Pioneer 10 Paper Model Activity

To complete the following unit,
you will need to print the following images.

- Please note that you may have to adjust image size to match your printing setup.
- It is recommended that you download the files, and then do a test print using Sheet #1 (the Dish.)
- If the edges are clipped, it is suggested you either adjust the margins, or the print size percentage to fit your particular printer.

Templates

- Sheet One
- Sheet Two
- Sheet Three
- Sheet Four
- Sheet Five
- Sheet Six

Photos of Model

- Photos 1 - 4
- Photos 5 - 7
- Photos 8 - 16
- Photos 17 and 18

Assembly Instructions

This is not a simple punch and tab model. It will require some patience and skill. The reward is a nice representation for classroom use of the Pioneer 10 spacecraft which was the first manmade object to leave the solar system. Pioneer 10 extended man's senses farther than we are ever likely to duplicate for decades to come. It is a landmark in space exploration. With preparation in the classroom this project can probably be completed in 2/3 class periods. The original model took less than one day to design and fabricate and the second model about 3 hours to complete. With care, you will have a model which will acquaint your classes of one of the most successful space missions of all time. A mission which is still rewriting the textbooks books for all time!

Materials Required:
Cardstock paper, Hobby Knives, Scissors, CA glue (hobby super glue

used for model airplanes), Spray Adhesive, Straws/Balsa Sticks, Rulers, Flat Black Hobby Paint, old AA battery, and Patience!

General Construction:
In general all parts are designed to be spray glued onto cardstock. There are a few exceptions which will be noted in the instructions. Spray adhesives are great in that they give you even coverage and do not soak through the paper. However, it is recommended that the instructor do this keeping in mind over- spray, and wind directions. It is suggested you do this outdoors due to possible fumes. Drying time is instantaneous so the parts are ready as soon as you glue the plans to the cardstock.

Parts which are meant to be folded will work extremely well if time is taken to carefully "score" the fold line. To do this take a sharp hobby knife and LIGHTLY cut along the line. A ruler is helpful to make sure that this is a straight line. If done correctly, the fold will be sharp and crisp - and will be easy to make. Have students practice on a sample.

When you bend the folds it is suggested that you place a ruler, or else do the bending along a sharp table edge, so that you get a crisp fold. It is imporant to have corners which are sharp, crisp, and clean.

Before any part is glued Make Sure That it Fits! If it needs to be trimmed, or cuts need to made in the part - it is best to do it before it is all assembled! Take a look at the Photo Pages which show images of the assembled parts prior to assembly!

The use of a hobby "super glue" called CA (available from most hobby stores) is recommended. It only takes small amounts of this to create a strong bond. In fact, one method is to place a drop on wax paper and to have students use a pin to apply the glue to selected areas. In fact, it works best when there is only a small amount. The other advantage is that the parts being glued are ready to use quickly. We all know that the super glues will glue skin very quickly also - have some of the super glue remover available! Other glues will work, but do not setup rapidly and can be an aggravation.

Because it is NOT a quick project an approach which will work well in the classroom is to perform the work very much like it is in the real world. Assign the various tasks to groups who are responsible for supplying their part to the project. Remind them that on a real project various responsibilities are assigned to "teams" which take care of just that one area. Then things are brought together for final assembly (or, as it is often called integration). This is also a great way to show students how projects depend on great coordination and support from many people. It is not possible for anyone to do the job by themselves. You may also expect that some pieces will have to be redone (so have some" spares" available for quality control), and that you may assign some members to do research on their "part" and do a presentation.

If you have any problems please feel free to contact us regarding this at bhillenbrand@mail.arc.nasa.gov and we will be most happy to help you with this project.

Now, Let's get started.....

Don't Panic Because We Have Lots of Instructions.
We are just trying to Anticipate any Difficulties!

