



# Juno Spacecraft Paper Model



*Juno is a sophisticated spacecraft designed to investigate Jupiter's elemental composition, gravity field, magnetic field, and more. You can build your own Juno scale model.*

Spacecraft by nature are made of lightweight materials, so a paper model can be highly realistic if it copies key structural and visual design features. Once you assemble your model, you'll know the Juno spacecraft very well indeed!

First, browse the [Assembly Instructions](#). Then, if you decide to tackle the project, you can download the three Parts Sheets (Parts Sheet A has two sides) to print, cut out, and glue together, going through the instructions step by step.

You'll need a color printer, some thick white paper (card stock), and a few other items, which are listed in the assembly instructions.

This detailed scale model is a construction project that is probably not appropriate for people younger than about ten years of age, depending largely on motivation and skill. Assembly requires several hours and great care.

Before starting you might wish to explore the [Juno mission website](#) and [NASA's Juno web pages](#), and browse detailed [images of the spacecraft](#) taken during preparations for launch. Learn about how missions like Juno operate, with JPL's tutorial, [Basics of Space Flight](#).

This model was designed in 2011 by John Jogerst and kindly made available to the Juno Project. The model was adapted for NASA distribution by David Doody at the Jet Propulsion Laboratory.

# Assembly Instructions



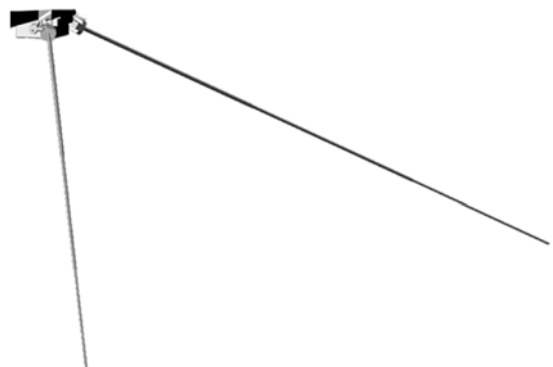
This is a great project for anyone who wants to learn about the Juno spacecraft and its mission to Jupiter. You'll have a handsome and accurate, one-50th scale model of the spacecraft to show for your effort. It is probably not an appropriate project for young children, although that largely depends on skill and motivation.

An interplanetary spacecraft is an enormously complex and capable robot, having a large variety of components and instruments of every size. The one-to-50 scale keeps the spacecraft's main visual cues intact. Juno's many instruments and engineering components appear on this model as two-dimensional images. If you would like to add three-dimensional detail to your model, see [Optional Finishing Touches](#) at the end of these assembly instructions.

## You'll need the following:

- White paper card stock (also called "cover" stock, about the thickness of an index card) that your computer's printer can accept
- A soda straw, which will be cut and installed to become the mounting point for your model
- 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.

- Needle-nose pliers, for squeezing parts together to glue
- A metal ruler, as a guide for cutting straight edges
- Wooden toothpicks for specific structural pieces, and for applying glue
- A bamboo skewer, or other small-diameter cylindrical stick, to help you roll some components into their shape for gluing
- A small cylinder about 2.25 inches (or 6 cm) in diameter, such as a wine glass, to support your model during construction
- Glue. 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" (Aleene's or equivalent).
- Space. Set up a well lit, 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 Juno 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 Juno, a sophisticated spacecraft.
- Optional: Waves antenna. Instructions for adding the Waves instrument's V-shaped antenna have not been included in this version. If your use of the model would NOT POSE ANY EYE SAFETY HAZARD, you can easily add the wires to your model.



- Optional: Model stand. You may wish to fashion a stand for your model. A simple stand can be made by bending a length of wire. If you choose to work with wire, be cautious to prevent eye injury. The image below shows a stand made of thick aluminum wire from a welding store inserted into a square wooden base.



