

12.400: The Solar System

Homework Problem Set #1

SEE CLASS WEBSITE FOR DUE DATE

Please show all work *neatly and clearly*. Circle final answer for clarity.

1. Distance Scales

The length of the infinite corridor is: 202.4 meters

In a scale model of the solar system, let the Sun-Pluto distance (39.5294 AU) be equal to the length of the infinite corridor. On this scale: (*Hint: Use pages 387-388 of Beatty*)

- What would be the diameter for the Sun?
- What would be the diameters for each of the nine planets?
- What would be the diameter of the Moon and its distance from Earth?
- How far from the Sun would we place each of the nine planets?
- How far from the Sun would we place the nearest star?
(Alpha Centuri is located 4.3 light-years away.)

2. Spacecraft Communication

- How many times can a photon travel the Earth's Circumference in one second?
- A spacecraft is sent to Pluto. At 12:00 noon ground controllers send a command to take an image. Upon receiving the command, assume the spacecraft instantaneously acquires the image and transmits it back to earth. Assuming Pluto is at its mean heliocentric distance, when is the image received?

3. Eclipses

- What is the apparent angular size of the Moon as seen from Earth?
(Use diameter and average distance given in class.)
- What is the apparent angular size of the Sun as seen from Earth?
(Use diameter and average distance given in class.)
- If a solar eclipse occurs with the Moon and Sun at these distances, does the Moon totally block the disk of the Sun? Explain.
- The Moon's orbit is not circular and at its closest it is 363,000 km from the Earth. If a solar eclipse occurs with the Moon at this distance, does the Moon totally block the disk of the Sun? Explain.

4. Density of the solar system

Assume that the mass of the nine planets plus Ceres is distributed in a uniform disk, 1 cm thick between 0.2 AU and 50 AU

- Divide the solar system into 10 zones, and compute the density within each zone.
(EXAMPLE: Assume the earth zone extends midway to Venus and to Mars, that is from 0.86 to 1.25 AU. Distributing the Earth's mass in this zone yields 10 g cm^{-3} .)
 - Discuss trends in the density, noting especially zone(s) of substantially lower density.
- c. A belt of comets (the Kuiper belt) is believed to extend from 35 to 50 AU from the Sun. The total population of these objects is estimated to be as high as 30,000 objects with diameters between 100 and 400 km. If these objects are taken into consideration in our density calculations, do they noticeably affect the calculated density distribution? (Assume an average diameter of 200 km and an average density of 1 g cm^{-3} for the comets.)