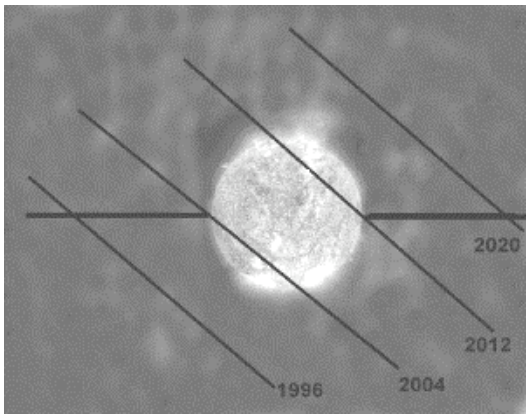
Transit Of Venus – A Scale Model

How much of the sun will be covered as Venus passes between the sun and the earth. To find out, we can build a scale model of the Sun, Venus, and Earth.



This photograph shows the path that Venus will take as it transits the Sun in 2004 and again in 2012. In 1996 Venus passed near the sun and in 2020 Venus will pass nearby once again.

Materials: (one set for every three students)

- a white paper plate, about 9 inches (22.86 cm) in diameter
- a clear sheet of transparency
- a manila folder
- pair of scissors
- a fine point permanent black marker
- meter sticks and/or tape measures
- a location that is at least 100 feet (30.5 meters) across.
- binoculars (optional)

To Do And Notice:

Facts we need to construct our scale model:

- The size of the real sun is 864,938 miles (1,391,980 km) in diameter.
- The **average distance between the earth and sun** is about 92,976,000 miles (148,761,600 km) – or about **107 "suns" laid end to end**.
- The **average distance between the Venus and sun** is about 67,221,648 miles (107,554,637 km) – or about **77 "suns" laid end to end**.
- Earth is 7926 miles (12,756 km) in diameter. That means that **109 Earth's laid end to end would equal the diameter of the sun.**
- Venus is 7520 miles (12,102km) in diameter. That means **115 Venus' s laid end to end would equal the diameter of the sun.**

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- Let's use the paper plate to represent the sun. We need to figure out how big the Earth and Venus would be using this scale. If 115 Venus's fit across the sun's diameter, then at this scale, Venus's diameter will be

Venus model = 9 inches/115 = 0.078 inches (0.20 cm)

If 109 Earths fit across the sun's diameter, then at this scale, Earth's diameter will be

Earth model = 9 inches/109 = 0.082 inches (0.21 cm)

- Cut the manila folder down the crease so that you have two pieces of cardboard that are 8.5 x 11 inches. Cut a large rectangular window out of the center of one of the pieces of cardboard and tape the transparency to one side. You now have made a cardboard frame that will hold the transparency rigid.

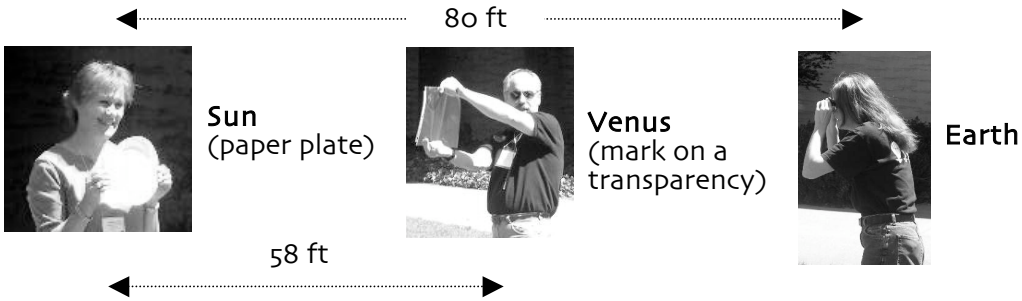
- In the center of the transparency, use the permanent marker to make a mark that is 0.078 inches (0.20 cm) in diameter. This will represent the Venus in our scale model.

- To create a scale model the transit of Venus, we will need to place the sun, Venus, and Earth in their proper positions. Have one student hold the paper plate representing the sun just under his/her chin. To place Venus, have another student hold the transparency with the black mark a distance equal to 77 paper plates laid end to end, or

The man in the distance is holding the paper plate representing the sun. The woman is holding the transparency with the mark that represents Venus.