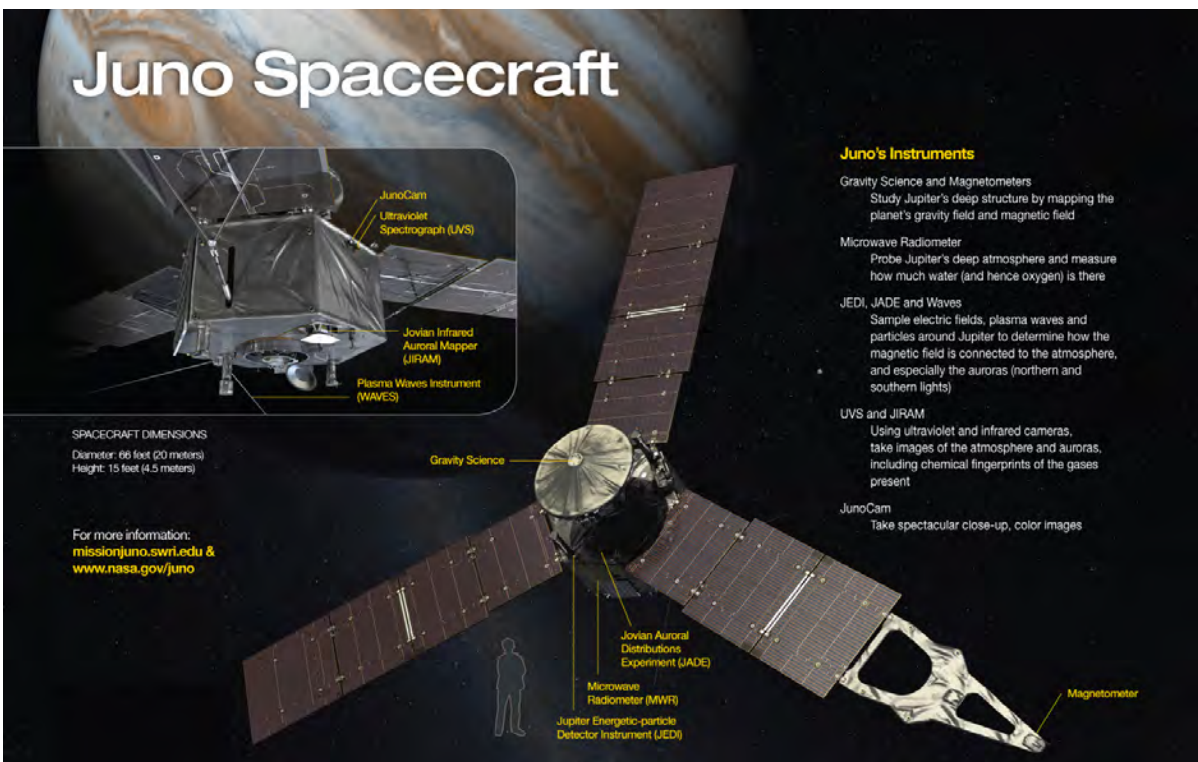
### Before beginning assembly:

- Print the three parts sheets. Parts sheets A and B should be printed on white card stock.
  - Examine all the parts on the parts sheets, and read their names.
- [\\*Assemble the solar arrays](#)
  - [\\*Assemble the spacecraft bus](#)
  - [Attach the solar arrays to the spacecraft bus](#)
  - [\\*Assemble the communications antennas](#)
  - [Install the communications antennas](#)
  - [Add optional finishing touches](#)

- Read all assembly instructions. Compare model parts with the illustrations.
- Have a look at some information about the Juno Spacecraft, and get a feel for how it looks. You can interact with a 3D Juno spacecraft model in your web browser by visiting [NASA's Eyes on the Solar System](#).

### To assemble your model:

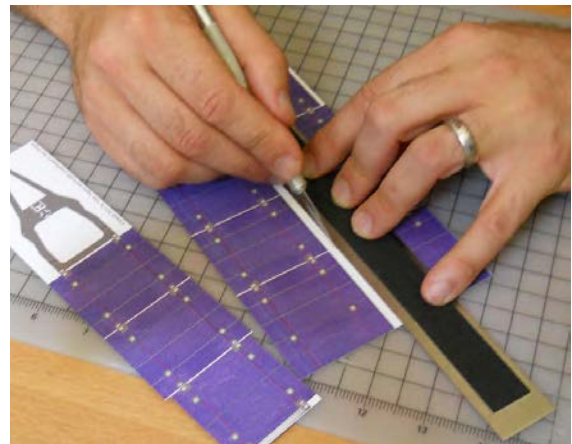
See each section below for illustrated step-by-step instructions. Sections marked with an asterisk (\*) may be accomplished at the same time if two or more people are working on assembly, or if you wish to work on one section while glue dries on another.



# 1. Assemble the Solar Arrays

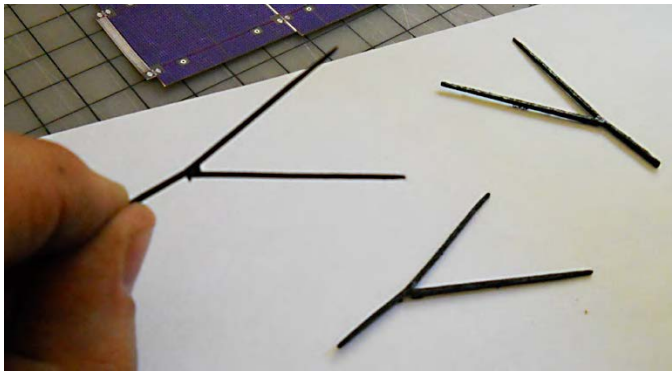


Juno has three giant solar arrays (also called photovoltaic arrays, or “PVAs”) that produce electrical power all the way out at Jupiter’s great distance from the sun. Juno is the first solar powered spacecraft to visit Jupiter, thanks to recent advances in solar cell technology. Each array is 30 feet (or 9 meters) long, but despite their size, the arrays only produce about 450 watts of electricity at far away Jupiter. That’s enough power for five average light bulbs. Juno is able to charge its batteries for most of its 11-day-long orbit and uses peak power for just a few hours when it gets close to Jupiter and focuses its instruments on the planet.



