



Worlds of the Solar System

Make a scale model of the sizes of planets in the Solar System

About the Activity

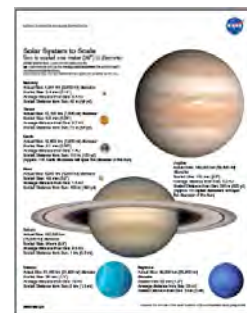
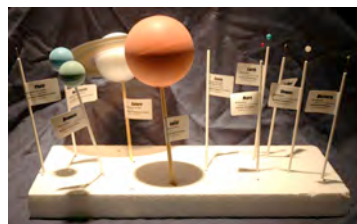
Use a set of scaled balls and beads to show the relative sizes of the planets, the Moon, Ceres, and Pluto to each other and to the Sun. This permanent model can be used over and over again in many ways. Handout included.

Materials Needed

(See *Helpful Hints* for more information on where to find materials)

- Solar System Scale Handouts for your visitors
- Balls of various sizes (we recommend having a few of each of the small beads and pins on hand):
 - 1 – 4" dylite ball for Jupiter
 - 1 – 3.25" dylite ball (can be cut in half or bought as halves) for Saturn
 - 2 – 1-3/8" dylite balls for Uranus and Neptune
 - 1 – 2.4mm beads for Moon
 - 1 – 9mm bead – Earth
 - 1 – 8.5mm bead – Venus
 - 1 – 3.5mm tip pin (standard "quilting pins")– Mercury
 - 1 – 5mm bead– Mars
 - 1 – 2mm Ball Head Pin– Pluto
 - Several 0.8mm balls for Ceres and asteroids
- Several skewer sticks
- Several lengths of thin wire
- Several standard flat-head pins
- Superglue
- White glue
- Clear tape
- Print Saturn Rings on a transparency
- Print labels for Planet Size and Distance
- Plastic yellow tablecloth, at least 1 meter wide for the Sun
- (Optional) Solar Viewer
- (Optional) Make a Pocket Solar System:

<http://nightsky.jpl.nasa.gov/download-search.cfm>



Topics Covered

- Scaled sizes of the worlds of the Solar System
- The realms of the Solar System

Participants

This activity is appropriate for families, the general public, and school groups ages 7 and up. Any number of visitors may participate.

Location and Timing

This activity can be before a star party, in a classroom, or in a general presentation. It takes 5–15 minutes, depending on the discussion.

| Included in This Packet | Page |
|---------------------------------|------|
| Directions for Assembly | 2 |
| Detailed Activity Description | 6 |
| Helpful Hints | 12 |
| Background Information | 13 |
| Saturn Rings | 14 |
| Planet Size and Distance labels | 15 |
| Solar System Handout | 16 |



Directions for Assembly

Gas giants:

(Optional) You can sand the Dylite balls smooth to get rid of ridges and surface features.

Jupiter:

Use the 4" Dylite ball.

Uranus and Neptune: 1-3/8" Dylite balls

Saturn:

Use the 2 half balls and the 8" rings printed on the square sheet of vinyl. Cut around the outside of the rings. Glue each half of Saturn on either side of the rings, in the middle. White glue works best for this. Allow drying.

Insert one of the chopsticks.



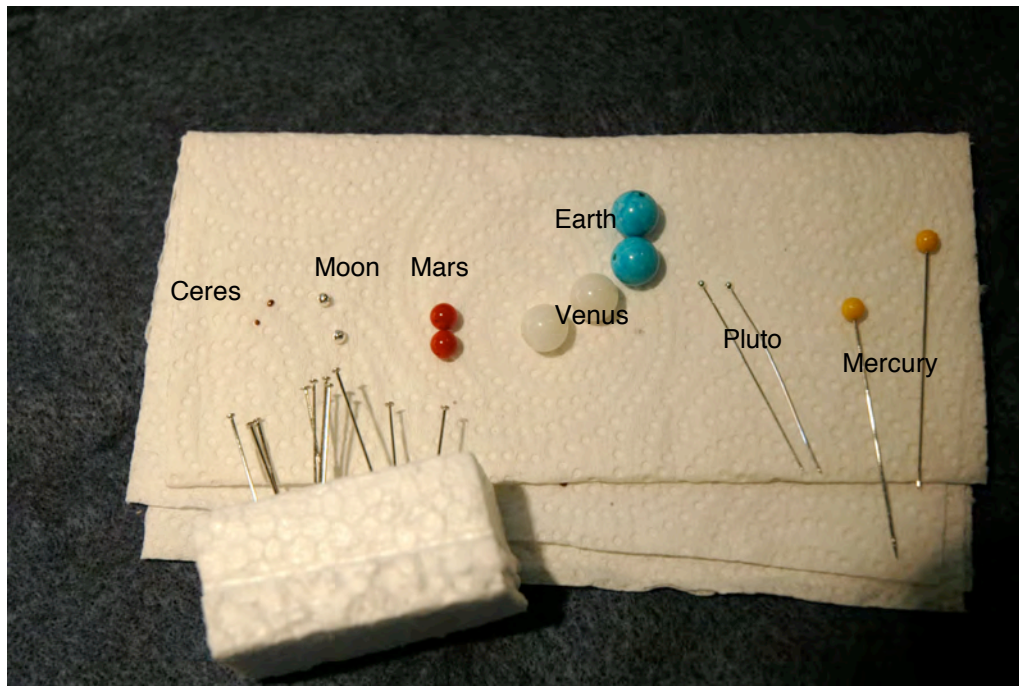
If you want to get creative, you can purchase acrylic paints from a craft store and paint the balls. Here is an example:



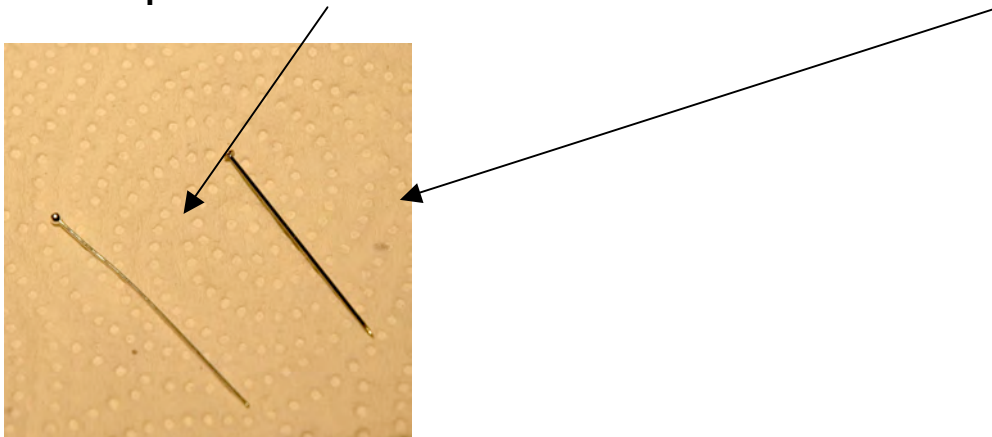
Smaller Worlds:

The small beads will be used to make the inner rocky planets, Earth's Moon, asteroids, and Pluto:

| | |
|---|--------------------------|
| Mercury: 3.5mm bead | Venus: 8.5mm bead |
| Pluto: Silver-top pin, 2mm | Earth: 9mm bead |
| Earth's Moon: 2.4mm bead | Mars: 5mm bead |
| Ceres (largest asteroid): Smallest Bead, 0.8mm | |



Pluto (silver-topped pin) and Mercury (yellow-topped pin) are pre-made. **Don't mix up Pluto (round-headed silver pin) with the flat-headed pins.**

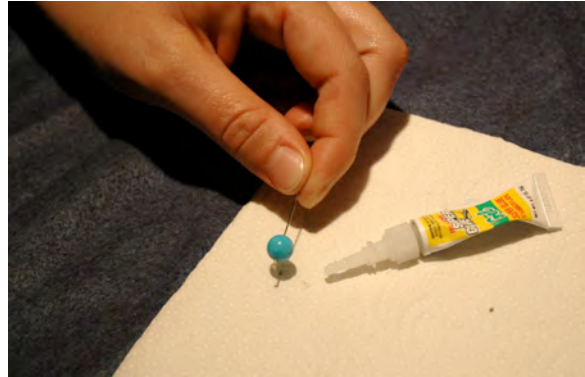


You can line up the rest of the beads in size order on a paper towel.

The smallest is Ceres, then Earth's Moon, Mars, Venus, and Earth.

Use the Super Glue and the flat-headed pins for assembling these. You might want to use the sandpaper to rough up the pins before gluing the beads on them for improved adhesion. Be sure to wipe off any residue before gluing.