Step 1:
Examine the Assembly Sheets and Make Sure that You Have 6 Sheets. Spray glue Sheet 1, 3 , 4, & 5 to cardstock. We will need Sheets 1 and 2. Locate them! *See Photo 1*

Step 2:
We will begin with the large Dish Antenna. It is simple and good to learn on. There are two antenna sheets - Front

(Sheet 1) and Back (Sheet 2). DO NOT GLUE the FRONT (Sheet 2) onto cardstock. Cut both circles out at this point.

Step 3:
The Back of the dish has small blocks on it. There is also a line going in toward the center of the circle. With a pair of scissors, cut along this line.

Step 4:
Next take and slide the cut which you just made toward the other line on the plans. As you do this the circle will begin to assume a "dish-like" shape. In the pie-shaped area lightly apply some super glue and hold the two wedges together until it dries - 20/30 seconds. Now when you let go it should hold together (hopefully your fingers are not part of the dish at this point - always be careful!) See the *Photo Illustration 2*.

Step 5:
Now take the sheet for the Front of the Dish and lay it inside the front with the dark side out. Test to see how it fits and then apply some super glue along the edges and in the center. Press the Front Sheet into the dish and smooth out. *See Photo 3*.

Step 6:
Place the Dish face down so that it looks like a "flat ice cream cone" sitting on the large end. Find the piece which is labeled "Experiment Truss" (Sheet 4). Cut it out! It is to bent into a circle. It will do this easier if you take and roll the paper along the edges of a desk with a rounded edge. It is kind of like what they do to Christmas ribbon to cause it to curl. Take and form a circle. Note the tabs on each end will allow you to glue the ends together. Bend the tabs to the inside of the circle. These go on top & the sides without tabs goes onto the back of the dish. Take and place the ring around the top of the dish and center it. Once centered apply some glue to the inside edges of the "Experiment Truss" and apply some pressure to ensure a tight fit. *See Photos 4 & 5*.

Step 7:
Equipment Boxes and Housings - Cut out, Score, and Read Below. Some of the areas on these will best be cut out using a Hobby Knife to cutout close areas. You can do most of the cutting with a pair of scissors. These are found on Sheet 3.

The Pioneer Main Body, Radiometer, and Meteorite "boxes" are based on the same concept. When properly folded they will all form a box which was created by folds, and by glue ing tabs inside these which holds everything together. The Pioneer Main Body is the largest and has lots of sides. Red Lines indicate lines which are to be cut. Solid Lines are Fold Lines and should be "scored". The Red "Y" shapes on the Pioneer Main Body are cut-outs for the RTG Booms to be attached. THESE SHOULD BE CUT OUT BEFORE YOU ASSEMBLE the Pioneer Main Body. Cut along the Red Lines and cutout a slot about 1/16 of an inch wide (the thickness of two layers of cardstock) in the "Y" shape. Blue tabs attach to body sides and Gray Tabs fold over to later attach to the Top Panel.

The Pioneer Main Body has 5 sides and a sixth side with an extension which will physically be about 3/4 of an inch thick when completed. The "side panel" for the front extension is on the "top panel" and will interlock with the bottom when completed. *See Photos 6 & 7*.

The Launch Support Ring is simply a strip which is formed into a circle which is glued to the bottom of the Pioneer Main Body. See Photo 16

for details.

The Micrometeorite Detector is open on one side and glues to the Truss Box when completed. *See Photos 8 & 9.*

The Radiometer Assembly is irregularly shaped and will also be open on the irregular side when completed. *See Photo 10*

Review the illustrations for a better idea of what each part is supposed to look like prior to assembly.

Each of these assemblies can be assigned to individual groups in the room. If possible, have spare sheets ready in case mistakes are made.

Step 8:
The RTG Assemblies. The Radioisotope Thermal Generators were used to power the spacecraft in the deep darkness of the outer solar system where light was too dim for solar cells. In addition these provided heat to keep the spacecraft warm. This is a part of the spacecraft model which will take some time and patience. It isn't all that hard, just time consuming.