## Instructions:

- Print Parts Sheet A on card stock. If your printer can print on both sides of the paper, do so with Parts Sheet A; the front and back images will line up back-to-back. Otherwise, cut out front and back sides separately, and glue them together.
- Lay the printed Parts Sheet A on a cutting surface, and use an art knife and metal ruler to cut out the three pieces.
- Carefully cut out the two white areas inside the Magnetometer Boom structure.



- Locate the red “Y”-shaped lines on Parts Sheet A, labeled “Toothpick brace pattern.” Take a toothpick, cut halfway into it with an art knife, break it partially, and line it up with the upper left line in the “Y”; cut it to length to match the red line.
- Cut another toothpick to the length of the lower red line. Line it up to the pattern, and glue one end to the “knee” in the first toothpick.
- Let the glue dry thoroughly, make two more of these toothpick brace structures (three in all), and paint them black. These pieces will represent the struts that hold the solar arrays in their deployed position on the spacecraft. Set them aside for now.

## 2. Assemble the Spacecraft Bus



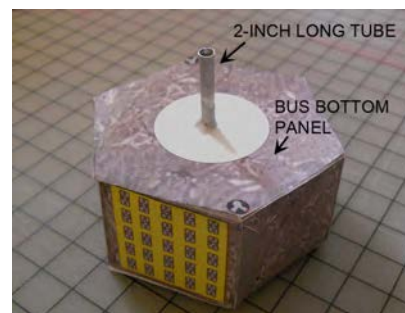
The “bus” is the main structure onto which all of a spacecraft’s components are attached. Think of it as the base or core of the spacecraft. Juno’s bus is a six-sided, or hexagonal, shape. Inside the bus are the spacecraft’s propellant tanks. The dimensions of each hexagonal side were intended to accommodate the largest of Juno’s six microwave antennas (the MWR instrument).

### Instructions:

- Print Parts Sheet B on card stock.
- Lay the printed Parts Sheet B on a cutting surface, and use an art knife and metal ruler to cut out the Spacecraft Bus. Note the fold lines indicated by

the red arrows. With art knife and ruler, lightly score each fold line.

- Fold the Spacecraft Bus into a ring and glue. Make a sharp crease in each fold line, folding down away from the printed side, toward the inside.



- Cut out the Bus Top Panel and glue it onto the top edge of the Spacecraft Bus. You'll see how the tab on the Bus Top Panel aligns with the Spacecraft Bus side.
- Cut out the Bus Bottom Panel and make a hole in the center, marked by the white dot.
- Obtain a narrow tube, such as a soda straw, whose diameter will fit onto your model stand (see suggested model stand on page 4). Cut the tube to a length of about 2 inches (or 5 cm). Apply glue to one end and set it inside the Spacecraft Bus, centered touching the inside of the Bus Top Panel.
- Work the tube up through the hole in the center of the Bus Bottom Panel, and glue the Bus Bottom Panel to the Spacecraft Bus tabs. Align the tube perpendicular and glue it in place where it comes out through the Bus Bottom Panel.
- Cut out the Launch Vehicle Payload Adapter, glue it into a circle, and glue it to the Bus Bottom Panel surrounding the grey circle.
- Cut out the two, smaller, Reaction Control System Thrusters for Bottom of Bus. Roll them into thin cyl-



inders with their circular caps, and glue to hold their shape. Glue them standing up from the two corners of the Bus Bottom Panel as indicated by the printed icons.

- Cut out the Vault from Parts Sheer B, score for folding using art knife and ruler, and glue it into its box shape. Set the Vault aside for now.

The real Juno vault is a box made of half-inch-thick titanium that shields the spacecraft's most critical and sensitive electronics from radiation in the space around Jupiter. The radiation makes Jupiter a pretty extreme place to send a spacecraft, and Juno is outfitted with this special armor to survive the voyage.



### 3. Attach the Solar Arrays to the Spacecraft Bus



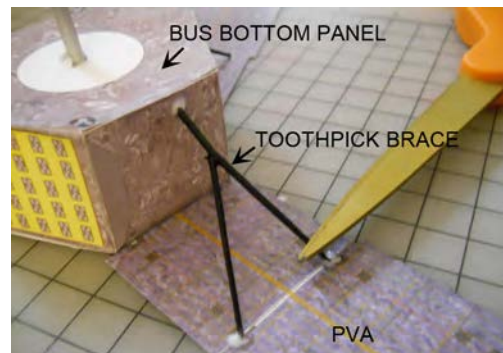
The solar arrays are attached to the real Juno spacecraft by hinges. The arrays were folded up, accordion-style, for launch and then deployed once Juno separated from its launch vehicle.

#### Instructions:

- Lay the three solar array panels blue side down on your work surface, and place the Spacecraft Bus down on top of them, so that the inboard edges lie just underneath the Bus Top Panel edges marked “PVA”. The PVA with the Magnetometer Boom should meet the Bus Top Panel edge marked “PVA-MAGBOOM”.
- Apply glue to the Bus Top Panel and join the PVAs in place. Align so they are symmetrical, and let the glue dry.
- Apply beads of glue to hold the toothpick brace in position. It’s convenient to position a pair of scissors

to gently hold the brace in position while the glue dries.

