Problem Set #8

Due Wednesday, May 21 by 5pm to Dickinson 104

Unless otherwise indicated, all problems come from "The Cosmic Perspective," 8e

1. Table 10.2 in your book shows that Venus's temperature in the absence of the greenhouse effect is lower than Earth's, even though Venus is closer to the Sun.
    a) What would Venus's "no greenhouse" temperature be if its clouds were more transparent, giving a reflectivity the same as Earth's? (*Note: Table 10.2 - along other parts of your book - uses "reflectivity" instead of "albedo," the word we used in class. They are the same thing; just different words.)*
    b) What would the actual surface temperature of Venus be in this case, assuming that greenhouse warming increased the surface temperature by the same amount is it does on actual Venus?
2. The star 51 Pegasi has about the same mass and luminosity as our Sun and is orbited by a planet (51 Pegasi b) with an orbital period of 4.23 days and a mass estimated to be 0.6 times the mass of Jupiter.
    a) Use Kepler's Third Law to calculate the 51 Pegasi b's average distance (semimajor axis) from its star.
    b) Suppose 51 Pegasi b reflects 30% of the incoming sunlight (as Earth does). Using Mathematical Insight 10.1, calculate its "no greenhouse" average temperature.
    c) Repeat part (b), but assume that the planet is covered in bright clouds that reflect 75% of the incoming sunlight (as Venus does).
    d) Based on your answers to parts (b) and (c), do you think it is likely that the conditions on 51 Pegasi b could be conducive to life? Explain.
    e) What fraction of light would need to be reflected by 51 Pegasi b to have its "no greenhouse" temperature match Earth's "no greenhouse" temperature?
3. Problem 10.55 *Earth to Mars*
4. Problem 24.43 *Likely Suns*
5. Problem 24.53 *Funding the Search for Life*
6. Venus, Earth, and Mars are the three planets in the solar system that are in (or close to in) the Sun's Habitable Zone. Earth is the one planet in our solar system around which "everything went right." That is, Earth is the only planet that had conditions necessary for complex, multicellular life to evolve. Explain how Earth was different, making sure to describe at least three physical processes that led to life forming on Earth but not on the other two planets.