Ceres is too small to have a hole. Just glue it on top of one of the pins. (left)

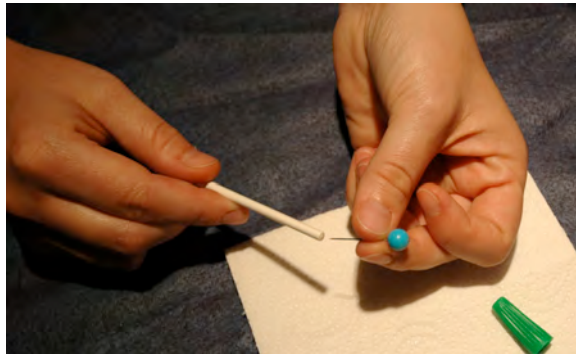


For the rest, insert the pins into the holes in the beads and glue the beads to the pins. (right)

Tweezers can be useful.

Attach Sticks:

For each of the smaller worlds, place a little glue on the pointed end of the pin and insert about 1/4" to 1/2" (10mm to 15mm) into the end of one of the white sticks.



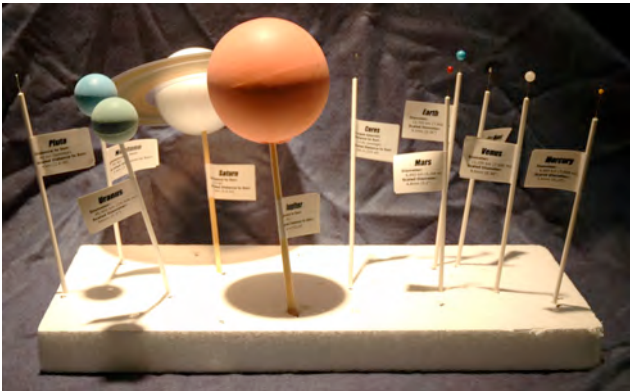
Attach Labels:

You can print the labels on sticky paper to make attaching them easier. Or just cut them out and cover with clear tape to attach.

Lining up the center line of each label with the stick, fold each label in half around the stick of the appropriate world. See photo at right.

(Optional) Display the Model:

Insert the sticks into a block of polystyrene foam.

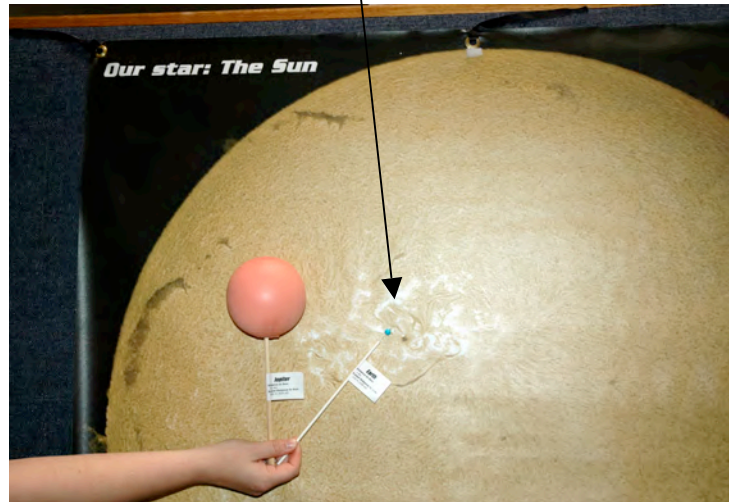


To Make the Sun:

Take a large plastic yellow tablecloth and cut it into a 1-meter circle to represent the size of the Sun on this scale. You can also print out the large Sun Banner that is used in the pictures in this activity. See Helpful Hints for information on where to find this.

Detailed Activity Description

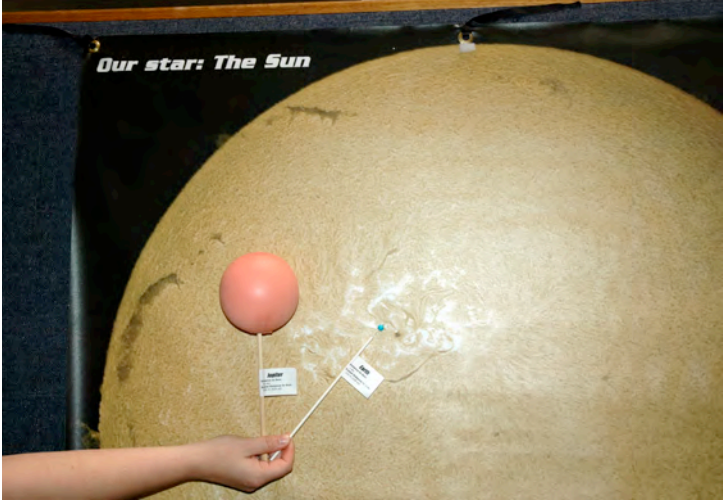
Worlds of the Solar System: Comparing Sizes & Distances

