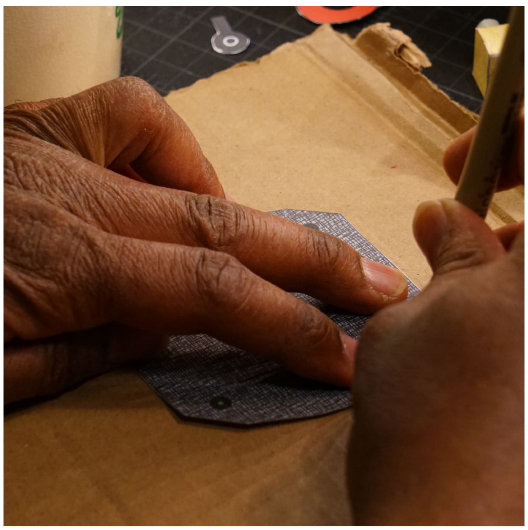
a. Cut out the Heat Shield Front and Rear.

b. Using the rear as a template, trace its shape on corrugated cardboard and cut it out.

c. Glue the rear to one side of the corrugated cardboard.

d. With a pin or needle, poke a hole through the center of each green dot on the rear and into the corrugated cardboard.

e. Glue the front to the other side of the corrugated cardboard.



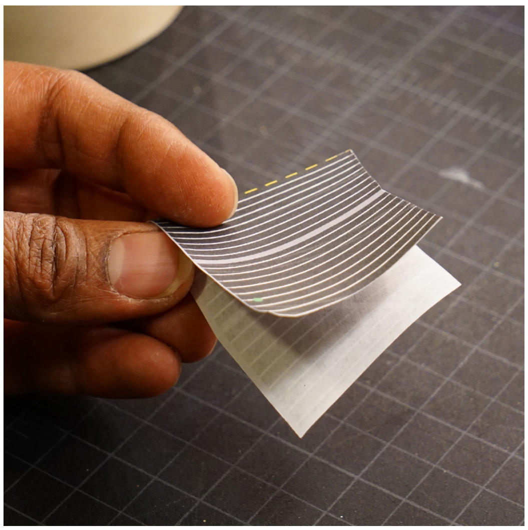
Step 10

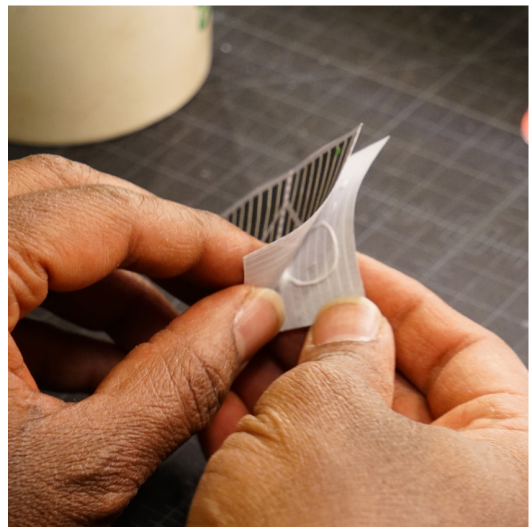
Prepare the Radiators.

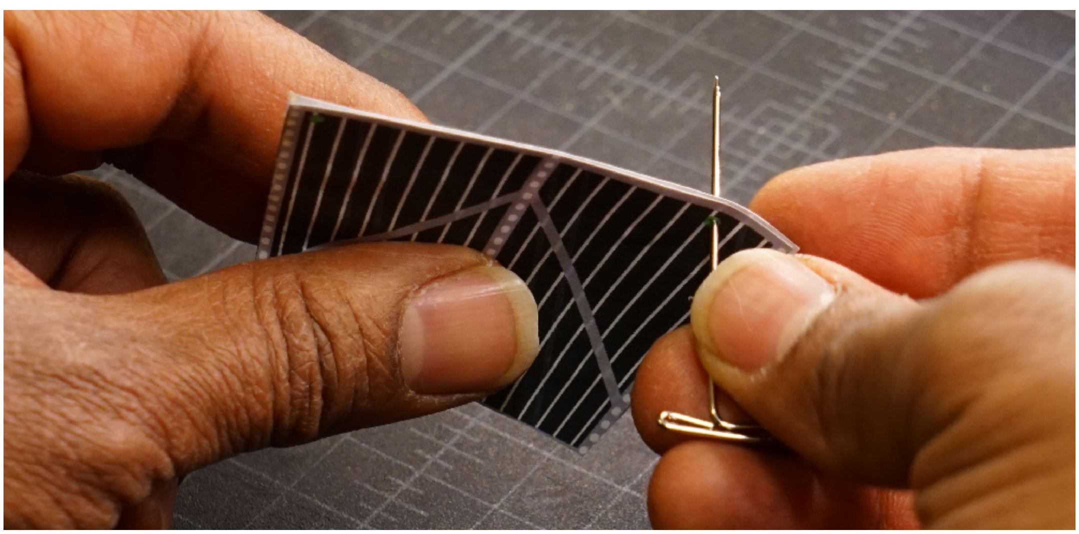
a. Cut out each Radiator and fold along the dashed line.

b. Apply light glue to the unprinted side of each Radiator and glue the two sides together.

c. With a pin or needle, poke a hole through the center of each green dot on the Radiators.







