Scale Model of Solar System

To be e-mailed to Tohline no later than 11:30 AM, Friday, 25 January 2008

This project will count toward 25% of your Exam #1 grade!

Shrink the Sun to the size of a basketball (30 inches in circumference) and scale all other lengths and distances accordingly.

Step #1:
Place a basketball (the "sun") in front of Mike the Tiger's habitat.

Step #2:

A.) Walk away from the basketball a distance equivalent to the Earth's mean distance from the Sun (that is, 1 astronomical unit = 1 AU).

B.) Take a picture that shows you (and others in your group, if appropriate) standing next to a well-identified landmark at this "Earth location."

C.) Take a picture of you (or a friend) holding a spherical object that is approximately the size of a properly scaled Earth.

D.) While standing at this "Earth location" aim your camera at the basketball (sun) and take a picture of it.

E.) From this Earth location, how far from your eye do you have to hold a dime such that it just marginally blocks out the basketball (sun)? Take a picture illustrating this "solar eclipse."

Step #3:

A.) Walk away from the basketball a distance equivalent to the planet Jupiter's distance from the Sun.

B.) Take a picture that shows you (and others in your group, if appropriate) standing next to a well-identified landmark at this "Jupiter location."

C.) Take a picture of you (or a friend) holding a spherical object that is approximately the size of a properly scaled Jupiter.

D.) While standing at this "Jupiter location" aim your camera at the basketball (sun) and take a picture of it.

Step #4:

A.) Move away from the basketball a distance equivalent to the planet Neptune's distance from the Sun.

B.) Take a picture that shows you (and others in your group, if appropriate) standing next to a well-identified landmark at this "Neptune location."

C.) While standing at this "Neptune location" aim your camera at the basketball (sun) and take a picture of it.

Assemble all of your images into a document (preferably in PDF format) that explains clearly how you calculated each of the relevant lengths and distances (see, for example, the accompanying worksheet). Each image should be accompanied by a useful, explanatory caption. The document should clearly identify you by name, and it should be easy for me to identify you in at least 3 of the images (part B of steps 2, 3, and 4).

Example "lengths/distances" Worksheet

1. If a basketball has a circumference of 30 inches, its radius is ___0.121___ meters.

2. From Appendix 6 of the textbook, the Sun has a radius of 7×10^8 meters.

3. The sun-to-basketball scaling ratio is "f = _5.77×10^9___". Hence every astronomical length/distance needs to be divided by this number "f" in order to obtain the length/distance that is appropriate to the scale-model solar system.

4. From Appendix 6 of the textbook, 1 AU = 1.5×10^{11} meters; hence, to scale, the Earth should be a distance of _____ meters from the basketball. [ANSWER: 26 meters]

5. From Appendix 2 of the textbook, the Earth's diameter is 12,756 km = 1.28×10^7 meters, so in this scale-model solar system I need to find a spherical object with a diameter of _0.00222__ meters (that is, 2.2 mm) to represent the Earth. [Circumference = 0.27 inches]

6. From Appendix 1 of the textbook, Jupiter's distance from the Sun is 5.2 AU, hence, to scale, Jupiter should be a distance of ___135___ meters from the basketball.

7. From Appendix 2 of the textbook, Jupiter's diameter is 11.2 times larger than Earth's diameter. Hence, in this scale-model solar system I need to find a spherical object with a diameter of __0.025____ meters (i.e., 2.5 cm = 1 inch) to represent Jupiter.

8. From Appendix 1 of the textbook, Neptune's distance from the Sun is 30 AU, hence, to scale, Neptune should be a distance of ___780___ meters (i.e., 0.485 miles) from the basketball.

Final Question: One of the nearest stars to the Sun, Alpha Centauri A, has approximately the same diameter as the Sun and is 4.36 light-years from the Sun (see Appendix 4 of the textbook). Using the same scaling ratio as in our scale-model solar system, in what city would you have to place this "Alpha Centauri" basketball in order to properly represent its distance from the Sun, that is, from Mike the Tiger's habitat? ANSWER: There are 3.156×10^7 seconds in 1 year and light travels at a speed of 3×10^8 m/s. Hence, light travels a distance of $(3 \times 10^8 \text{ m/s}) \times (3.156 \times 10^7 \text{ s}) = 9.5 \times 10^{15}$ m in one year. So, a star that is 4.36 light-years away is $(4.36 \text{ ly}) \times (9.5 \times 10^{15} \text{ m/ly}) = 4.13 \times 10^{16}$ m away. In our scale model, therefore, this neighboring "basketball" is 7.15×10^6 m from Mike-the-tiger's habitat. This is equivalent to 4400 miles!

ANSWER:
The "Alpha Centauri" basketball should be placed in the city of _____.