Begin, by cutting out each of the Support Parts. These will need to be scored along the lines and bent. The Gray Lines bend outward, and the Gold Lines bend inward. Refer to the opening remarks about folding. If you do all of the inner folds first and then the outer ones using a ruler it will help.

When you get done you should have a "Y" shaped truss. *See Photo 11.*

Next carefully wrap the RTG Roll around an old AA battery. Be careful to make it a straight roll. When you get towards the end, place some glue along the edge and hold is place. Don't roll it to tight on the battery or else it will not slide off when done. *See Photo 12.*

Score all of the long lines on the RTG Fins part, vertical as you look at the original sheet.

Next Cut out the row of RTG Fins along the short lines. The two black lines on either end should have been scored so that as you bend the fin in half, you should now have a tab on each end which bends outward. *See Photo 13.*

Place a bit of glue on the tabbed end of the Fin and arrange them so that you have 4 rows along the sides of the RTG main body. *See Photo 15.*

Once you have all the Fins in place, then cut three grooves to match the ends of the RTG Support. Place the RTG on the end of the Support and glue.

You will have to "notch" the other end of the RTG Support to match the size of the "Y" you cut in the side of the Pioneer Main Body. Trim the notches to size and fit to the Main Body. *See Photo 16.*

Step 9:
The Antenna Feedhorn (Sheet 6)

This is a simple step. Cut out each of the two halves of a circle. Take the Outer one (Gray) and make a cone out of it similar to what you did to the Main Dish. It this case you want the opening to be about 1.25 inch across. Glue the ends to form the cone.

Next roll the Inner Cone and make it smaller than the Outer one. Slip it inside and allow to expand and fill the inside of the Feedhorn. Glue in place.

Next, either take straws or 1/8th inch balsa sticks and cut them about 3 inches in length. You are going to build a "tripod" for the Feedhorn. Hold the "cone" above the center of the dish and hold one support next to it. Estimate the angle at which the support need to be cut. Cut it and test. If good, then copy it two more times to make the 3 legs.

Next glue one support about half way up the "cone". Allow to dry and glue the other two supports at equal distances around the "cone". Center the Feedhorn on the dish and glue supports to the dish. *See Photo 17.*

Step 10:
The Final Step! Placing the magnetometer on the Spacecraft.

You will probably want to use an 1/8 piece of balsa for this since the "stick" needs to be 14 inches long. You can make it longer to glue inside the Pioneer Main Body.

Locate a "red square" on the longest side of the Main Body It is nearly centered. Take a Hobby Knife and make a small hole there into which you can insert the balsa "stick" (keep it tight for support). This is the Magnetometer Boom. You may want to glue a tiny "bulb shape" at the end. This was a device designed to sense magnetic fields around the spacecraft. It has been important in determining just how far the influence of the Sun extends throughout the solar system and beyond In a real effort this instrument is defining what "interstellar" means. *See Photo 18.*

You are Done!

Touch Up Suggestions:
You may want to get some paint to make your model look a bit better. Flat Black for the insides of the open instrument packages on the sides of the Main Body and the mangeto- meter Boom, and Silver for the Antenna "Tripod". You may also consider using Christmas ribbon materials to wrap around things to simulate the gold and silver insulation used on the spacecraft as well. Later missions like Voyager were nearly all black. Can you figure out why?

If you have any questions or difficulties please contact us at bhillenbrand@mail.arc.nasa.gov Your inquires will be responded to promptly.

This NASA K-12 Internet Initiative Web page was last updated on January 27, 1997.