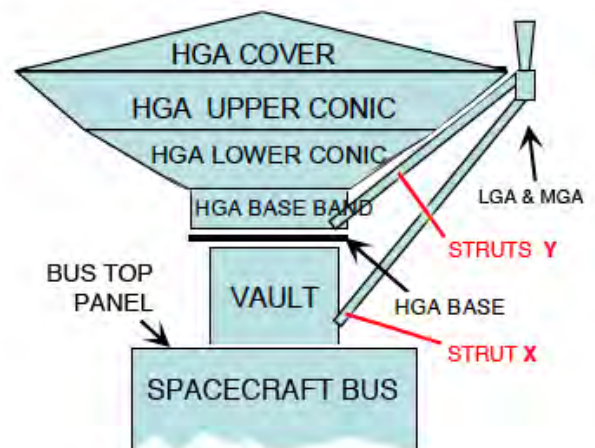
- Repeat with the other two braces, and allow the glue to dry thoroughly before proceeding.
- After the glue is thoroughly dry, bend a slight length-wise curvature into each of the solar array panels, to prevent them from sagging. The amount of curvature should hardly be noticeable.



## 4. Assemble the Communications Antennas

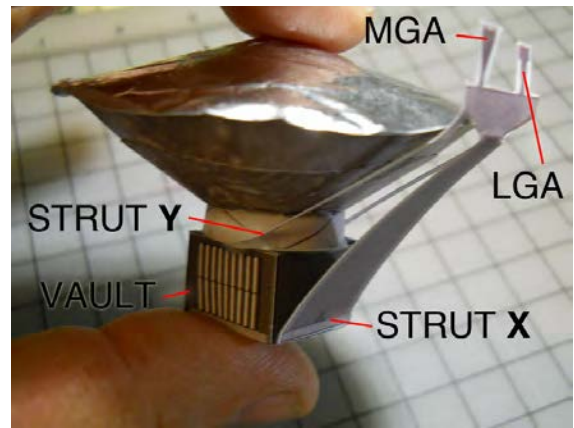


Juno communicates with Earth via a radio link. It is equipped with a sophisticated two-way radio and an assortment of antennas that allow the spacecraft to communicate via NASA's [Deep Space Network](#). Juno's saucer-shaped main antenna is like a laser pointer — it has a narrow beam that is extremely efficient, focusing the energy needed for communication. Juno's other antennas — the Low-Gain Antenna (LGA) and Medium-Gain Antenna (MGA) — have broader beams, enabling Juno to stay in communication with Earth even when the main antenna can't be pointed at Earth.



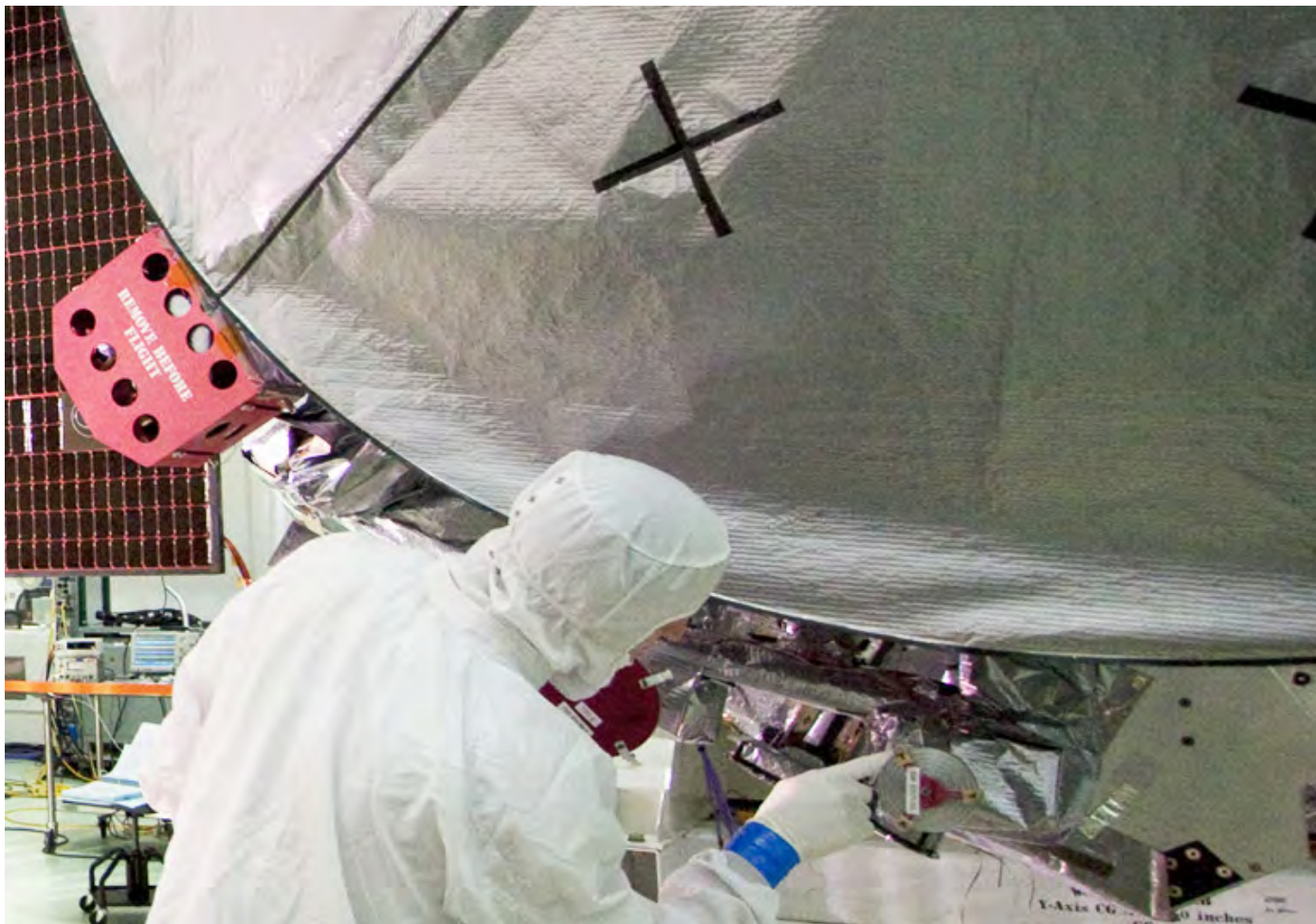
## Instructions:

