

# Lunar Prospector Spacecraft

## 1/25 Scale Model

### Assembly Instructions

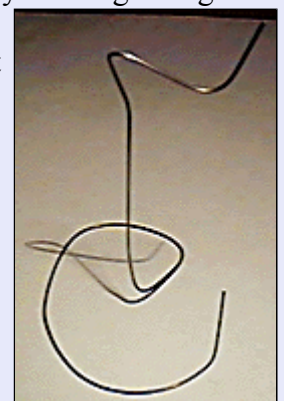
Version 1.2



This is a project which is probably not appropriate for people younger than about ten years of age, depending on skill and motivation. The image above shows a completed scale model. Click on it for more views of the model.

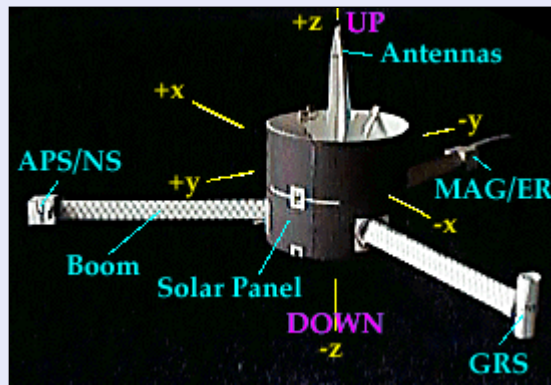
#### YOU'LL NEED THE FOLLOWING:

- White paper card stock (also called "cover" stock, about the thickness of a postcard) which your computer's printer can accept. If you have a sheet of glossy card stock, you might wish to use it for the SOLAR PANEL part on Sheet 1, to simulate the glossy appearance of the solar cells.
- Scissors, to cut most parts from the parts sheets.
- An art knife, such as X-Acto #11, with a sharp new blade, and a proper pad on which to cut. This will be needed to cut some parts from the parts sheets, and to make small detail cuts. **Adult supervision is required** for children using this and other sharp tools. **Caution:** one can injure oneself, and the furniture, with an art knife.
- Wooden toothpicks for applying glue.
- Glues. Use regular white glue (Elmer's Glue-All or equivalent). You might also try a thick white glue, sold in art and fabric stores, called "TACKY GLUE" (Aleen's or equivalent). A low-moisture glue, such as a glue-stick, will also be needed.
- A dark blue ink felt-tip pen for coloring solar cells on the SOLAR PANEL.
- Space. Set up a well lighted, comfortable work area, with room to set glued parts to dry.
- Time. Plan to set aside several hours for unhurried assembly. It may take four hours or more to assemble your Lunar Prospector Scale Model.
- Patience. There may be some trying times. If so, remember that extra time and care will pay off with a surprisingly accurate, and handsome representation of NASA's Lunar Prospector, a sophisticated spacecraft.
- Optional: A small piece of aluminum foil would add some realism to your model. A square of about 5 cm, or 2 inches, would be more than enough.
- Optional: For additional detailing, use a metallic-gold ink and a metallic-silver ink pen to add small touches of detail where suggested.
- Optional: Spherical propellant tanks are represented in your model by flat circles. Although they are difficult to see once assembly is complete, you might want to locate or fabricate some 3-dimensional objects to replace them in your model. A ball of crumpled aluminum foil would work well, especially since the spacecraft's tanks are covered with aluminized thermal blanketing that looks somewhat like aluminum foil.
- Optional: You may wish to fashion a stand for your model. A simple stand can be made by bending a length of wire. Brass wire from a hobby store, or steel wire such as coat hanger wire, will work. About half a meter, or 18 inches, in length is plenty. Such a stand may also be convenient to support parts during assembly. If you choose to work with wire, be cautious to prevent eye injury. This image shows a stand made of soft iron wire obtained from a craft store.
- Optional: You might find it helpful to use an electric hair drier to set the glue in some places. If you do, be very careful not to blow the pieces apart.