For questions about Pioneer 10 Project, contact: Dr. Larry Lasher
For questions about this Web server, contact: Karen Traicoff

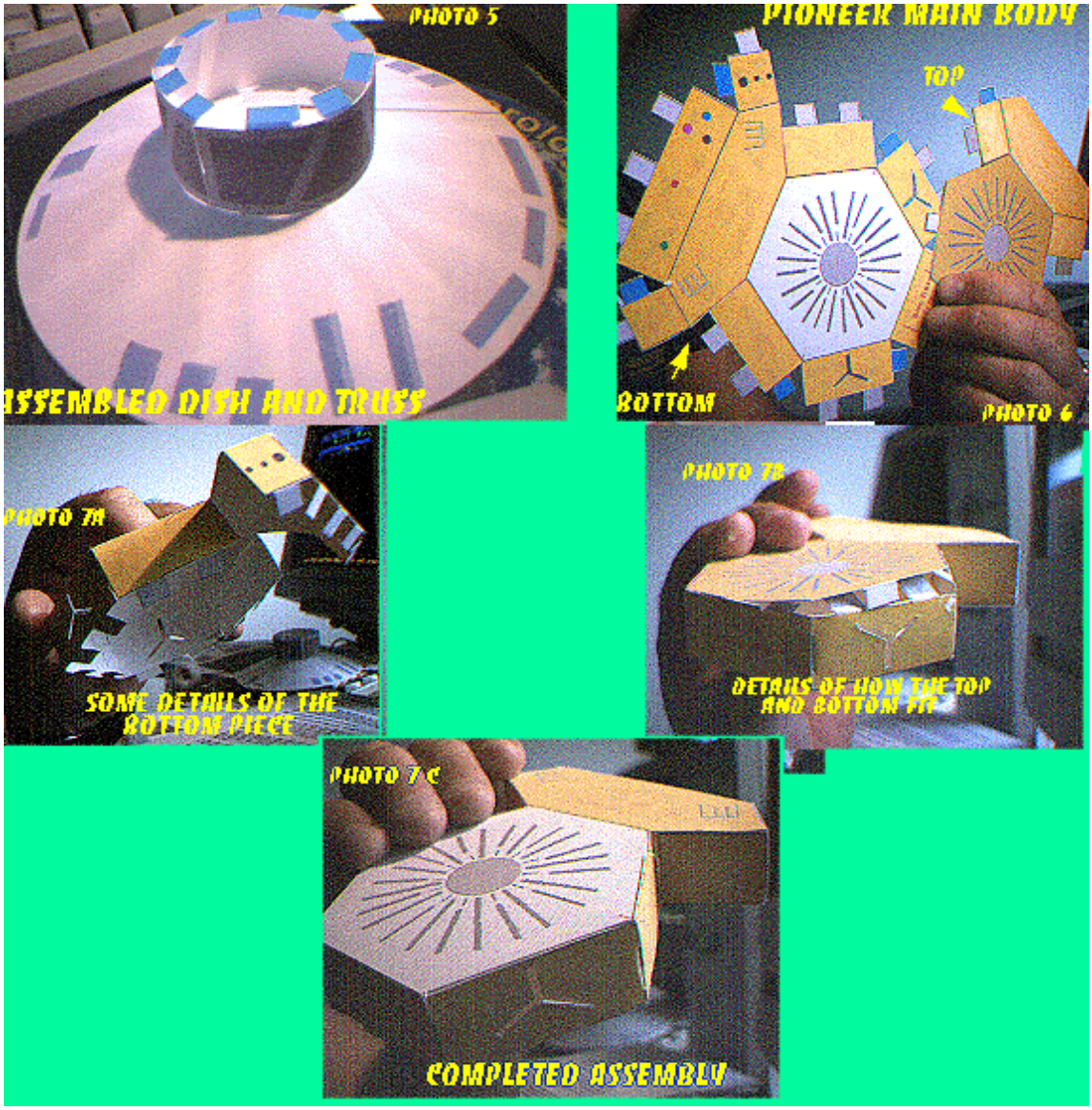
