Physics 306, Honors Astronomy, Exam 2

NAME______________________________________

You are graded on your work, with partial credit where it is deserved.

1. We discussed 6 basic methods for determining distances to objects in astronomy, 3 of which involved "standard candles" and 3 of which involved other techniques. Below, pretend that you are describing each of these 6 methods to a family member or friend who knows nothing about astronomy, and who will look at you quite skeptically unless you are absolutely clear about how the method works.

I.e., the score on the question depends on how clear and convincing your description is. Draw a picture if it will help.

(a) (4)

(b) (4)

(c) (4)

(d) (4)

(e) (4)

(f) (4)

2. Again pretend that you are explaining to a skeptical family member or friend who knows nothing about astronomy. This time describe in a couple of sentences what is meant by each of the following features in a spiral galaxy. For a visible part, say something about the nature of the stars found there.

(a) (3) dark matter halo

(b) (3) halo (meaning visible halo with stars)

(c) (3) disc

(d) (3) nuclear (or central) bulge

(e) (3) globular cluster

(f) (3) density wave

3. (a) (3) Why is the sky blue?

(b) (3) Why are sunsets red?

4. Looking for something more dramatic than a roller-coaster, you ride an accretion disk into a black hole. 10% of your mass is radiated away.

(a) (5) Calculate your mass using the fact that a weight of 2.2 pounds means a mass of 1 kg. Then calculate how much energy is radiated away according to Einstein's famous mass-energy relation.

(b) (5) It turns out that you normally radiate about 100 watts of infrared (heat) energy when you are sitting still. How long would you have to radiate at this rate to emit the energy that you calculated in Part (a)?

5. (15) The innermost rings of Saturn orbit in a circle with a radius of 67,000 kilometers at a speed of 23.8 km/s. Calculate the mass within these rings, which is essentially the mass of Saturn.
(Recall $M = rv^2 / G$, $G = 6.67 \times 10^{-11}$ m^3/kg s^2 .)

6. A hydrogen atom emits a red visible-light photon of wavelength 656 nm when the electron falls from the 3 to the 2 level. When you measure the wavelength for this same spectral line but for hydrogen in a distant star, you find the Doppler-shifted line to be 636 nm.

(a) (7) Is this star moving toward you or away from you? Explain.

(b) (8) Calculate its speed. (Recall $\frac{v_{\text{radial}}}{c} = \frac{\lambda_{\text{shifted}} - \lambda_{\text{at rest}}}{\lambda_{\text{at rest}}}$, $c = 3.00 \times 10^8$ m/s.)

7. Star A (a blue giant) has a surface temperature of 30,000 K, and Star B (a red dwarf) has a surface temperature of 3000 K.

Let λ_A be the wavelength for Star A at the peak in intensity-versus-wavelength (i.e., what the textbook calls λ_{max}), and λ_B be the corresponding quantity for Star B.

Let I_A be the intensity of the radiation emitted by Star A (in watts/m^2), and I_B be the corresponding quantity for Star B.

(a) (6) Calculate λ_A / λ_B using Wien's law for how the characteristic wavelength λ_{max} changes with temperature.

(b) (6) Calculate $\frac{I_A}{I_B}$ using the Stefan-Boltzmann T^4 law.

8. (a) (5 points extra credit) Discuss active galaxies, following Dr. Lifan Wang's presentation on this subject. Please give some specific facts about these galaxies.

Have a pleasant weekend!