## BEFORE BEGINNING ASSEMBLY:

- Download and print the two [Parts Sheets](#). They need to print on white card stock. You might also wish to print these instructions, if it isn't convenient to refer to your computer during assembly.
- Examine all the parts on both sheets, and read their names.
- Read all of these instructions. Compare model parts with the illustrations.
- Have a look at some information about the Lunar Prospector Spacecraft.
- Get your bearings: Examine the image of the spacecraft below. For the purpose of these instructions, "Up" will be defined as toward the COMMUNICATIONS ANTENNAS shown in the image. "Down" will be defined as toward the other end of the spacecraft. This is the basis for references to "Top," "Bottom," "Above," "Below", etc. in the instructions "Inboard" is defined as toward the center of the spacecraft, and "Outboard" is defined as away from the center. The spacecraft's X, Y, and Z axes are also illustrated for information.



## IN GENERAL:

- Most folds will be made in the direction away from the printed side, leaving the printed side facing out. There are a few exceptions, which are clearly mentioned.
- Score for folding, where directed. Scoring will help make a neater model, with straight, clean folds. To score a part, place a straight edge along the line on the part as instructed, then lightly scratch along the line with an art knife, guided by the straight edge. Be careful not to cut through the paper, but just break the surface. After scoring, the fold will always be in the direction away from the scored side.



## TO ASSEMBLE YOUR MODEL:

Click on each step below for illustrated step-by-step instructions. Sections marked with a \* may be accomplished at the same time if two or more people are working on assembly, or if you wish to work on one section while glue dries on another.

Model design by Dave Doody  
Thanks to Lisa Chu Thielbar of the Lunar Prospector Mission for reviewing and polishing.  
Not produced at taxpayer expense.  
24 February, 1998

## 1. ASSEMBLE THE SOLAR PANEL.

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Lunar Prospector's SOLAR PANEL is a cylinder which surrounds the spacecraft. It supports several thousand thin rectangular silicon wafers, called photovoltaic cells (or solar cells) which convert sunlight to electricity. These individual cells are wired in series and parallel, to produce enough electricity to operate the spacecraft as it rotates. The SOLAR PANEL also shades sunlight from the spacecraft bus, to prevent overheating.

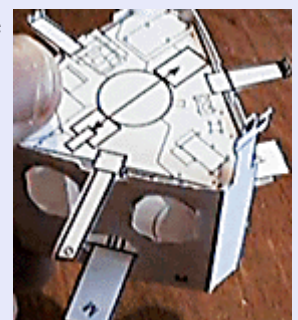
- Print [Parts Sheet 1](#) onto a sheet of white card stock. Optionally, print it again on a sheet of glossy card stock so the SOLAR PANEL part will appear glossy like the spacecraft's solar cells.
- Using a blue felt-tip pen, color the solar cells on the SOLAR PANEL. The cells are represented by thousands of tiny rectangles, each nearly the same size. Some unevenness in coloring is acceptable, since the individual cells vary somewhat in apparent color (due to reflections). Do not color the various other features on the SOLAR PANEL.
- Cut out the rectangular SOLAR PANEL. Cut out the three circles marked X.
- Option: Add gold metallic ink detailing by filling in the three squares which surround the cut-out circles, and in the two vertical rectangles near the middle of the part. Add silver metallic ink along each of the long, thin rectangles lengthwise along the center of the part.
- Apply low-moisture glue (such as a glue stick) to the white rectangle marked GLUE.
- Wrap the rectangular SOLAR PANEL around into a cylinder, and overlap the area marked GLUE with the opposite end, keeping the printed detail facing out. Adjust into an even cylindrical shape, and squeeze the seam until dry.
- Readjust the shape if necessary, to make the SOLAR PANEL an even cylinder.



## 2. ASSEMBLE THE SPACECRAFT BUS.

Lunar Prospector's SPACECRAFT BUS houses supporting subsystems, such as radio gear for communications with Earth, propulsion for adjusting the orbit, spin, and attitude, optical devices to provide attitude control knowledge, and mechanical support and deployment mechanisms for the science instrument booms.