Step 11

Attach the Heat Shield to the Spacecraft Bus.

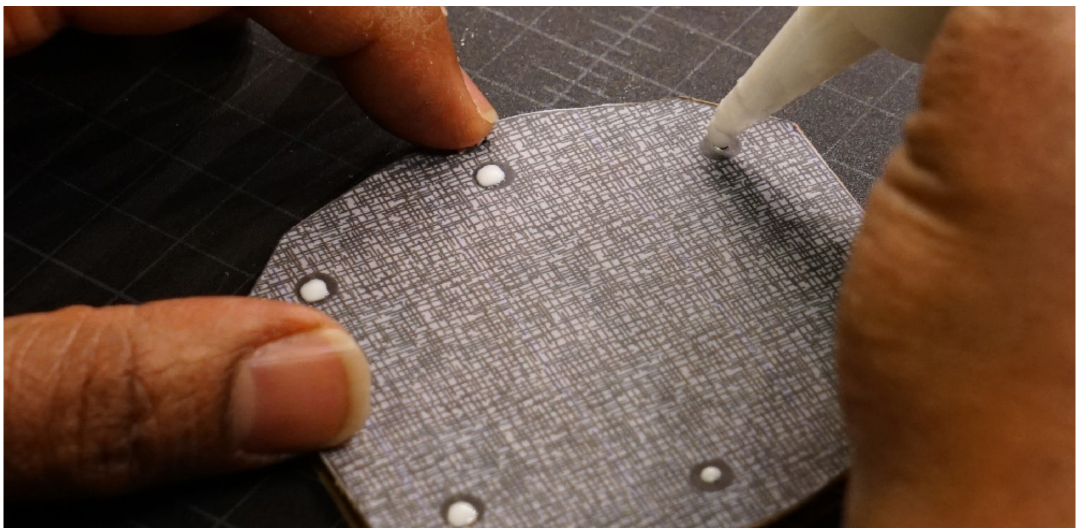
a. Place the assembled Heat Shield on your work surface, white side down.

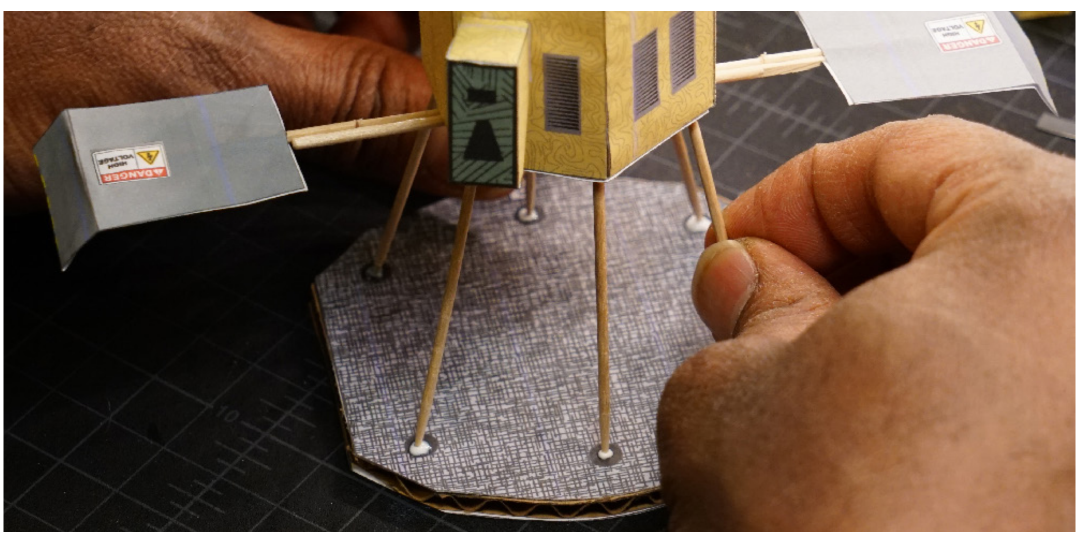
b. Put a dab of glue on top of each hole you poked.

c. Put the free ends of the toothpicks that were glued into the holes in the Spacecraft Bus into the holes in the assembled Heat Shield.

d. The Solar Panels should stick out over the flat edges of the shield.

e. It will still be a little wobbly and crooked, but don’t worry! We’re going to take care of that right now.





Step 12

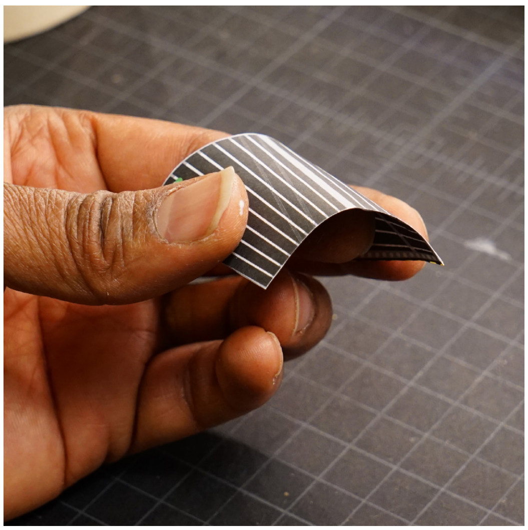
Attach the Radiators to the Probe.