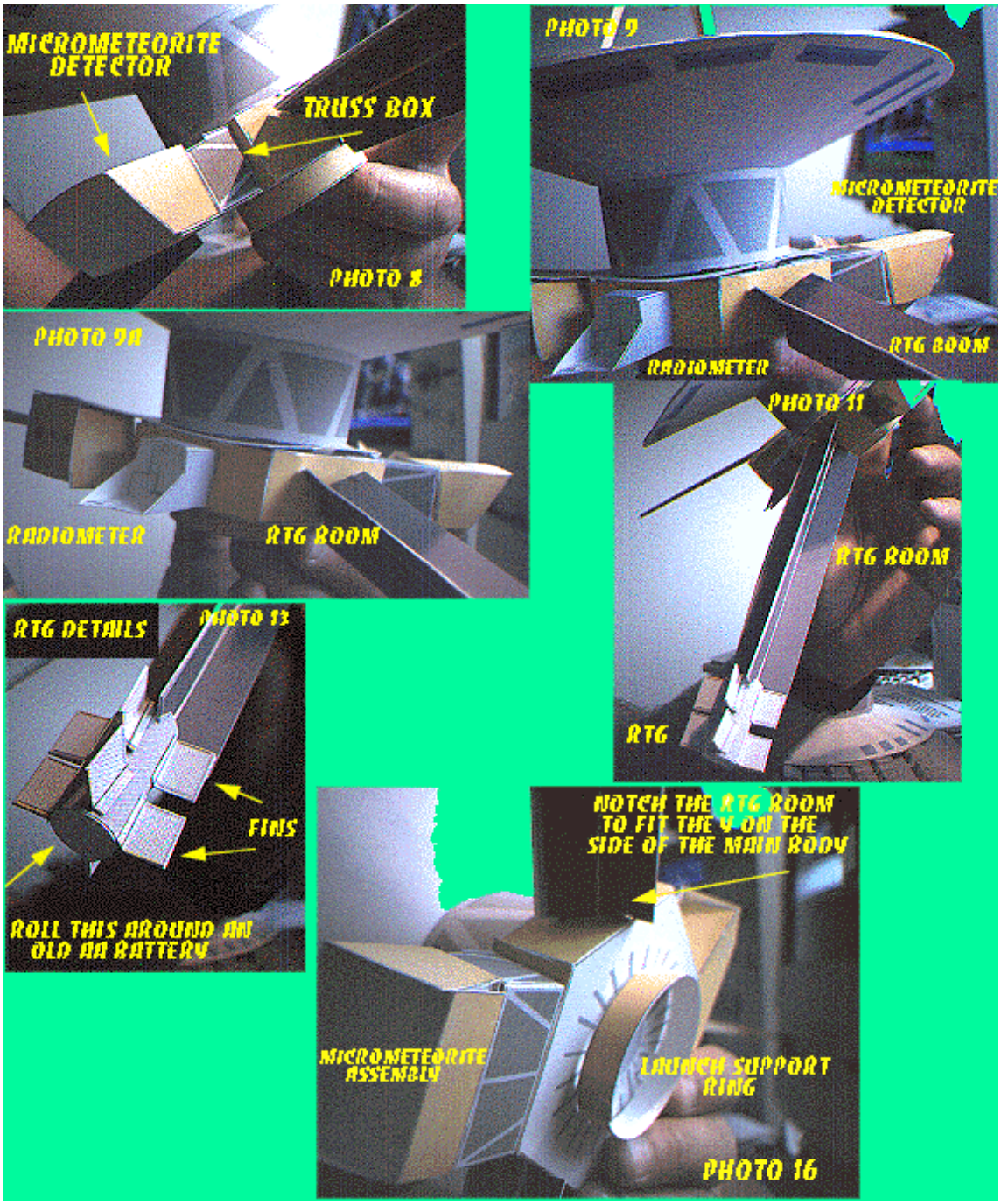
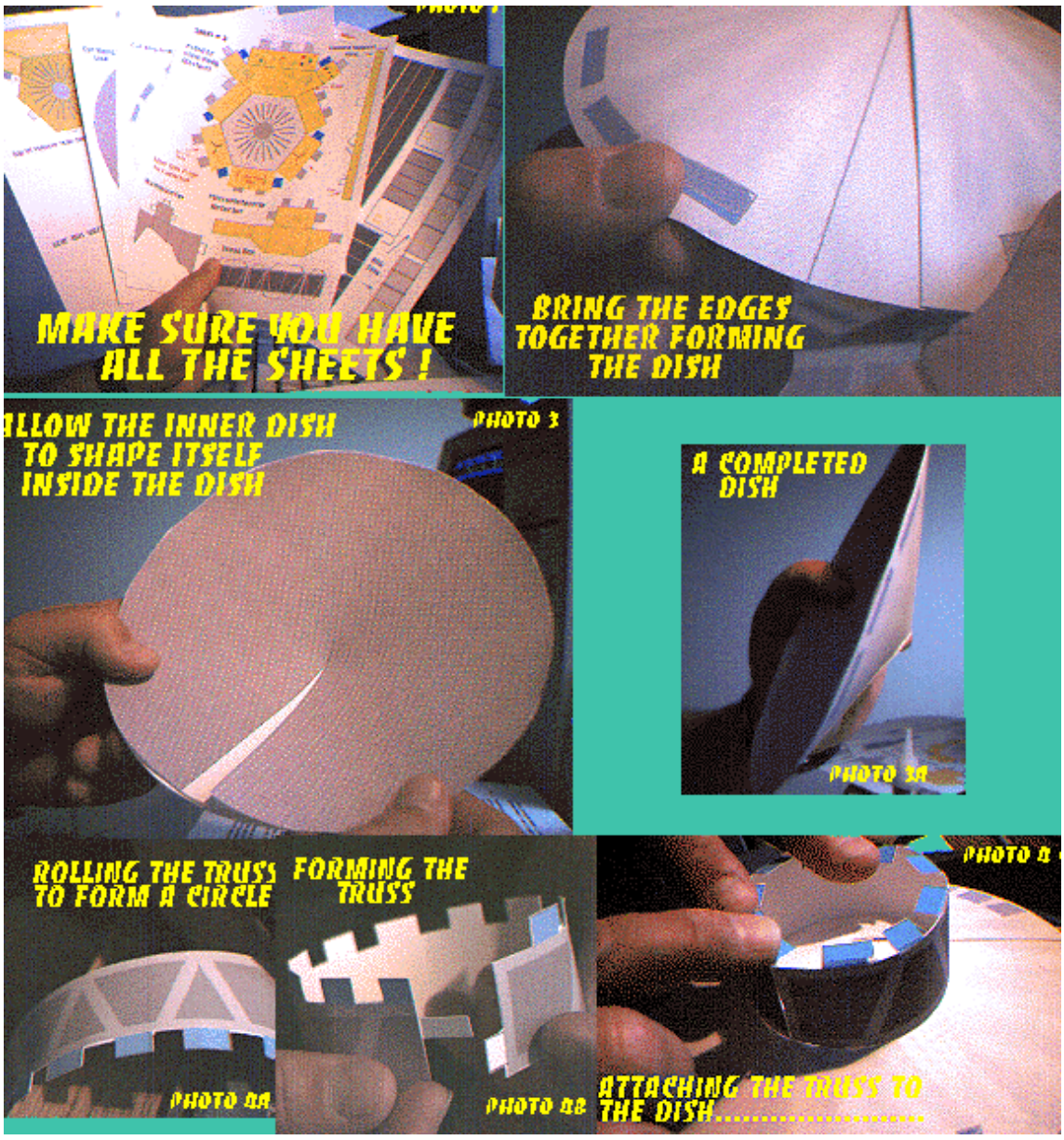