- Print Parts Sheet C on regular copy paper. Notice the blue arrows indicating that the HGA Upper Conic will set atop the HGA Lower Conic, and these will go atop the rolled HGA Base Band and atop the HGA Base. The HGA Cover will top off the stack.
- Note: an optional “finishing touch” suggestion is to apply aluminum foil to the HGA Cover, for visual effect. You could clad the entire HGA assembly in foil, for that matter, although it would be a difficult task. If you choose to add foil, be sure to copy the “X” marks onto the foil with black ink (a fine-point permanent marker works well).
- Lay the printed Parts Sheet C on a cutting surface, and use an art knife to cut out the HGA Upper Conic and the HGA Lower Conic. Score the tabs for folding.
- Glue each HGA Conic into a cone.
- Glue the HGA Base Band into a ring, and fold the tabs inward.
- Cut out the circular HGA Base.
- Glue these parts together according to this guide (but don’t set them onto the Vault until the glue is good and dry).



- Once the glue is thoroughly dry, glue the HGA Base to the top of the Vault.
- Once the Vault glue is dry, cut out the MGA-LGA Assembly from Parts Sheet B.
- Glue the tab near the “X” marked on the struts to the base of the Vault. Glue struts “Y” up higher by the HGA Band, so that the MGA and LGA are positioned as shown.

## 5. Install the Communications Antennas and the Remaining Reaction Control System Thrusters

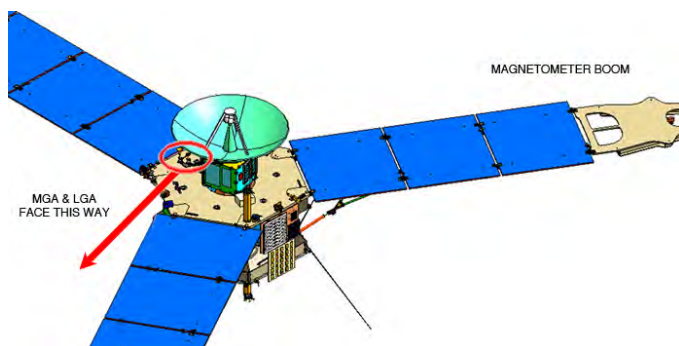


- Set your model atop a wine glass or other cylindrical object with the Bus Top Panel facing up.
- Orient the Vault atop the Bus Top Panel so that the MGA and LGA are facing as shown:
- Glue the two remaining Reaction Control System thruster masts on the Bus Top Panel in the corners marked with the icons.

### ***Your model is now complete!***

Once the glue dries, you may install your model on a display stand, or glue a thread to the model for suspending it. Now that you're familiar with the spacecraft, be sure to browse the Juno websites — [missionjuno.swri.edu](http://missionjuno.swri.edu) and [www.nasa.gov/juno](http://www.nasa.gov/juno) — to learn about Juno's exciting mission to Jupiter.

If you like, check out the next step to see some optional suggestions for adding finishing touches.



