

Exercise on Relative Sizes of Earth, Moon, and Sun

Correct responses shown in boldface.

Astronomers use various ways to understand large masses and distances, such as ratios and scientific notation. For example, if you are told that a jet airplane is 40 meters long, that might not register as well as being told that it is eight times as long as a car. This exercise explores ratios and scientific notation.

Let's try the same logic on the sizes of the earth and moon:

The diameter of moon is 3,476 km

The diameter of the earth is 12,756 km

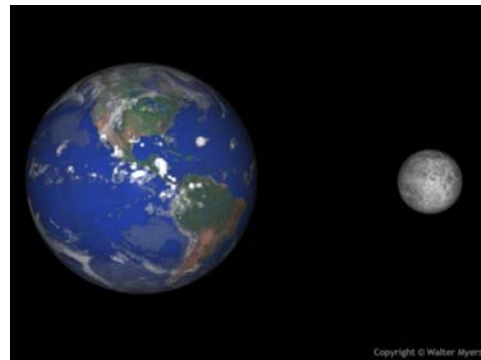
These numbers are too big to register in terms of everyday experience, but maybe we can make a scale model in our minds (like the one of the solar system in the first lecture). If we divide the diameter of the earth by that of the moon, we get

$$\frac{\text{Earth diameter}}{\text{Moon diameter}} = \frac{12756 \text{ km}}{3476 \text{ km}} = 3.70 \approx 4$$

Here, the two squiggly lines (\approx) mean "is approximately equal." That is, the earth is about four times wider than the moon, or for our model, we should use something four times smaller for the moon than for the earth.

1. Which would you pick for such a model?

- a.) a basketball and a soccer ball
- b.) a basketball and a baseball (hardball)**
- c.) a basketball and a ping pong ball
- d.) a basketball and a pea
- e.) a basketball and a grain of salt



2. The distance from the earth to the moon is about 384,400km (this is the radius of the orbit of the moon, which is half of its diameter). This is about 30 times the diameter of the earth, so your model moon would be how far from your model earth?

- a.) the width of the lecture hall**
- b.) the height of your chair
- c.) the height of the Administration building
- d.) the length of the campus

The diameter of the sun is 1,392,000km. We then have

$$\frac{\text{Sun diameter}}{\text{Earth diameter}} = \frac{1392000\text{km}}{12756\text{km}} = 109 \approx 100 = 1 \times 10^2$$

3. Therefore, for your model to include the sun, you would need a ball about as big as

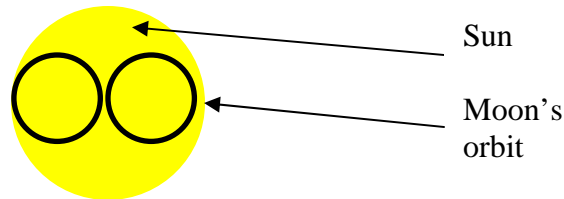
- a.) a large SUV is long
- b.) a two story house is high
- c.) a football field is wide**
- d.) the UA campus from end to end
- e.) the distance to Phoenix

Now, let's compare the diameter of the sun with the size of the moon's orbit around the earth, which is 769,000km in diameter. The ratio of the sun's diameter to the diameter of this orbit is about 2:

$$\frac{\text{Sun diameter}}{\text{Moon's orbit diameter}} = \frac{1392000\text{km}}{769000\text{km}} \approx 2$$

Does this mean that two suns placed side to side would fit within the orbit of the moon, or that two orbits of the moon would fit inside the sun?

4. Draw a sketch below to illustrate your answer.



Volumes of spheres can be compared by comparing the cubes of the diameters. Therefore, the volume of the sun compared to the volume of the earth is

$$\frac{\text{Volume of Sun}}{\text{Volume of Earth}} = \left(\frac{1392000\text{km}}{12756\text{km}} \right)^3 \approx 100^3 = 1 \times 10^2 \times 1 \times 10^2 \times 1 \times 10^2$$

5. In scientific notation, this ratio is

- a.) 1×10^5
- b.) 1×10^3
- c.) 1×10^6**
- d.) 1×10^8

6. In scientific notation, what is the ratio of the volume of the sun to that of the moon?

- a.) 16×10^5
- b.) 8×10^4
- c.) 64×10^6**
- d.) 4×10^8