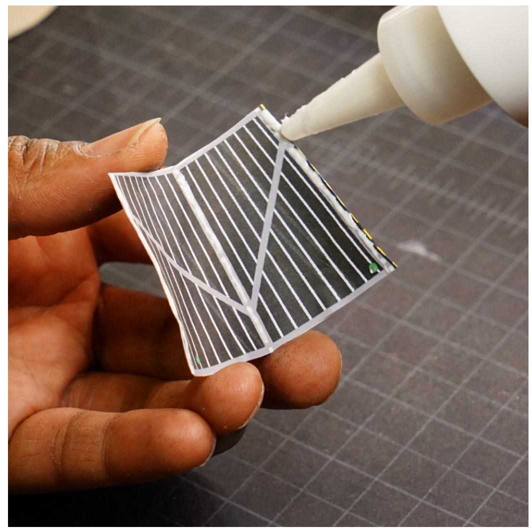
a. Curve the assembled Radiators into a slight bend as illustrated.

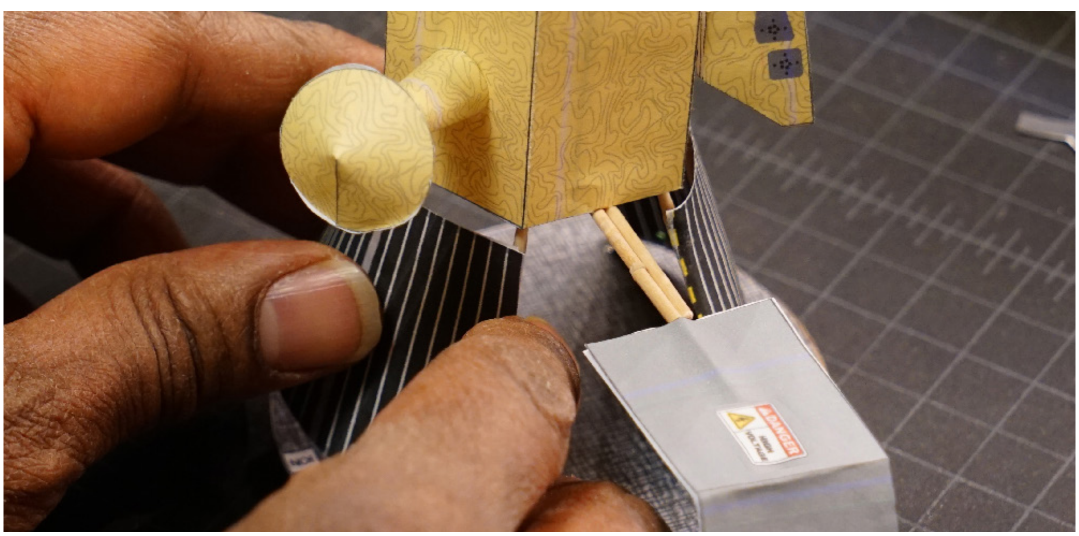
b. Apply glue to the dotted lines.

c. Glue the Radiators to the toothpicks joining the Spacecraft Bus to the Heat Shield as shown. Hold in place for a minute while the glue sets. The Radiators will hold the Spacecraft Bus and the Heat Shield in the right position.

d. Let it dry.







Step 13 & 14

Form the four lateral antennae of the FIELDS instrument.

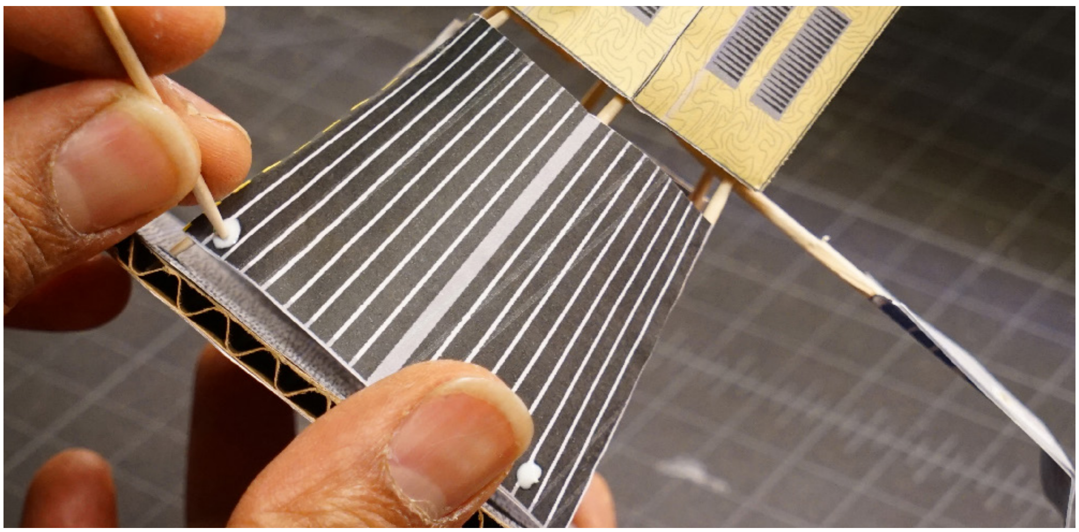
a. Put a dab of glue on one end of each of four more toothpicks.

