Name:

1. What astronomy/astrophysics/or cosmology courses you have taken at CMU or elsewhere (list topics, not course numbers)?

2. What programming languages have you used before, and how much? Do you have any experience with Python, and if so how much / what did you do with it?

3. What are you most interested in learning about in this course?

4. Do you have any questions or concerns about the course you would like me to address next time?

Review and Diagnostic Exercise

1. Using this Hertzsprung-Russell diagram, answer the following questions. If two stars look like they might have the same position horizontally or vertically, they in fact do.

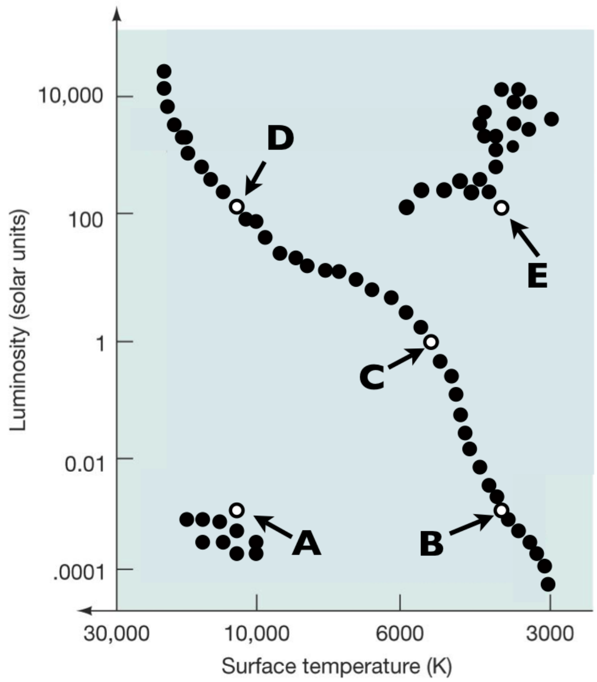

Figure 1: Hertzsprung-Russell Diagram.

A) Which marked star (A-E) is the highest-mass main sequence star shown?

B) Which marked star(s) will have the longest main-sequence lifetime?

C) Which marked star(s) will not be seen in a 100,000 year old star cluster (i.e., one in which all the stars are 100,000 years old)?

D) Which marked star(s) will not be seen in a 9 billion year old star cluster?

E) Which marked star(s) will have spectral type K?

F) Which marked star(s) will have the highest density of matter?

G) Which marked star(s) will appear bluest?

H) Which marked main sequence star(s) will be most abundant?

2. What are the three main types of galaxies? List the types from greatest (maximum) mass to least. Indicate which type(s) contain a large number of young stars (as fraction of the total), and which type of galaxy we live in.

3. We attempt to measure the age of stars in a galaxy 3 billion parsecs away. If all of the stars formed 12.8 billion years ago (1 billion years after the Big Bang), what will we measure their age to be? *(Note: useful constants are on the last page)*?

4. The distribution of dark matter in a galaxy can be approximated as being spherically symmetric, with density falling off with radius as r^{-2}; hence we can write the density as $\rho(r) = \rho_0 r^{-2}$. Determine an expression for the total mass of dark matter within radius R.

5. Consider a galaxy that starts at time $t = 0$ with some amount of gas, $M = M_0$, and gradually turns it into stars at a rate proportional to the amount of mass in gas available: so $\mathrm{d}M/\mathrm{d}t =$ - λM, where λ is some number.

   a) Give an example of appropriate units for λ.

   b) Given the information above, determine a formula for the amount of gas available at time t; i.e., what will $M(t)$ be?

6. What is the most abundant element in the Sun?

7. Summarize the life cycle of a star like the Sun (beginning before it is a star and continuing to >10 billion years in the future). How does it produce energy at each stage?

8. Why are supernovae important for the existence of life on Earth?

9. Explain the process that leads to at least one type of supernova (explain two distinct types, if you can).

10. The Earth goes around the Sun in an orbit that is approximately a circle with radius 1.5×10^{11} m, taking one year (3.16×10^{7} seconds) to go around once completely. Given this information, what is the mass of the Sun, in kilograms?

11. Write a few lines of Python code that print out the numbers from 1 to 10 (using some form of loop/iterator). (If you don't know how to do this just indicate that!)

12. Write a few lines of Python code that plots sin(x) as a function of x over the x range from 0 to 10. (If you don't know how to do this just indicate that!)

13. Describe some methods to measure the distance to an astrophysical object.

1 Numbers for reference

- The universal gravitational constant is $G = 6.67 \times 10^{-11}$ m^3/(kg s^2) $= 4.5 \times 10^{-6} (km/s)^2 kpc/\mathrm{M}_\odot$, where $\mathrm{M}_\odot$ is the mass of the Sun.
- The speed of light in a vacuum is $c = 3 \times 10^8$ m/s.
- The mass of the earth is $M_\oplus = 6 \times 10^{24}$ kg.
- The radius of the Earth's orbit is 1 AU $= 1.5 \times 10^{11}$ m
- The surface temperature of the Sun is $T_\odot = 5800$ K.
- 1 AU $= 1.5 \times 10^{11}$ m.
- 1 pc $= 3.09 \times 10^{16}$ m $= 3.26$ ly.
- 1 ly $= 9.46 \times 10^{15}$ m.
- There are roughly 3.155×10^7 seconds in a year.