The Earth and Moon to Scale

We have all seen drawings or sketches in books that show Earth and moon together in the same view, but in reality they are really very different in size, and are much farther apart than you might think.

By creating properly scaled drawings, you will get a better idea of what their sizes are really like! All you will need is a compass, a metric ruler, and a calculator.

The photo above was taken by the Voyager 1 spacecraft on September 18, 1977 at a distance of 7 million miles from Earth, and it has not been edited in any way. Are their diameters to scale? Their distance from each other? Even actual images can be distorted because of perspective and distance effects.

Problem 1 - The radius of the Moon is 1,737 kilometers, and the radius of Earth is 6,378 kilometers. What is the ratio of Earth's radius to the Moon's?

Problem 2 - To the nearest whole number, about how much larger is the diameter of Earth than the moon?

Problem 3 - With your ruler and compass, draw two circles that represent this size difference, and use a radius of 1 centimeter for the moon disk. Inside the circles, label them 'Earth' and 'Moon'.

Problem 4 - The distance between the center of Earth and the Moon is 384,000 kilometers. To the nearest integer, how many times the radius of Earth is the distance to the Moon?

Problem 5 - Cut out the circles for Earth and the Moon from Problem 3. Using the radius of your circle for Earth as a guide, how far apart, in centimeters, would you have to hold the two cut-outs to make a scale model of the Earth-Moon system that accurately shows the sizes of the two bodies and their distance?

Problem 6 - Look through books in your library, or use GOOGLE to do an image search. Do any of the illustrations show the Earth-Moon system in its correct scale? Why do you think artists draw the Earth-Moon system the way that they do?

Answer Key

Problem 1 - 6378 / 1737 = **3.7.**

Problem 2 - 3.7 is closest to 4.0, so Earth is about **4 times bigger than the Moon in size.**

Problem 3 - **Draw the disks on a separate paper, but make sure that the Moon has a 1 cm radius and Earth has a 4 cm radius.**

Problem 4 - 384,000 / 6378 = 60.2 which is **60 times Earth's radius.**

Problem 5 -   If the radius of the Moon disk was 1 centimeter, the Earth disk would be 4 centimeters in radius. The distance to the Moon would be 60 times this distance, or 4 cm x 60 = **240 centimeters** (2.4 meters).

Problem 6 - Very few. Artists try to show a vast 3-dimensional image in a flat perspective drawing that is only a few inches across on the printed page. To draw the Earth-Moon system in the proper perspective scale, the Moon would be a small dot. Also, illustrations that show the phases of the Moon, or eclipses, are also badly out of scale most of the time, because you can't show the phases clearly if the Moon is only the size of a small dot in the illustration. There are other purely artistic reasons too!

Note: The image below was taken by the Mars Odyssey spacecraft soon after launch in April 2001 when Earth and Moon were at their <u>maximum separation</u>. The image is not edited, and shows the disks at their true separations. From the diameter of Earth (12800 km) and its measured diameter in millimeters (4.5 mm) the scale of the image below is   12800/4.5 = 2840 km/mm. The separation from the center of Earth to the Moon 'dot' is 126.5 mm or 126.5 mm x 2840 km/mm = 359,000 km. However, although Earth is 3.7x bigger than the Moon, it is clear that the lunar dot, which measures just under 0.5 mm) is much smaller than it should be (diameter = 3,474 km or 1.2 mm). **Compared to the Earth-Moon distance, how far from the Moon was the Mars Orbiter in order to see the Moon with this disk diameter? Answer: About 359,000 km x 1.2/0.5 = 860,000 km.**