## 6. Add Optional Finishing Touches

Here's a placard to print and apply to your model's stand:



- If you would like to add more three-dimensional detail, including science instruments and engineering components, refer to the original [Juno 1:24 scale model by John Jogerst](#), available on the Web.
- For a striking bit of metallic sheen, add some wrinkled aluminum foil to the HGA Cover. Be sure to ink in the eight “X” markings on top of the foil.
- Instructions regarding wires to represent the Plasma Waves Instrument have not been included in this version. If your use of the model would NOT POSE ANY EYE HAZARD, you can easily add the wires to your model. The Waves antenna was deployed on the spacecraft after launch.
- Many close-up views of the actual Juno spacecraft being assembled and tested are available from the NASA Kennedy Space Center [photo archive](#). Based on what you find, you might want to touch up your basic model with metallic pens and additional 3-dimensional detail. Note that in general, items such as aperture covers and nozzle protectors are colored a bright red, and were removed before flight.



Now that you're familiar with all of the spacecraft's major structures, be sure to browse the [Juno mission website](#) and [NASA mission pages](#). There you'll learn more about the spacecraft, its mission and its anticipated discoveries.

**Congratulations! You've finished your Juno spacecraft model.**

# Juno 1:50 scale model Parts Sheet A

Download from [www.jpl.nasa.gov/scalemodels](http://www.jpl.nasa.gov/scalemodels)

Front Side

**PRINT ON CARD STOCK**

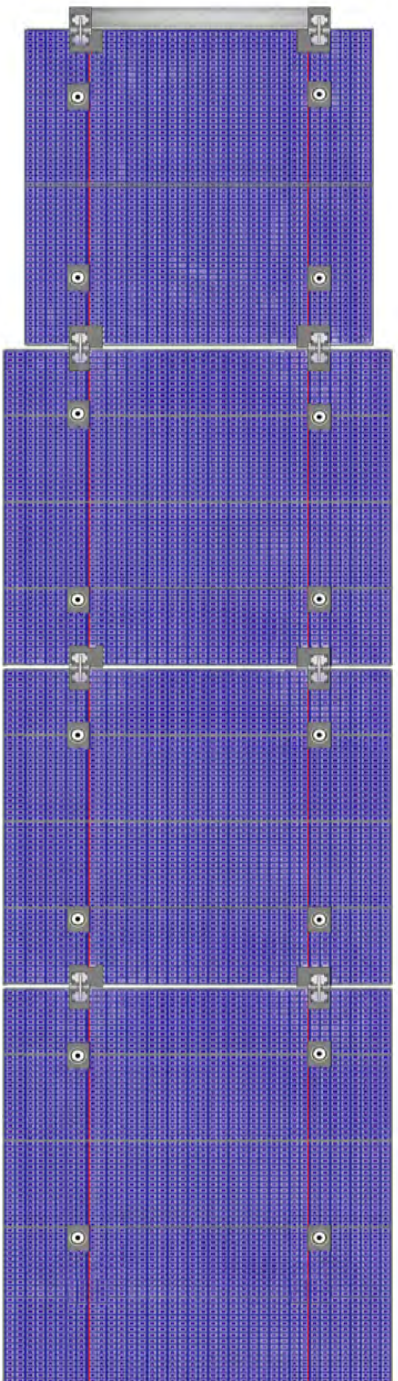


PHOTO-VOLTAIC ARRAY (PVA)

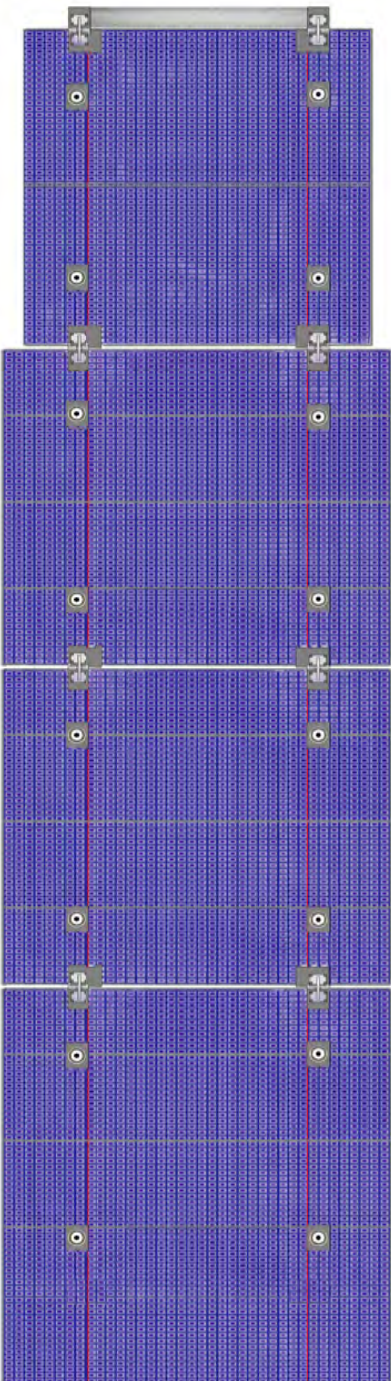
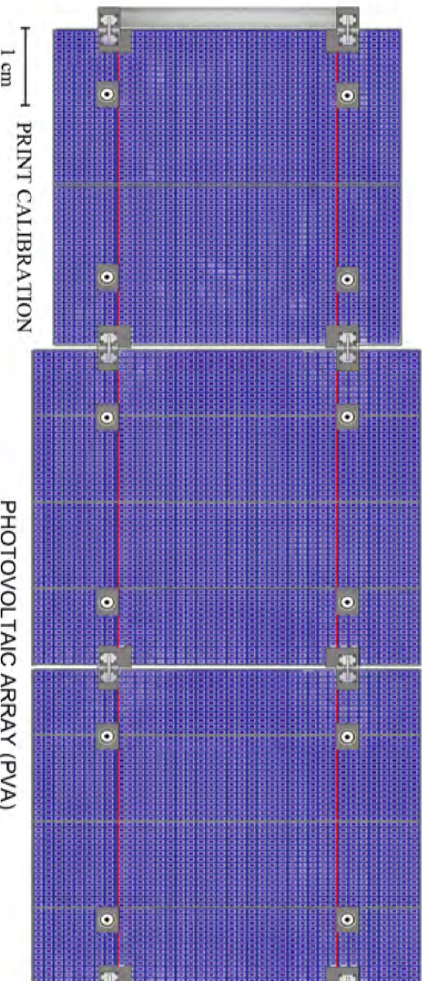
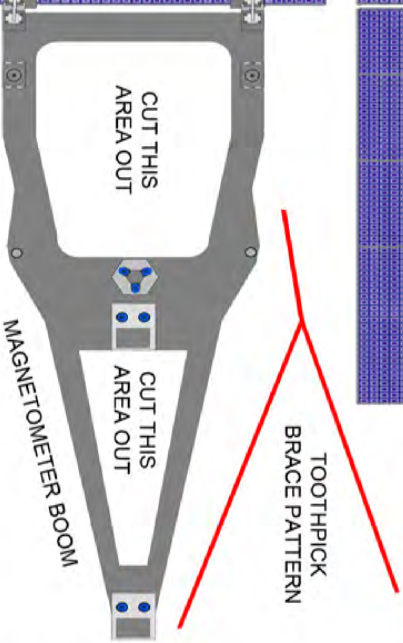