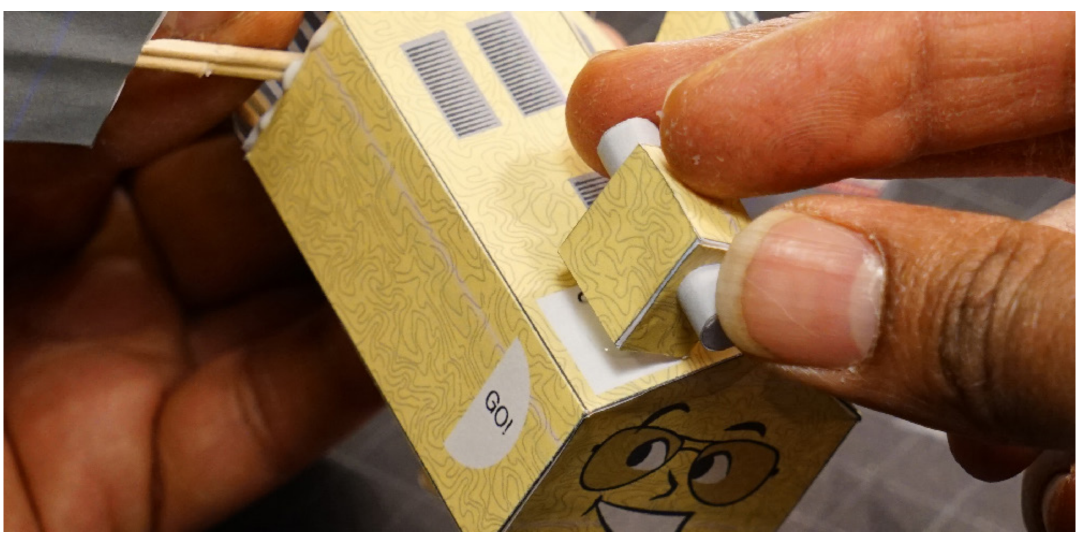
b. Poke just the tip of the toothpicks into the holes in the Radiators.

Attach the Forward-Facing Solar Wind Ion Sensor and SWEAP to the Probe.

c. Glue the assembled Ion Sensor over the labeled white square on the Radiator.

d. Glue the assembled SWEAP over the labeled white square on the Spacecraft Bus.