Distance between Sun and Venus Models = 77 x 9 in = 693 in ~ 58 ft (17.6 meters)

- To place Earth in its proper position, have another student stand a distance equal to 107 paper plates laid end to end, or … **107 x 9 in = 963 in ~ 80 ft (24.5 meters)**



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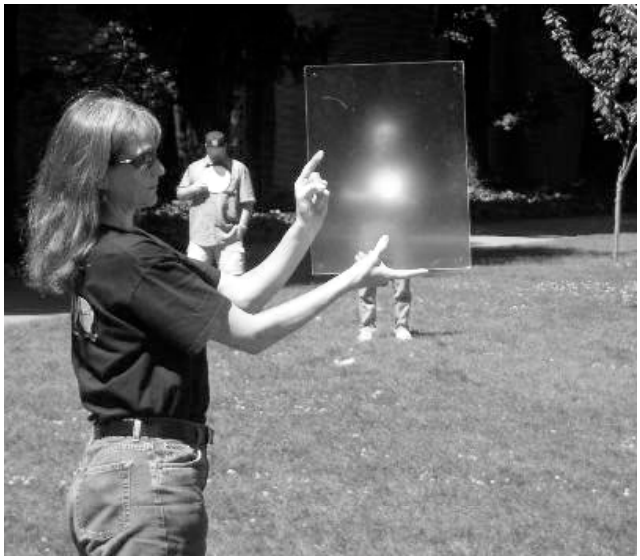
- To model the transit visible on June 8th 2004, have the student representing the earth close one eye and position the other two students so that the mark on the transparency representing Venus crosses in front (or "transits") the paper plate.

- Try using a pair of binoculars to help you see the tiny mark representing Venus. Using the binoculars, try lining up your friends so that Venus transits the paper plate representing the sun. Is this any easier?



It's hard to see in this photograph, but the mark on the transparency representing Venus is transiting the paper plate representing the sun.

Some other things to do and notice

- *How large does the paper plate seem to be when standing at the earth's position?* The student representing the earth should hold out their arm straight out and compare the size of the paper plate to the fingers of their hand. If you have constructed your model accurately, the paper plate should be much smaller than the tip of a pinkie. (For most people, the paper plate will be about the size of half the tip of a pinkie.) The apparent size of this model is equal to the size of the real sun in the real sky. But don't try looking at the sun to check your answer.

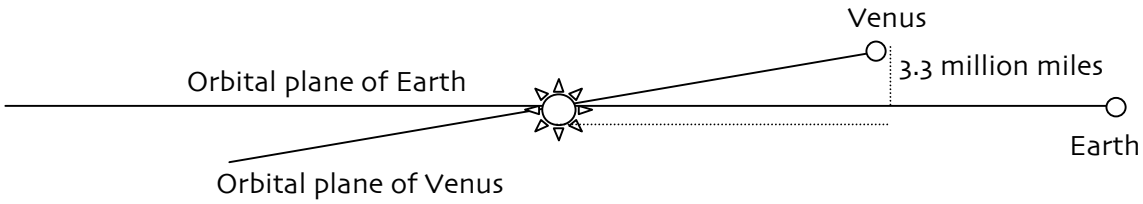
- *When you have lined up the Sun and Venus using one eye, try closing that eye and opening the other.* You'll notice that the position of "Venus" again the "Sun" has shifted. You may even find that Venus is no longer transiting the paper plate.

- *How far to the right and left (or up and down) can the student holding Venus move the mark on the transparency and still "transit" the distant paper plate representing the sun?* In this model, 1 inch (2.5 cm) of movement = 96,850 miles (155,000 km).

What's Going On?

We don't see a transit of Venus every time Venus passes between Earth and the Sun – which happens about every 584 days or 1.6 years. That's because Venus does not orbit in the same plane as the Earth. Compared to the Earth's orbit, Venus's orbit is inclined at about 3.5°. This takes Venus as much as 3.3 million miles above the orbital plane of the earth – much too high above the earth's orbital plane to transit the sun. To appear to transit the sun, Venus has to nearly cross the Earth's orbital plane. That happens about twice every century (usually a pair of transits 8 years apart), making a Venus transit a very rare astronomical event indeed.

Here are two people holding transparencies with marks representing Venus. Their partners are directing them to move their transparencies so that they can see a transit.



Our thanks to the wonderful teachers of Shasta County's Project ARISE for helping us pilot test this activity.

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Going Further

Web Pages

A great animation showing the transit of Venus can be found at the following NASA site:
http://svs-f.gsfc.nasa.gov/%7Ewfeimer/SEC/Gen_SEC/IP/Transit.mpg

A really wonderful description of the importance of Venus transits to astronomers (written by Edna Devore, SETI Dircetor of Education and Public Outreach) can be found at this web site:
http://space.com/searchforlife/seti_transits_030904.html

A comprehensive list of web sites devoted to Venus transits of the past can be found at:
http://www.transitofvenus.org/historic.htm

An excellent description of the transit of Venus that will occur on June 8, 2004 (written by Fred Espenak)can be found at this web site:
http://sunearth.gsfc.nasa.gov/eclipse/OH/transit04.html

Here's a link to a wonderful Venus transit activity that uses a paper plate to create a model of the orbits of Earth and Venus around the sun.
http://analyzer.depaul.edu/paperplate/Transit%20of%20Venus/Introduction.htm