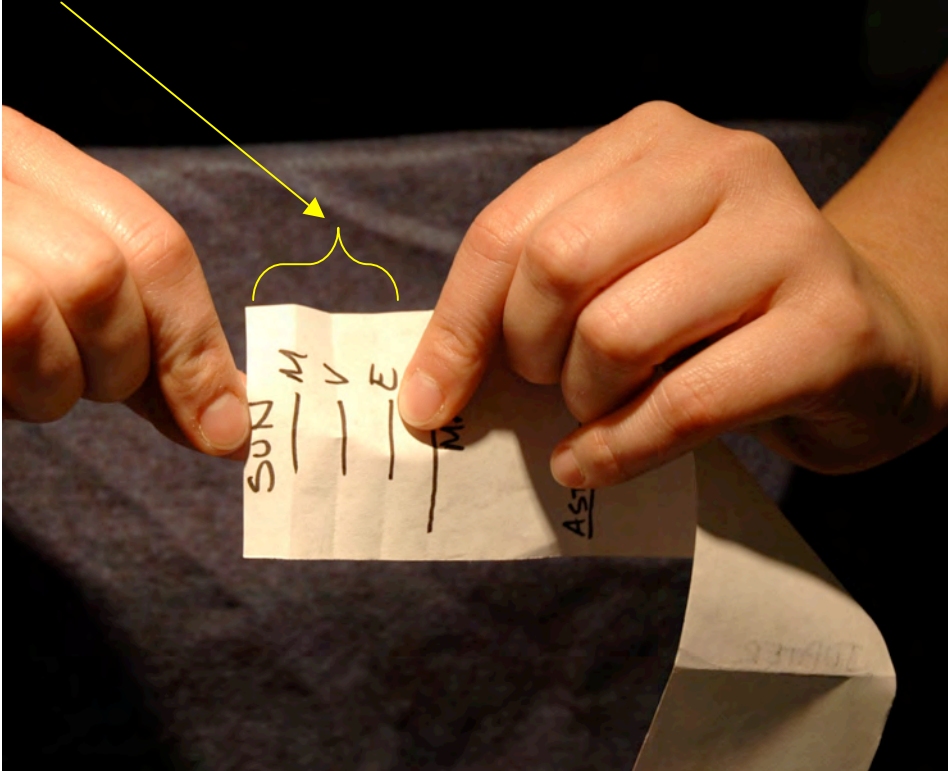
| Leader's Role | Participants' Role (Anticipated) |
|--|--|
| <p><i>Optional (you supply):</i> Local Map marked with a few distances of planet orbits on the scale of the scale model: It can be helpful to make a small Pocket Solar System on the same scale as the map (2-1/2 miles or 4 km on the map = the length of the Pocket Solar System). See table under "Background Information"</p> <p><u>To Do:</u> Hold up the 4" Jupiter ball.</p> <p><u>To Say:</u> How big do you think the Sun would be if this was the size of Jupiter, the largest planet? Show me with your hands.</p> <p><u>To Do:</u> Put up the Sun banner or have two visitors hold it up. Pass out the planets to your visitors and have them hold the planets next to the Sun and the planets to each other to get a sense of the size relationships.</p> <p><u>To Say:</u> Compare the sizes of the planets to the Sun – and to each other. What do you notice? Any surprises?</p> <p>How does the size of Earth compare to a sunspot?</p>  <p>Notice that if we made the Sun much smaller than one meter, Ceres, the largest asteroid, would be too small to see!</p> | <p>Visitors hold hands out.</p> <p>Variety of comments. Wow – it would fit inside!</p> |

| Leader's Role | Participants' Role (Anticipated) |
|---|--|
| <p><u>To Do:</u> Refer to the visitor who has Earth.</p> <p><u>To Say:</u> Show me how far away you think the Earth should be on this scale.</p> <p>Hold out your hand at arm's length and close one eye. How many fingers does it take to cover the Sun on the banner?</p> | <p>Visitor holding Earth moves the planet a few feet away.</p> <p>My whole hand.</p> |
| <p><u>To Say:</u> From here on Earth, the real Sun looks a lot smaller than that in our sky. Don't look directly at the Sun.</p> <p><u>To Do:</u> Hand the visitor a solar Viewer.</p> <p><u>To Say:</u> Here's a viewer to allow you to safely observe the Sun. Close one eye and hold this at arm's length toward the Sun. With your other hand, use your fingers to measure the size of the Sun. Which is the smallest finger you can use to cover it?</p> | <p>It's smaller than my pinkie finger!</p> |
| <p><u>To Say:</u> Right! You need to move Earth far enough away so that <i>this</i> Sun (indicating the banner) looks smaller than the tip of your pinkie finger.</p> <p>Let me give you another hint. There are about 100 Sun diameters between Earth and the Sun. So we'd need to fit 100 one-meter Suns between you and this Sun. A meter is a little more than one yard. What can you think of that is 100 yards long?</p> <p>Yes – we'll have to move you at least 100 yards away from this Sun. When you get to the right distance, you should be able to cover the Sun on the banner with your pinkie.</p> | <p>A football field?</p> <p>Visitor holding Earth starts walking away.</p> |

