Part I: Inverse Square Law

The observed brightness of an object drops off as one over the square of the distance. That is, each time you double the distance from a glowing object, the brightness of it you observe will drop by a factor of four.

1) Consider two stars, Star A, and Star B. Suppose that Star A has exactly the same luminosity as Star B. If Star A is 10pc away, and Star B is 20pc away, what is B_B/B_A, the ratio of the observed brightness of Star B to that of Star A?

2) Now consider Star C, which has one half the luminosity of Star A. Suppose it is at the same distance as Star A. Will it have the same brightness as either Star A or Star B (and if so, which one), will it be brighter than both, will it be dimmer than both, or will it have a brightness somewhere in between? Explain your reasoning.

3) Star D has the same luminosity as Star A, and is at a distance of 40pc. What is the ratio B_D/B_A of the brightnesses of Star D and Star A?

4) Two students are discussing their answers to question 3:

   Student 1: *Star D should be 1/8 as bright as Star A. It is four times as far away, and we know that when you double the distance, the brightness drops four times. Four times as far away means that you had to double twice, so you have to drop the brightness by four times twice.*

   Student 2: *You didn't drop the brightness by four times twice. A ratio of 1/8 means that you divided the brightness by four, but then only by two, as 1/4 divided by two is 1/8. If Star D is four times as far away as Star A, but has the same luminosity, then it will be four squared, or sixteen times, dimmer. The brightness ratio of Star D to Star A is 1/16.*

   Student 3: *Why do Students 1 and 2 always get all the glory? Doesn't anybody want to hear what I have to say?*

   Do you agree or disagree with either or both students? Why? (Please continue to ignore Student 3.)

Part II: Luminosity/Brightness/Distance/Temperature/Size

5) Consider Star E and Star F. You measure the parallax angle of Star F to be twice that of Star E. Which star is closer?

6) Suppose that Star E and Star F have exactly the same color. What can you say about the temperature of the two stars?

7) Suppose that Star E and Star F are observed to have the same brightness. Which star is bigger, or are they the same size? Explain your answer.

8) Prepare to do some math. This one is harder.

   Star G appears four times as bright as Star H. Parallax measurements indicate that Star G is twice as far away as Star H. Suppose you are able to determine that Star G is twice the size of Star H.

   If Star H has a surface temperature of 6,000K, what is the surface temperature of Star G? (**Hint:** this one is hard to do in one step. Discuss what steps you might break this down into with the people you're working with.)

Part III: Mis-estimating Distance

9) You observe a star. From it's spectral type, you are able to determine what its luminosity ought to be. You measure the brightness, and by comparing the luminosity and the brightness you determine a distance estimate to the star.

   However, what you don't realize is that there is a dark, dusty cloud between you and the star. This dusty cloud absorbs some of the light of the star, making it appear 1/25 as bright as it would have if there hadn't been all that dust in the way.

   Will this make your distance determination to the star an *overestimate* or an *underestimate*? Explain.

10) By what factor (i.e. 5 times, 10 times, etc.) did you overestimate or underestimate the distance to the star in question 9? If you calculated a distance of 100pc, how far away is it really?