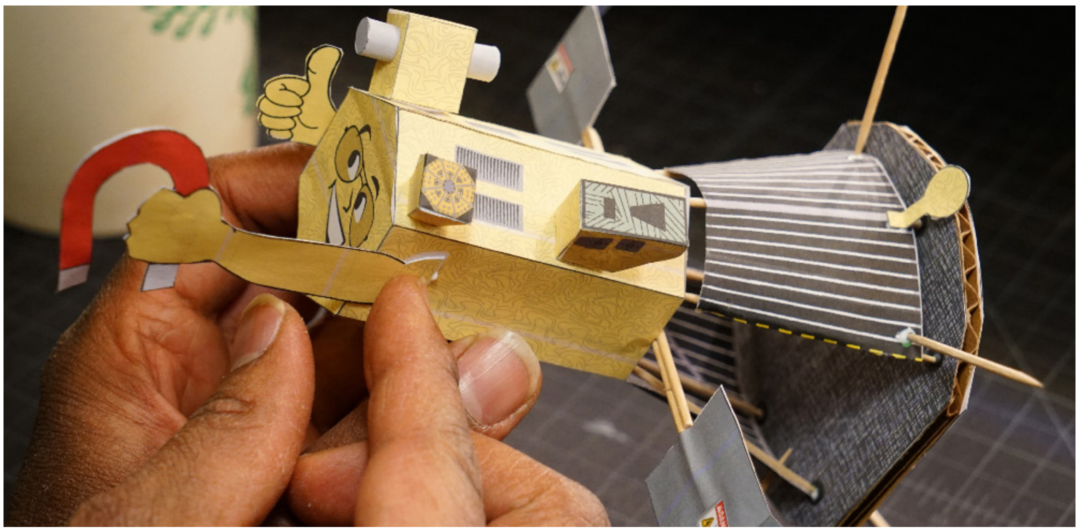
Steps 15 & 16

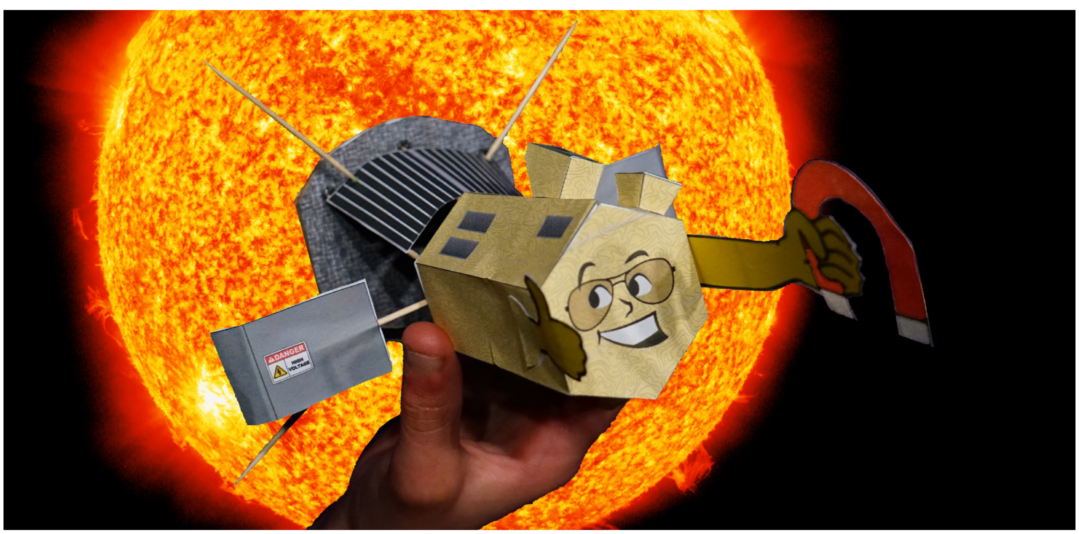
Attach the arms to the Probe.

Glue the Magnetometer Arm and All Systems Go! to the labeled half-circles on the Spacecraft Bus. You're done!

Display your creation!

Tie black thread around one of the toothpicks separating the Spacecraft Bus from the Radiators. The probe is quite light, so sewing thread is fine. Hang in a window, and watch it spin in the sunlight!





Glossary & Further Resources

FIELDS: This consists of several antennae, four of which are depicted on this model. These detect changes in electric fields, like the magnetometer detects changes in magnetic fields.

Forward-Facing Solar Wind Ion Sensor: This peeks around the heat shield to scoop up and analyze material that is being blasted off of the Sun's surface.

Heat Shield: This is a brittle, spongy mass of pure carbon that is painted white on the Sun-facing side. Of all parts of the probe, this is the one that has been the hardest to engineer. The idea for a solar probe has been around for at least 60 years, but only in the last few decades have we known how to make this critical component.

High-Gain Antenna: Ask someone to draw a cartoon sketch of a space probe and they'll include one of these—a round "satellite dish" stuck on the side. It allows radio communication between the Parker Solar Probe and Earth. Spacecraft typically have a high-gain antenna for transmitting data and receiving instructions, with low-gain antennae for basic maintenance communication and for emergencies, in case the spacecraft loses its ability to point the high-gain antenna towards Earth.

Integrated Science Investigation of the Sun (SIoIS): A set of detectors (only one is included in this model) that detect high-energy and low-energy ions—heavier atoms like oxygen and carbon which have lost one or more electrons.

Magnetometer: Magnetometers measure the strength and direction of magnetic fields, which is particularly important when studying the environment around the Sun, as magnetic fields control the behavior of ions and charged particles expelled by the Sun. Most spacecraft carry magnetometers of one kind or another. They are relatively cheap and power-thrifty and have no moving parts.

Solar Arrays: These convert sunlight into electrical current to run the spacecraft. When the Parker is at its closest approach to the Sun, the arrays are retracted into the shadow of the heat shield, and batteries—charged by the panels—provide power.

Solar Wind Electrons, Alpha particles, and Protons (SWEAP): The SWEAP experiment is a set of detectors (only one is included in this model) which pick up the number, direction of motion, and speed of subatomic particles as they are thrown out of the Sun. It is clouds of these particles (electrons, alpha particles, and protons) that can cause the sort of electric-grid frying events that occurred in 1859 and 1989 on Earth.

Spacecraft Bus: This is the boxy heart of a robotic spacecraft. Like a city bus, it's packed with "passengers." Attached to the bus are cameras, antennae, and sensors of various kinds. Inside the bus are items like the onboard computer, radio, batteries, and fuel tanks.

Wide-field Imager for Solar Probe (WISPR): The only set of cameras aboard the Parker Solar Probe, and they look off to the side of the Sun, not directly at it. Their target is the Sun's extensive, extremely thin and hot outer atmosphere, the corona. Parker will be the first mission to return images of the corona from the inside as it flies through it.