| Leader's Role | Participants' Role (Anticipated) |
|--|---|
| <p><u>To Do:</u> Send Venus out about 2/3 of the distance the Earth is and Mercury about 1/3 the distance. Ask the people holding Venus and Mercury how many fingers it takes to cover the Sun from where they are.</p> <p>Then bring everyone back.</p> | <p>Venus and Mercury walk to their positions and measure the size of the Sun on the banner.</p> |
| <p><u>To Do:</u> If you have a local map marked with distances, show where the planets on this scale would be. If you made a Pocket Solar System on the scale of the map, have your visitors hold the map with the Pocket Solar System against it.</p> <p><u>To Say:</u> Earth's distance from the one meter Sun is about the length of a football field. We only went out to the distance of Earth's orbit. Pluto's average orbit is two and a half miles away on this same scale. Who wants to take Pluto and walk there? This illustrates why it is difficult to make a scale model of the Solar System scaled to both size AND distance!</p> | <p>Laughs.</p> |

Worlds of the Solar System: Relationships

| Leader's Role | Participants' Role (Anticipated) |
|--|---|
| Objective: <ul style="list-style-type: none"> Help visitors remember a few sizes of the planets. | |
| <p><u>To Do:</u> Pass out "Solar System to Scale" handouts. Hold up the Jupiter ball and the Earth ball</p> <p><u>To Say:</u> Note that it takes roughly 10 Earths to span the diameter of Jupiter.</p> <p><u>To Do:</u> Put Jupiter next to the 1-meter Sun</p>  <p><u>To Say:</u> And how many Jupiters to span the diameter of the Sun? Let's count them.</p> | <p>Visitors count. "10 Jupiters."</p> |
| <p>Presentation Tip: There are closer to 11 Earths to span Jupiter, but 10 Earths and 10 Jupiters is easier to remember!</p> | |
| <p><u>To Say:</u> Yes, 10. So, it takes about 100 Earths to span the diameter of the Sun (10 Earths x 10 Jupiters).</p> <p>And the distance between the Sun and Earth? About 100 Sun diameters.</p> | |

| Leader's Role | Participants' Role (Anticipated) |
|---|-------------------------------------|
| <p><i>(Optional) To Do:</i> Show a Pocket Solar System</p> <p><i>To Say:</i> So, if we look at the Pocket Solar System, the distance from Sun to Earth is 100 Sun diameters.</p>  <p>How big would the Sun be on the scale of the Pocket Solar System?</p> | <p>Just a little dot!</p> |

Worlds of the Solar System: Building a Scale Model

Leader's Role

Objective:

Involve visitors in pacing off the distance to planet orbits.

To Do:

A useful web site for **calculating scale models of the Solar System** is available from the Exploratorium:

http://www.exploratorium.edu/ronh/solar_system/

Use the scaled Worlds of the Solar System as props as you pace out the distances to the orbits of planets.

To make your model more realistic, use the actual locations of the planets around the Sun, which can be found here:

<http://www.fourmilab.ch/cgi-bin/uncgi/Solar>

Just print out the map and send people off in the appropriate directions.

An easy way to estimate distances is to remember the **Pocket Solar System** and these relationships:

The distance from the Sun to Earth is roughly 100 Sun diameters (1 AU). "AU" stands for "astronomical unit" and is defined as the average distance between the Sun and the Earth.

Saturn is about 10 times the distance from the Sun to Earth (approx 10 AU).

From the **Pocket Solar System**, you remember that Saturn's orbit is 1/4 of the distance between the Sun and the average distance of Pluto.



