ASTR 220 Homework #7
Spring 2005
Due Tuesday, April 19, 2005, *at the beginning of lecture.*

All of the textbook questions are from *The Essential Cosmic Perspective.*
Please neatly write or type your homework.
Be aware of potential plagiarism: make sure to put the answer into your own words. Feel free to discuss the questions with your classmates, but write up the answers yourself - do not copy.
Make sure to show your work for any calculations - answers that appear like magic will receive no credit.

1. Explain why more massive white dwarfs are smaller in size than less massive white dwarfs.

2. Jocelyn Bell discovered the first pulsar by observing that it emitted radio waves every 1.337301 s. The radio waves have a wavelength of 18 cm (0.18 m).

   (a) What is the speed of the radio waves?
   (b) What is the frequency of the radio waves she detected?
   (c) From your previous answer, what is the period of the radio waves?
   (d) Why isn't your answer in part c equal to 1.337301 s? (It shouldn't be.)
   (e) If you had extremely sensitive hearing, would you be able to hear the pulses from the pulsar?

3. Ch. 13, Review Problems, #10.

4. Ch. 13, Sensible Statements, #19.

5. Calculate the Schwarzschild radius for each of the following.

   (a) A supermassive black hole with 1×10^8 times the Sun's mass that is in the center of a quasar. (The Sun's mass is $2 \times 10^{30} kg$.)
   (b) A black hole that has 5 times the Sun's mass and formed in the supernova explosion of a massive star.
   (c) A mini-black hole that formed when an extremely advanced civilization of aliens decides to punish you (unfairly, of course) by squeezing you until you become so small you are a black hole. (You'll have to estimate your mass. 1 kg = 2.2 lbs.)

6. How many orbits around the Milky Way galaxy will the Sun make in its lifetime? Show your work.

7. In class, we discussed how the spiral arms in the Milky Way cannot be created by a fixed pattern of the same stars. You are going to show this by drawing diagrams of the motions of three stars in the disk of the galaxy. You will draw five separate diagrams as described below.

   In your diagrams, assume that we are looking down on the Milky Way so that it looks round. Mark a dot in the center for the center of the galaxy. We are looking down at the "north" pole, so the stars will orbit in a counter-clockwise direction.

   Draw orbits for three stars, evenly spaced away from the center of the galaxy. The inside orbit is for Star 1, which has an orbital period of 60 million years. The middle orbit is for Star 2, which has an orbital period of 90 million years. The outside orbit is for Star 3, which has an orbital period of 120 million years.

   Now draw a diagram for each of the following times (on the next page). On each diagram, mark where each star is, and draw a line connecting the three stars. (This line represents a possible spiral arm.)

- t=0. (The starting time. You can line up all three stars right in a row.)
- t = 30 million years.
- t = 60 million years.
- t = 90 million years.
- t = 120 million years.

After you are finished with the diagrams, *use them to help you explain why spiral arms cannot be made of fixed patterns of the same stars.*

8. Ch. 14, Sensible Statements, #17.

9. Ch. 14, Sensible Statements, #24.