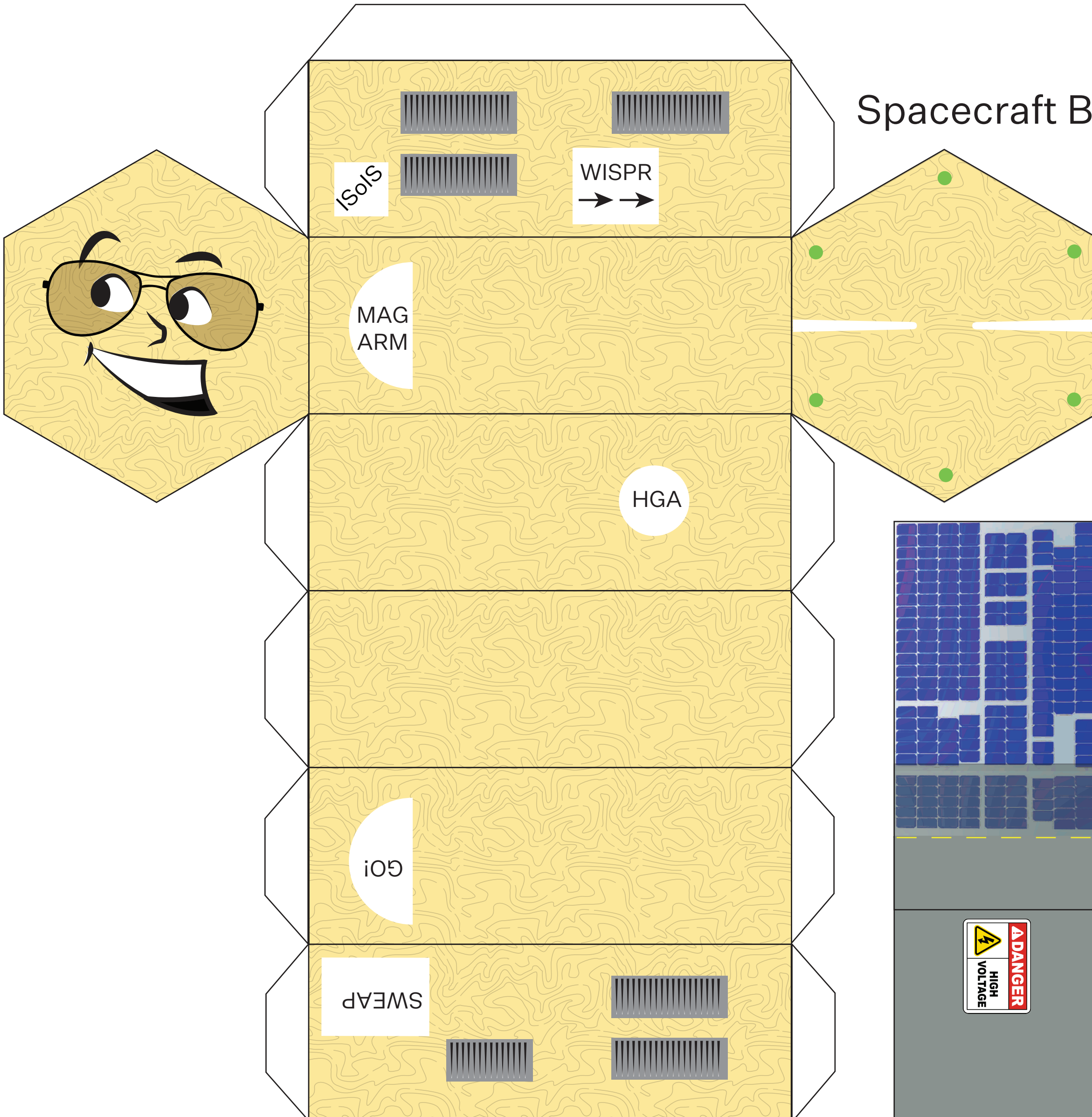
Parker Solar Probe Official Website

http://parkersolarprobe.jhuapl.edu/

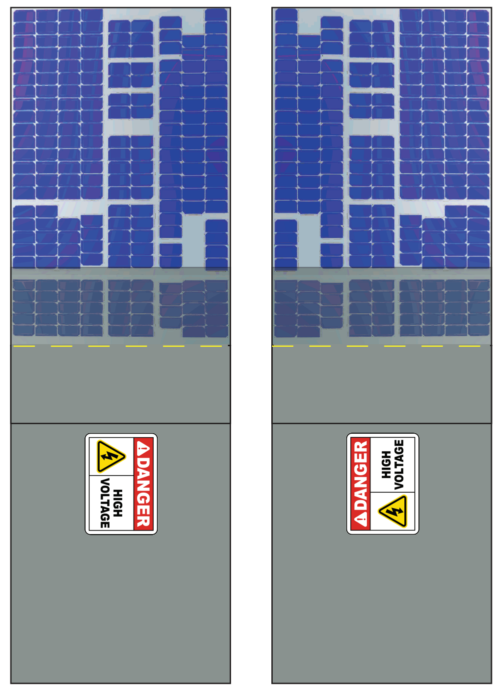
View and rotate a 3D VR model of the Parker Solar Probe