Kids in Maryland walk the scaled distance from the Sun to Earth. (Courtesy of W. Bird)

Helpful Hints

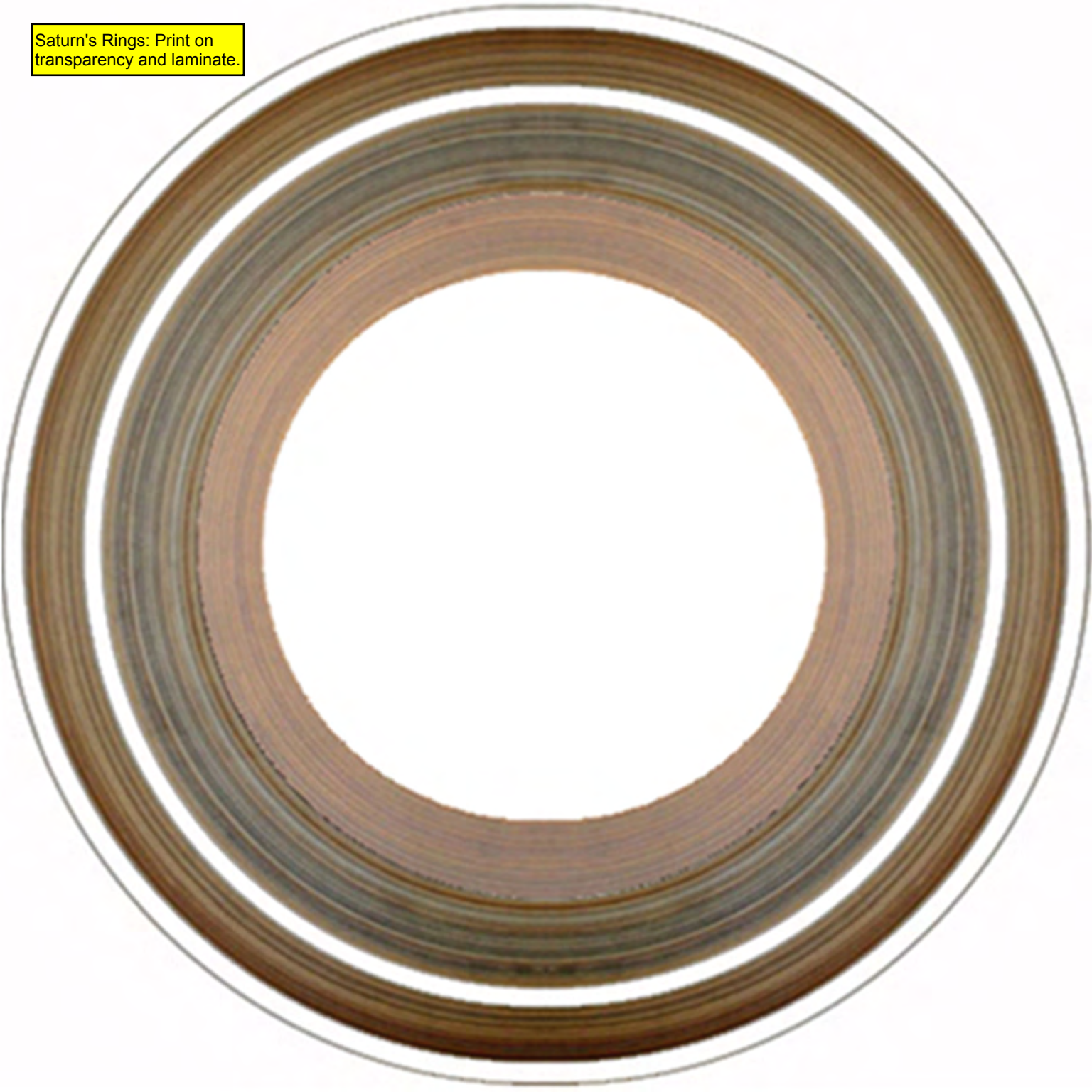
Where do I get additional materials?

- Dylite (or polystyrene) balls: search the Internet for “Dylite balls”:
 - 4” ball – Jupiter
 - 3-1/4” half-balls – Saturn (You can also get by with 3” half-balls) OR buy 3-1/4” whole balls and cut them in half
 - 1-3/8” balls – Uranus and Neptune
- Saturn’s rings: print template below on a transparency sheet and either laminate it a couple of times or glue a 3 or 4 blank transparency sheets to it. This is to stiffen the rings.
- Sandpaper: hardware store
- Sheet of Labels for all planets: print from template below. (formatted for Avery 5162 1-1/3” x 4”)
- Straight pins: sewing store
- Silver-topped pins for Pluto: sewing store: 1-1/2-inch Ball Head Pin .020 Dia.
- Yellow-topped pin: this is a standard “quilting pin” and can be obtained at a sewing store.
- Beads can be obtained from craft stores or online at any number of bead suppliers. Search the Internet for the “Search for” description:
 - Silver 2.4mm beads for Moon: Search for “Silver Plate 2.4mm round beads”
 - Blue 9mm bead – Earth: Search for “9mm blue round beads”
 - White 8mm bead – Venus: Search for “White 8mm round beads”
 - Red 5mm bead– Mars: Search for “Coral Red 5mm round beads”
 - Copper 0.8mm balls for Ceres: Search for “Glass spheres 0.8mm Brown”
- White Sticks: These are sucker sticks you can get from a baking or crafts store. You can also use wooden skewer sticks.
- Super glue: craft store
- Sheet of polystyrene: Styrofoam from a craft store will work as well.
- Solar Viewer: search the Internet for “solar viewer”

