AST 105IN ANSWERS TO HOMEWORK ASSIGNMENT 2

Chapter 2, "The Science of Life in the Universe"

"Science or Nonscience?"

19. Much more nonscience than science.. Tho there is an evidential (objective, scientific) basis for such a claim, such am absolutist opinion must have a strong subjective nature to it based upon the personal foibles and tastes, maybe even nationality, of the person making the claim, as well as limitations of the data regarding all other soccer players of the world. A LOT of work would have to go into making such a sweeping claim. If meant to be scientifically established, then ALL the data on Beckham AND ALL the data on ALL the other soccer players of the world must be known and examined and found to be complete and accurate. As in pretty much all claims in sports, politics, and religion, easier to cut short the research and just blow out an opinion, the more strongly held them more people seem impressed. ("He knows his mind." "He's so sure of himself, he must be right.") But as was written by Charles Dickins in *A Christmas Carol*, "The narrower the mind, the broader the opinions."

21. Nonscience, clearly, because of the supernatural nature of the subject. Scientific thought can only study what is physically real, i.e., natural.

23. Scientific. This assertion meets the related scientific criteria of being naturalistic and testable now or in the foreseeable future.

25. Mostly Nonscientific. The claim meets the scientific requirement of being naturalistic, but how would one test it? What aliens? How can we study what they allegedly do? Studying the people abducted is possible, but forget interviewing them–"…without the people ever realizing they were taken. There might be some physical effects of the abductions and time travel, a la in Michael Chrichton's Timeline, but for those to be helpful, they must be unambiguously interpretable.

27. God no, as it were, this isn't scientific. It's a religious claim futilely attempting to explain the natural world. Futile because it only begs the question. If one accepts that God is real, then further accepts that God made the laws, one is still no closer to asking the real scientific question here: How did those laws come about?

"Quick Quiz"

29. b
30. a
31. b
32. b
33. c
34. c
35. b
36. b
37. a
38. b

"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 date. Note 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 is at 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, cancel out to 1. We note that there is simply a linear, direct relation between the force of gravity and the mass involved. 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. ($Fg \propto 1/d^2$) So, the inverse of ⅓ 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 ⅓ its present size.