https://solarsystem.nasa.gov/resources/2356/parker-solar-probe-3d-model/

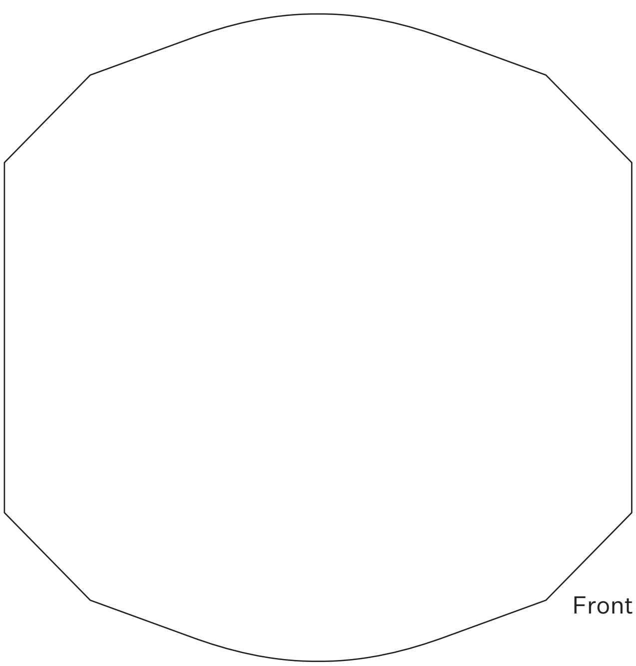
Spacecraft Bus



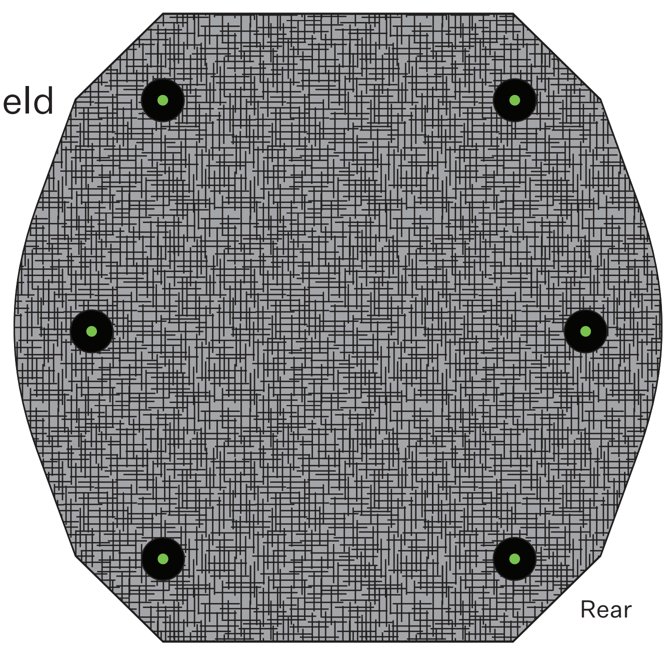
Solar Arrays



Heat Shield

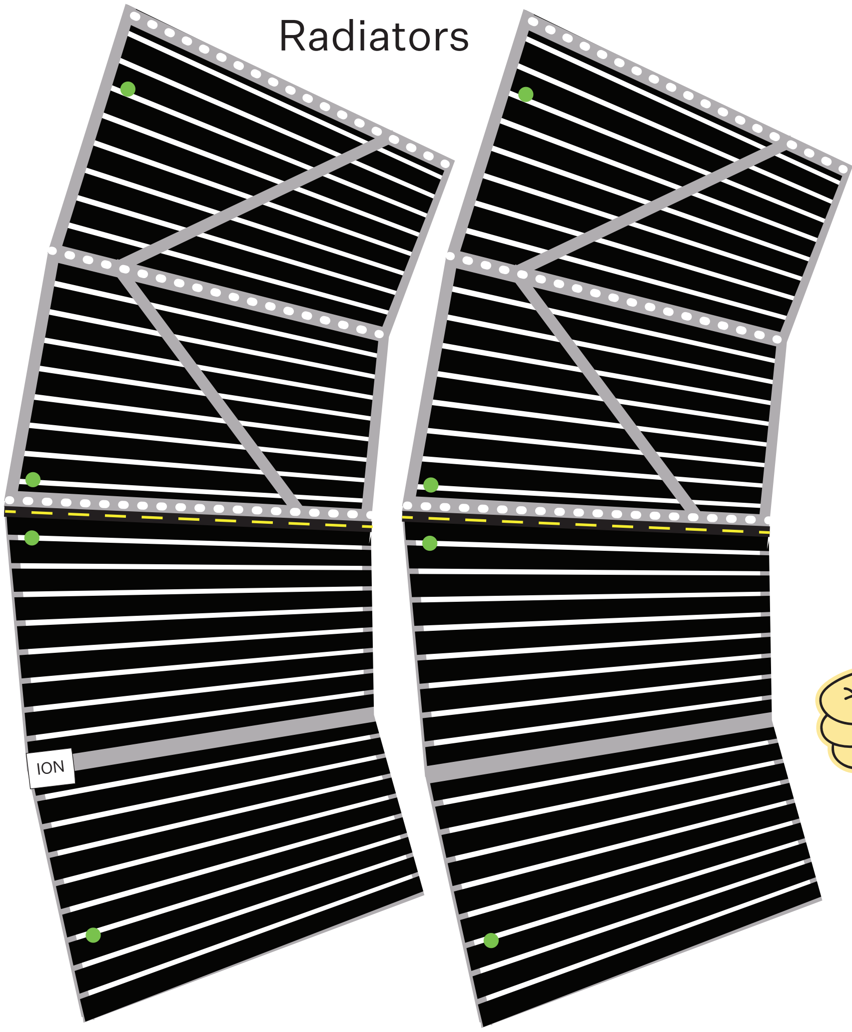


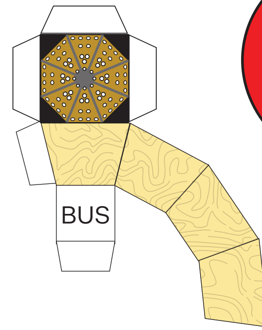
Front



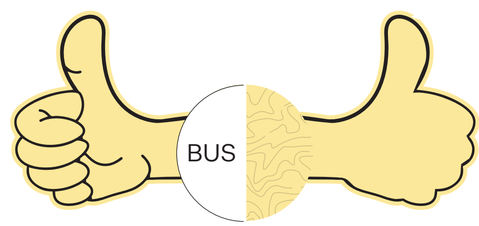
Rear

Radiators

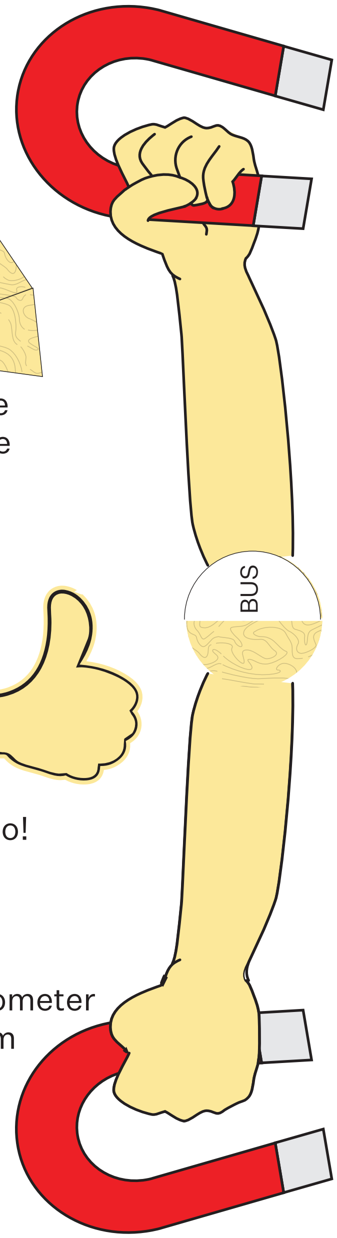