PHOTO-VOLTAIC ARRAY (PVA)



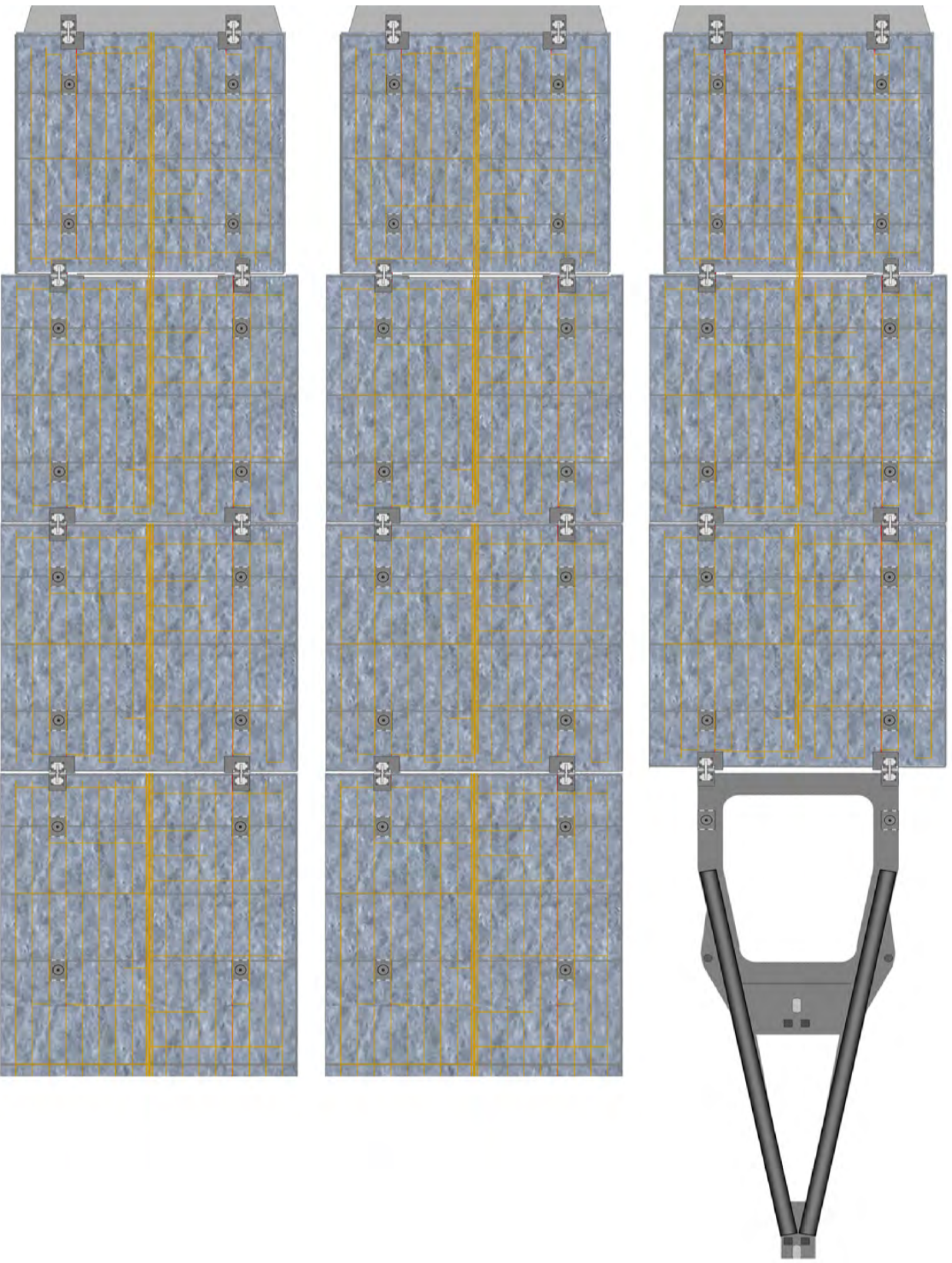
PHOTOVOLTAIC ARRAY (PVA)



