

AST 105IN ANSWERS TO HOMEWORK ASSIGNMENT 1

Chapter. 1, “A Universe of Life?”

Review Questions

NOTE: The answers to the Review Questions (RQ) in all chapters are clearly stated within the chapter text. The questions and answers are in the same order. I have nothing to add to what the authors give you, so these answer sheets will not give you responses to the RQs. It’s better for you if, in writing your responses, that you use mostly your own wording, as opposed to just copying the authors’ words.

Quick Quiz (QQ)

- 11. b
- 12. c
- 13. a
- 14. b
- 15. c
- 16. a
- 17. c
- 18. c
- 19. b
- 20. c

Chapter 2, “The Science of Life in the Universe”

“Quick Quiz”

- 31. b
- 32. b
- 33. c
- 34. c

“Quantitative Problems”

52. This is a Kepler’s Third Law of Planetary Motion problem, which quantitatively shows the relation between two orbital elements, the size of an orbit, measured by its semimajor axis, a , and its period, P . The relation is that the square of the period is equal to the semimajor axis cubed, using the units of AU for the semi-major axis and year for the period. You can manipulate the equation simply to solve for one or the other orbital elements.

Here, we are given the semimajor axis, so the solution for P is $509^{3/2}$, which equals 11,500 years. (Note the round-off to 3 significant figures, which is what we are given in the input data.) Note also that this is one of the farthest objects we have discovered to date in the Kuiper Belt. Compare its orbital elements to those for Pluto, which averages 40 AU and takes about 250 years to complete an orbit around the sun.

53. Same relation as in problem 52, but this time we are given the period, 560 years; the authors challenge us to figure out its orbital size. This results from solving the $P^2 = a^3$ law for a . So, $a = P^{2/3} = 560^{2/3} = 68$ AU. Compare to Pluto. Eris is the object, discovered in the summer of 2004, that reduced Pluto to being the second largest Kuiper Belt Object (KBO) and forced the issue of Pluto's planetary status to be resolved at an international meeting just before the 2nd edition of the textbook came out. The authors' use of the term dwarf planet arises from that resolution.
- 56a. This is a comparison problem, applying Newton's Law of Gravity. It relates quantitatively the force of gravity to the factors that determine it—mass and distance. It looks like this:

$$F_g = Gm_1m_2/d^2$$

In this case, Newton's Law of Gravity simplifies by cancelling out the Gravitational constant, G . Remember that constants cancel out when taking ratios. For that matter, you can ignore the masses involved, because they don't change in the different circumstances described here, either. The only thing that changes is the distance, see? Looking at the relation between gravitational force with distance in Newton's gravity equation, you see that $F \propto 1/d^2$. This is the inverse-square law, which pops up in physics in several different, but related, situations. You don't necessarily need exact distances, only their ratios in these comparative situations. The situation compared to is the objects original separation distance, so that distance is unity (1). One over one squared = one—only this "one" represents the original gravitation force operant here. At four times that distance, the force is $1/4^2$ as strong or $1/16$ (0.0625) as strong as when closer together.

- b. Here, the only factor that changes is the mass, so the other factors, remaining the same and are hence irrelevant to any other changes, cancel out to 1. We note that there is simply a linear, direct relation between the force of gravity and the mass creating the gravity effect. Double the mass of one of the objects and the force is likewise doubled. That's it.
- c. Ok, this is like part a, where we changed the distance to learn that the force of gravity varies with the inverse-square of the ratio of the two relevant distances. Here the original distance, being the comparative distance is unity (so that goes in the denominator—remember, we can ignore all other factors here—distance is the only thing that changes to cause a change in the gravity. In this case we reduce the distance by a factor of 3. the numerator of this distance comparison is. Gravity varies with the inverse-square of the distance ratio. ($F_g \propto 1/d^2$) So, the inverse of $1/3$ is 3 and squaring that results in 9. That is, the gravity pull of the sun on Earth would be 9 times stronger were the Earth's orbit to shrink to $1/3$ its present size.