- Cut out the SPACECRAFT BUS part from Sheet 1. Cut out the six ovals, and the three circles, marked X. Lightly score each of the six vertical lines within the part.
- Apply glue to the rectangle marked GLUE. Fold back, away from the printed side, on each of the six scored lines, and overlap the glue with the opposite end. Squeeze the seam until dry.
- Adjust the angles of each fold to be equal. The object protruding above, by the way, represents optical devices used for attitude control and navigation. Their fields of view are toward the +X direction.
- Print [Parts Sheet 2](#) onto white card stock. Cut out the BOOM AND TANK SUPPORT.
- Cut out the six PROPELLANT TANK HALVES. Slit each along the vertical line, and then fit pairs of circles together, slot into slot, at right angles. Fold tab Z over 90 degrees, so you can stand the tank upright. These parts represent spherical tanks which hold propellant. (Optionally, you might want to replace these with some spherical objects of the same size.)
- Apply glue to the end, near tab Z, of one PROPELLANT TANK, and stand it, centered in a circle on the BOOM AND TANK SUPPORT. Repeat with the remaining tanks. The markings in the part's center, by the way, represent the mechanism which reeled out three restraining tapes to deploy the booms, which spring out, uncoiling, from their canisters.
- Find a letter printed on each protruding rectangle. They indicate particular science instruments supported by booms: A for APS/NS, G for GRS, M for MAG/ER. Find the same letters printed on the SPACECRAFT BUS part.
- Work the BOOM AND TANK SUPPORT up inside the SPACECRAFT BUS, inserting each of the rectangles through its corresponding circular hole, from inside the SPACECRAFT BUS: rectangle A through hole A, etc. Tanks face up. Adjust so that the SUPPORT is level and even, and its rectangles rest as low as they can in each circular hole. Secure with glue where each rectangle protrudes from a hole. Add a little more glue inside where the parts touch. Wait for the glue to dry. The photo in this DRAFT version shows the tanks too short. They should be centered within the six ports on the spacecraft bus piece.
- Cut out the SPACECRAFT BUS TOP from Sheet 2. Fold the small tab Z up, away toward the printed side, about 80 degrees, on each of the two arms.
- Set the SPACECRAFT BUS TOP (shown in the image) into the upper end of the SPACECRAFT BUS, at right angles to it, rotated so that the arm marked o is above the rectangle marked M. Printing faces up. This piece fits just inside the SPACECRAFT BUS, supported by its protruding arms. Glue in place.
- Cut out the SPACECRAFT BUS BOTTOM from Sheet 2. Cut out the circle marked X. Fold the small tab Z back, away from the printed side, about 80 degrees, on each of the three arms.
- Turn the SPACECRAFT BUS upside down. Set the SPACECRAFT BUS BOTTOM (not illustrated) into the lower end of the SPACECRAFT BUS, at right angles to it, rotated so that the arm marked -X is parallel to the rectangle marked G. Printing faces down, toward the outside. This piece fits just inside the SPACECRAFT BUS, supported by its protruding arms. Glue in place.



### 3. ASSEMBLE THE SCIENCE INSTRUMENT BOOMS.

Lunar Prospector's science instruments are supported at the end of three booms. Each boom is made of thin fiberglass trusswork, which is tightly coiled up inside a cannister prior to launch, ready to spring out. The scale size of the cannister is the size of the rectangles, labelled A, G, and M, protruding from the spacecraft bus. Enroute to the Moon, the booms were deployed by reeling out a restraining tape, one for each boom, from the center of their support structure inside the bus.