Sun Banner: “Our star: The Sun”: The PDF for this banner can be found on the Resource Download Site on The Night Sky Network. The file name is “SolSysDiagramSun.pdf”. You may have a full-size banner made from these files at a copy store or other printing company.

<http://nightsky.jpl.nasa.gov/download-search.cfm>

Saturn's Rings: Print on transparency and laminate.



Solar System Model Labels: Formatted for Avery Label 5162: 1-1/3" x 4"; 14 labels to a page

Mercury

Diameter:
4,900 km (3,000 mi)
Scaled Diameter:
3.4mm (0.14")

Mercury

Distance to Sun:
0.4 AU
Scaled Distance to Sun:
42 m (48 yd)

Venus

Diameter:
12,100 km (7,500 mi)
Scaled Diameter:
8.6mm (0.34")

Venus

Distance to Sun:
0.7 AU
Scaled Distance to Sun:
75 m (84 yd)

Earth

Diameter:
12,800 km (7,900 mi)
Scaled Diameter:
9.1mm (0.36")

Earth

Distance to Sun:
1 AU
Scaled Distance to Sun:
110 m (120 yd)

Mars

Diameter:
6,800 km (4,200 mi)
Scaled Diameter:
4.8mm (0.2")

Mars

Distance to Sun:
1.5 AU
Scaled Distance to Sun:
165 m (180 yd)

Earth's Moon

Diameter:
3,500 km (2,200 mi)
Scaled Diameter:
2.5mm (0.1")

Earth's Moon

Distance from Earth:
385,000 km (240,000 mi)
Scaled Distance from Earth:
28 cm (11 inches)

Ceres

(Largest Asteroid)
Diameter:
960 km (600 mi)
Scaled Diameter:
0.8mm (0.03")

Ceres

(Largest Asteroid)
Distance to Sun:
2.6 AU (average)
Scaled Distance to Sun:
285 m (310 yd)

Jupiter

Diameter:
143,000 km (88,800 mi)
Scaled Diameter:
100mm (3.9")

Jupiter

Distance to Sun:
5.2 AU
Scaled Distance to Sun:
560 m (625 yd)

Saturn

Diameter:
120,500 km (75,000 mi)
Scaled Diameter:
84mm (3.3")

Saturn

Distance to Sun:
9.5 AU
Scaled Distance to Sun:
1 km (0.6 mi)

Uranus

Diameter:
51,100 km (31,800 mi)
Scaled Diameter:
34mm (1.3")

Uranus

Distance to Sun:
19 AU
Scaled Distance to Sun:
2 km (1.3 mi)

Neptune

Diameter:
49,500 km (30,800 mi)
Scaled Diameter:
33mm (1.3")

Neptune

Distance to Sun:
30 AU
Scaled Distance to Sun:
3 km (2 mi)

Pluto

Diameter:
2,400 km (1,500 mi)
Scaled Diameter:
1.6mm (0.06")

Pluto

Distance to Sun:
40 AU (average)
Scaled Distance to Sun:
4 km (2.6 mi)

Sun

Diameter: 1,391,000 km (864,000 mi)
Scaled Diameter: 1 meter (39")
(Approx 110 Earth diameters)
(A little more than 100 Sun Diameters to span distance
between Sun and Earth)

Solar System to Scale

Sun is scaled one meter (39") in diameter

Actual Size of Sun: 1,391,000 km (864,000 mi)

AU ("Astronomical Unit") is the average distance between the Sun and Earth:

150 million km (93 million mi)

A little more than 100 Sun diameters will span the distance of one AU

Mercury

Actual Size: 4,900 km (3,000 mi) diameter

Scaled Size: 3.4 mm (0.14")

Average distance from Sun: 0.4 AU

Scaled Distance from Sun: 42 m (48 yd)



Venus

Actual Size: 12,100 km (7,500 mi) diameter

Scaled Size: 8.6 mm (0.34")