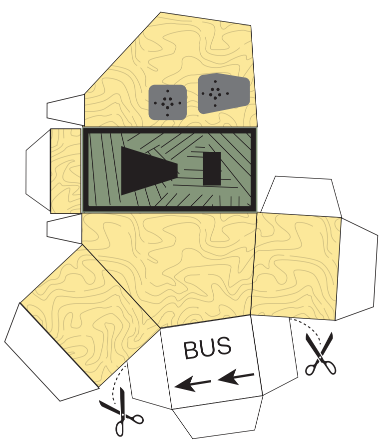
Integrated Science Investigation of the Sun (ISoIS)



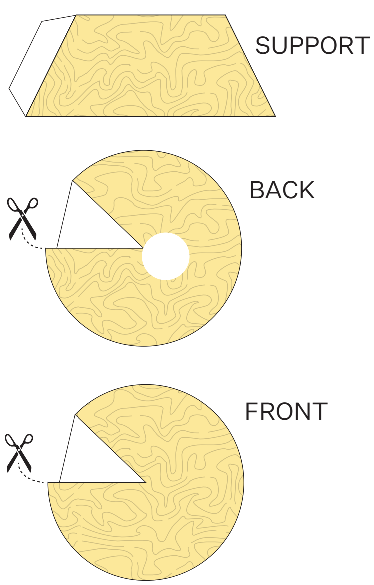
All Systems Go!



Magnetometer Arm

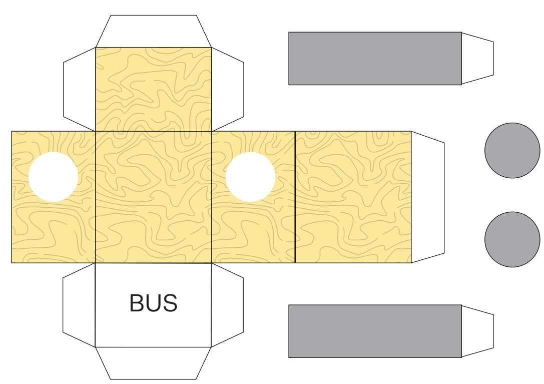


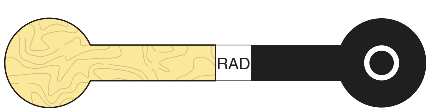
Wide-field Imager for Solar PRobe (WISPR)



High-Gain Antenna and Support

Solar Wind Electrons, Alpha particles, and Protons (SWEAP)





Forward-Facing Solar Wind Ion Sensor