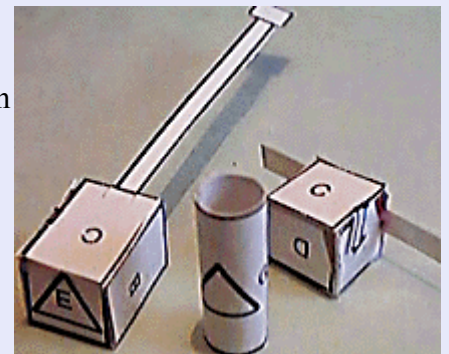
- Cut out one of the SCIENCE INSTRUMENT BOOMS from Sheet 1.
- Lightly score along each of the two lines running lengthwise along the piece. Score the two little triangular tabs so they'll fold over easily.
- Fold along each scored line, bringing two outer panels up to touch, creating a boom with a triangular cross-section. Crease the fold. Fold the two triangular tabs over onto the mating panel, and glue to hold the boom's shape. Apply more glue along the crease.
- Repeat with the two remaining SCIENCE INSTRUMENT SUPPORT BOOMS.



### 4. ASSEMBLE THE SCIENCE INSTRUMENTS.

Lunar Prospector's science experiments are the whole reason for flying the mission. The instruments perform sensing of the lunar surface and environment, and the radio communications link provides a means to measure gravity field via Doppler shift.

- From Sheet 1, cut out the single piece which represents the ALPHA PARTICLE SPECTROMETER AND NEUTRON SPECTROMETER (APS). Score the lines joining the six squares, and fold into a box. Printing faces out. The unmarked tab glues onto panel A to close the box. Let the appendages NS protrude. Secure with glue.
- Cut out the MAGNETOMETER/ELECTRON REFLECTOMETER (MAG/ER) from Sheet 1 and form a box as above. Let the long member, which supports the magnetometer, protrude straight out. You may wish to reinforce it against sagging.
- Cut out the GAMMA RAY SPECTROMETER (GRS). Roll it into a cylinder, and glue together at the end marked GLUE.
- Notice each SCIENCE INSTRUMENT piece has a triangle printed on it. This indicates how it will attach to the end of its SCIENCE INSTRUMENT BOOM.
- Option: Apply aluminum foil to the whole GRS.
- Option: Apply gold ink to the rectangular box portion of the MAG/ER
- Option: Apply gold ink to appendages NS of the APS.



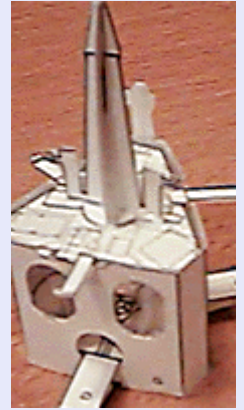
## 5. INSTALL THE COMMUNICATIONS ANTENNAS.

The top part of the COMMUNICATIONS ANTENNAS represents the low-gain antenna. The remainder of the structure is the medium-gain antenna.

- Cut out the COMMUNICATIONS ANTENNA HALVES from Sheet 2. Slit the central lines, and fit them together, slot into slot, at right angles.

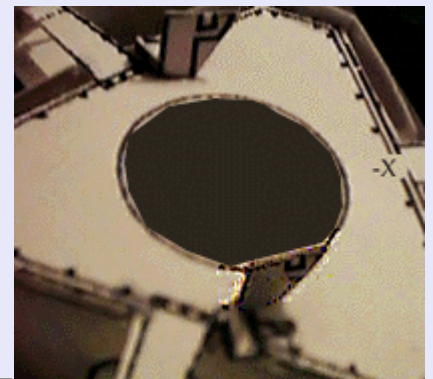
The two arm-like objects on one piece represent the thrusters mounted on the +Z side of the spacecraft. They are part of the propulsion subsystem, not the communications antennas.

- Apply glue to the base of the ANTENNAS assembly.
- On the top of the SPACECRAFT BUS, apply glue along the central black line which has arrows at its ends. Set the ANTENNAS assembly down onto the top of the SPACECRAFT BUS, rotated so the thrusters are in line with the arrows. Straighten it up, and add glue where needed.