Average distance from Sun: 0.7 AU

Scaled Distance from Sun: 75 m (84 yd)



Earth

Actual Size: 12,800 km (7,900 mi) diameter

Scaled Size: 9.1 mm (0.36")

Average distance from Sun: 1 AU

Scaled Distance from Sun: 110 m (120 yd)

(Approx. 110 Earth diameters will span the diameter of the Sun)



Mars

Actual Size: 6,800 km (4,200 mi) diameter

Scaled Size: 4.8 mm (0.2")

Average distance from Sun: 1.5 AU

Scaled Distance from Sun: 165 m (180 yd)



Jupiter

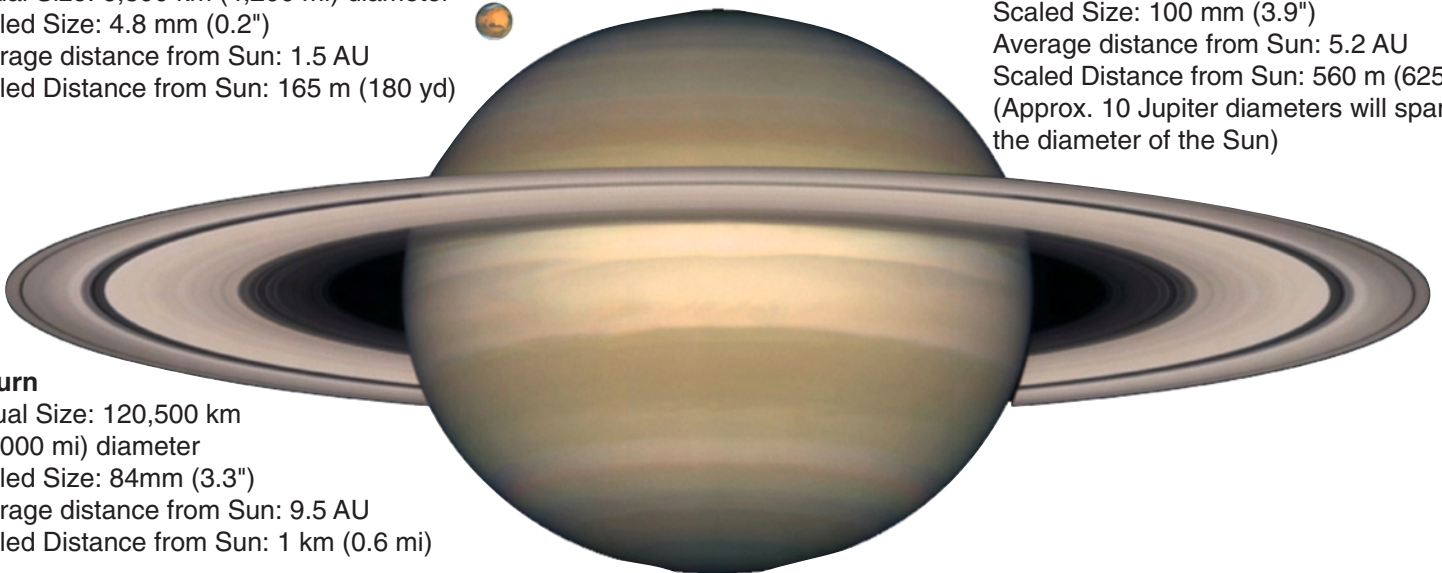
Actual Size: 143,000 km (88,800 mi) diameter

Scaled Size: 100 mm (3.9")

Average distance from Sun: 5.2 AU

Scaled Distance from Sun: 560 m (625 yd)

(Approx. 10 Jupiter diameters will span the diameter of the Sun)



Saturn

Actual Size: 120,500 km (75,000 mi) diameter

Scaled Size: 84mm (3.3")

Average distance from Sun: 9.5 AU

Scaled Distance from Sun: 1 km (0.6 mi)

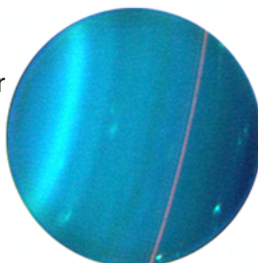
Uranus

Actual Size: 51,100 km (31,800 mi) diameter

Scaled Size: 34 mm (1.3")

Average distance from Sun: 19 AU

Scaled Distance from Sun: 2 km (1.3 mi)



Neptune

Actual Size: 49,500 km (30,800 mi) diameter

Scaled Size: 33 mm (1.3")

Average distance from Sun: 30 AU

Scaled Distance from Sun: 3 km (2 mi)