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**Juno 1:50 scale model Parts Sheet A** Back Side

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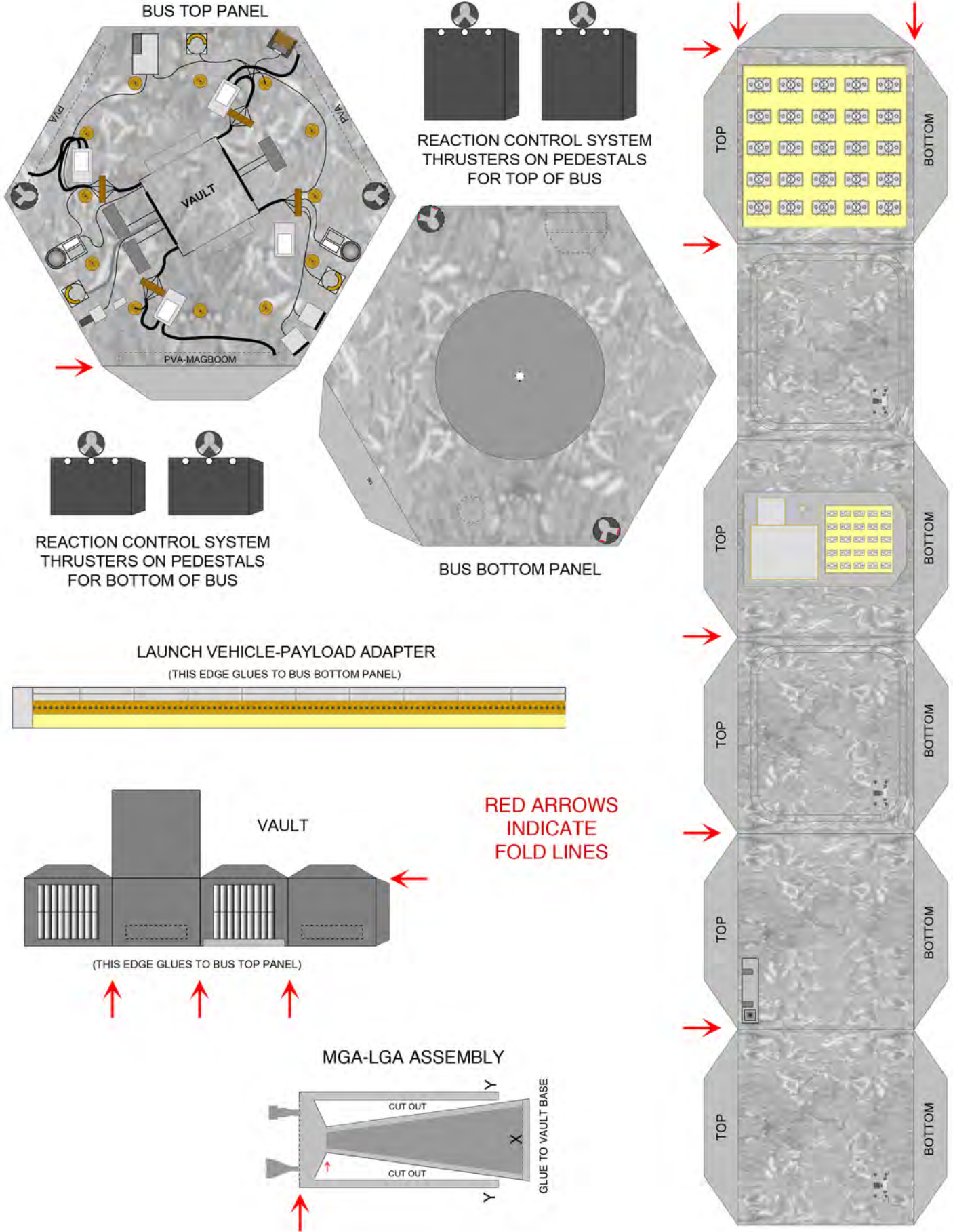


# Juno 1:50 scale model Parts Sheet B

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# Juno 1:50 scale model Parts Sheet C

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