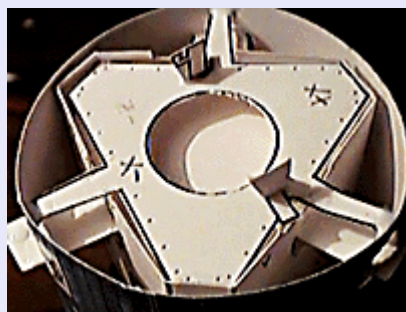
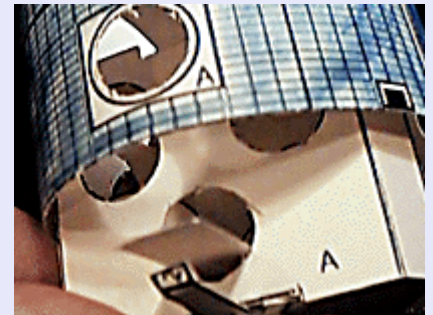
## 6. INSTALL THE MINUS-Z THRUSTERS.

- Cut out the last remaining parts, the -Z THRUSTERS from Sheet 2. Fold tab Z over 90 degrees to form a stand.
- Glue the thrusters, at the base where tab Z is, to the bottom of the SPACECRAFT BUS. There is a small rectangle printed where the thrusters attach. Rotate each one so its pipe-shaped appendage faces in the -X direction.



## 7. INSTALL THE SOLAR PANEL.

- On the SOLAR PANEL, find the circular opening marked A. On the SPACECRAFT BUS, find the rectangle labelled A. Insert the top of the SPACECRAFT BUS up through the bottom of the SOLAR PANEL and work rectangle A out through hole A. Work the two remaining rectangles out their respective holes.
- Glue the protruding rectangles A, G, and M. to the lowest point they will reach in the SOLAR PANEL's holes A, G, and M.
- Adjust the arms which end in tabs Z so that they go straight out from the SPACECRAFT BUS. There are three at the bottom, and two at the top. Ignore the arm marked o for now. Adjust all tabs Z so they contact the inside of the SOLAR PANEL, and glue them there.
- Pull the arm marked o up to the top edge of the SOLAR PANEL, bending it where it attaches to the SPACECRAFT BUS. Let it extend past, and rest against the top of the SOLAR PANEL. Glue it where it meets the SOLAR PANEL. This arm supported the magnetometer, hinged up to meet it, during launch, while its boom was stowed.
- Straighten up the assembly before the glue dries, adjusting so that the ANTENNAS rise perpendicular to the top of the SOLAR PANELS, and that the only contacts with the SOLAR PANELS are by rectangles A, G, and M, and by tabs Z and tab o. Let the glue dry before proceeding.



## 8. INSTALL THE SCIENCE INSTRUMENT BOOMS.

- Insert the blank end of one SCIENCE INSTRUMENT BOOM through hole A the SOLAR PANEL. Push it in until it enters hole A in the SPACECRAFT BUS. Apply glue at all points of contact, and arrange so that the boom sticks straight out (perpendicular to the tangent of the solar panels). Let it rest until the glue dries thoroughly.
- Repeat the above step with the two remaining SCIENCE INSTRUMENT BOOMS. Make sure they are straight as the glue dries.



## 9. INSTALL THE SCIENCE INSTRUMENTS.

- Apply glue to the outboard end of the SCIENCE INSTRUMENT BOOM installed at hole G. Apply glue to the triangle printed on the GRS. Attach the GRS to the end of the boom, rotated so the GRS cylinder is vertical. Let the glue dry.
- Apply glue to the outboard end of the SCIENCE INSTRUMENT BOOM installed at hole M. Apply glue to the triangle printed on the MAG/ER. Attach the MAG/ER to the end of the boom, rotated so panel C faces up. Let the glue dry. Straighten the member that points straight out from the MAG/ER's rectangular box.
- Apply glue to the outboard end of the SCIENCE INSTRUMENT BOOM installed at hole A. Apply glue to the triangle printed on the APS. Attach the APS to the end of the boom, rotated so panel C faces up. Let the glue dry.

## Assembled Lunar Prospector Spacecraft - 1/25 Scale Model

