

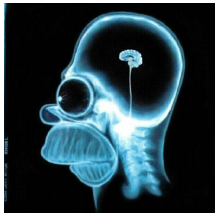
General Astronomy II, Spring 2019

PROBLEM SET 4



Deadline: 11PM THURSDAY, MAY 30, 2019

Submission: ILM5 PLATFORM



Early one morning, you bumped into Homer Simpson in a coffee shop. Homer had his own ideas of how and why everything is in the universe and insisted that his ideas were right. But you know that a lot of his thoughts may not be correct, not any better than what shows in an X-ray image of his brain.

After hearing what Homer had to say, you decided to convince him with what you have learned in the class. You must let Homer know which part of his arguments went wrong.

1. **Planet's orbital motions (40%).** The Solar system has eight planets orbiting about the Sun.

Homer: I know Kepler's first law, which says the orbits of the planets are not perfect circles but elliptical. The four seasons is caused by the varying distance between the Sun and the Earth. The summer is when the Earth is around the perihelium (the closer vertex).

- (a) (20%) Use Table A-10 (the Appendix A of your textbook) to find the two planets with the largest and smallest orbital eccentricities, together with the Earth. On a sheet of A4 size paper, mark the Sun at the center and plot the orbits of the three selected planets. Can you tell whether these orbits are elliptical? To convince yourself, you should also draw a perfect circle to compare with the orbit with the largest eccentricities.
- (b) (20%) Do you agree with Homer's idea about the cause of the four seasons? If not, tell him what is the expected outcome of his idea? In addition, compute the difference in the incident flux (energy per unit second per unit area) on the Earth on the summer solstice and winter solstice.

2. **The solar nebula theory (40%).** The solar nebula theory successfully explains a good number of observation properties of the Solar system.

Homer: I have heard about the solar nebula theory that grows our planets in a rotating disk of gas and dust around the proto-Sun. Planet formation is a natural part of star formation. The matter in the solar nebula was sorted by density, with heavy rock and metal sinking toward the Sun and gases being blown outward, just like sedimentation.

- (a) (10%) Using Table A-10, plot density versus distance to the Sun for the 8 planets in the Solar system. Convince yourself that the closer a planet to the Sun, the higher its density.
- (b) (10%) Do you agree with Homer's idea about why the 8 planets show such tendency to be denser near the center? If not, tell him what is the expected outcome of his idea?
- (c) (20%) Can you tell him what astronomers suggest to explain this observed property otherwise?