PHOTO 5
ASSEMBLED DISH AND TRUSS
PIONEER MAIN BODY
TOP
BOTTOM
PHOTO 6
PHOTO 7A
SOME DETAILS OF THE BOTTOM PIECE
PHOTO 7B
DETAILS OF HOW THE TOP AND BOTTOM FIT
PHOTO 7 C
COMPLETED ASSEMBLY

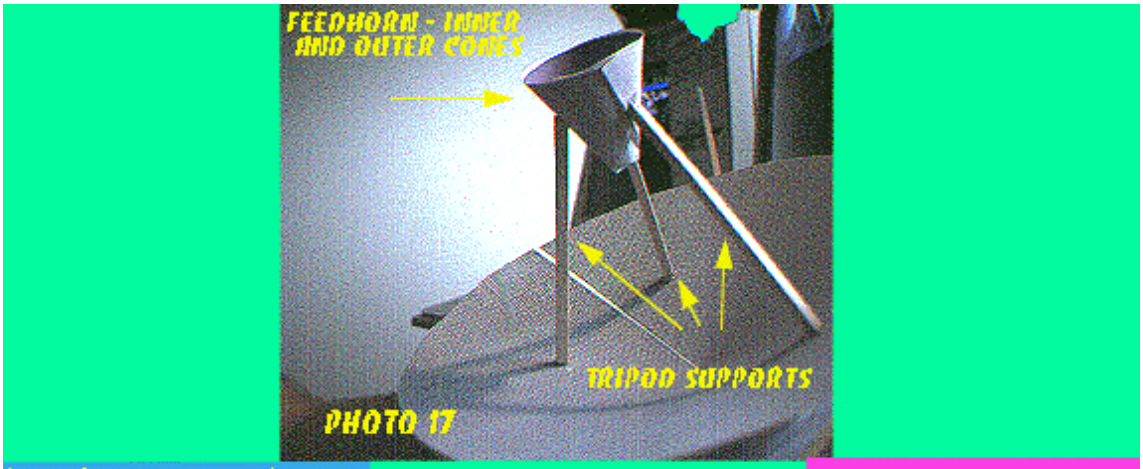
BACK

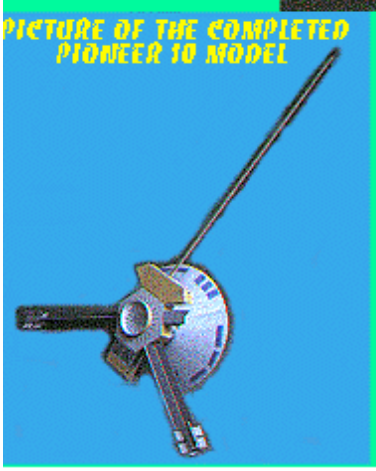

MICROMETEORITE DETECTOR
TRUSS BOX
PHOTO 8
PHOTO 9
MICROMETEORITE DETECTOR
RTG BOOM
RADIOMETER
PHOTO 9A
RADIOMETER
RTG BOOM
PHOTO 11
RTG BOOM
RTG
RTG DETAILS
PHOTO 13
FINS
ROLL THIS AROUND AN OLD AA BATTERY
NOTCH THE RTG BOOM TO FIT THE Y ON THE SIDE OF THE MAIN BODY
MICROMETEORITE ASSEMBLY
LAUNCH SUPPORT RING
PHOTO 16

BACK


MAKE SURE YOU HAVE ALL THE SHEETS !
BRING THE EDGES TOGETHER FORMING THE DISH
ALLOW THE INNER DISH TO SHAPE ITSELF INSIDE THE DISH
PHOTO 3
A COMPLETED DISH
PHOTO 3A
ROLLING THE TRUSS TO FORM A CIRCLE
PHOTO 3B
FORMING THE TRUSS
PHOTO 3C
ATTACHING THE TRUSS TO THE DISH.....

BACK


FEEDHORN - INNER
AND OUTER CONES
TRIPOD SUPPORTS
PHOTO 17


PICTURE OF THE COMPLETED
PIONEER 10 MODEL

BACK