Astronomy 102: Stars and Galaxies

Examination 2 Review Problems

Multiple Choice Questions: The first eight questions are multiple choice. Except where explicitly noted, only one answer is correct for each question. Circle the letter of the correct answer. Each multiple choice question is worth **4 points**

1. Which of the following statements is true?
- (a) All stars appear the same color.
- (b) All stars are the same temperature.
- (c) All stars have the same luminosity.
- (d) All stars are the same age.
- (e) We can only see any stars from the surface of the Earth during night time.
- (f) No statement in (a) through(e) is true.

2. An artist who likes working with sources of light decides to make a modern sculpture out of electrified glass tubes that contain a very thin (rarefied) gas. When the sculpture is finished, and the electricity is turned on, the tubes glow with a rich red color. What we are primarily seeing is:
- (a) A cool spectrum
- (b) A continuous spectrum
- (c) An absorption spectrum
- (d) A blackbody spectrum
- (e) An emission spectrum

3. An astronomy graduate student studies a new star and wants to determine its temperature. She would do this by:
- (a) Measuring the wavelengths and the strengths of the star's absorption lines
- (b) Measuring the brightness star at two different wavelengths and comparing the flux at each wavelength
- (c) Measuring the intensity of ultraviolet the star gives off
- (d) Measuring the total brightness of the star
- (e) Measuring the parallax of the star
- (f) Sending a space probe with a thermometer to the star

4. Why are high temperatures required in order for Hydrogen to undergo fusion?
- (a) Because higher temperatures imply a bluer object, and bluer stars have more fusion than redder stars.
- (b) Because higher temperature gas is always denser, and you need a high density so that Hydrogen atoms react frequently.

(c) Because higher temperature means that the individual particles are moving faster; positively charged Hydrogen nuclei have to be moving very fast to overcome their electrostatic repulsion.

(d) Because you can't produce neutrinos at lower temperature

(e) Because fusion occurs at the cores of stars, and stars are the only bodies that emit their own light. The light that stars emit comes from energy generated by fusion.

5. The Sun is an enormous ball of gas. Left to itself, a ball of so many atoms should collapse under its own tremendous gravity. Why is our Sun not collapsing?

(a) The gravity of the planets around the Sun pulls its material outward, preventing collapse.

(b) The pressure of the photosphere keeps the Sun's main body of gases confined to a small volume.

(c) Nuclear fusion in the core keeps the temperature and the pressure inside the Sun at a high enough level so that gravity is balanced.

(d) Neutrinos from the core exert an enormous pressure on the layers of the Sun as they travel outward, and keep our star from collapsing.

(e) The Sun's rotation pushes the material outward to balance the inward pull of gravity.

6. Using a pair of binoculars, you observe a section of the sky where there are stars of many different apparent brightnesses. You find one star that appears especially dim. This star looks dim because it is:

(a) Radiating most of its energy in the infrared region of the spectrum.

(b) Very far away

(c) Very low in luminosity

(d) Partly obscured by an interstellar cloud

(e) It could be more than one of the above; there is no way to tell which answer is right by just looking at the star.

7. An astronomer measures a certain amount of energy in red light, and the *same* amount of energy in blue light. Which statements below are true? **More than one answer may be correct; circle all that apply.**

(a) The astronomer has measured more red photons than blue photons.

(b) The astronomer has measured more blue photons than red photons.

(c) The astronomer has measured the same number of red and blue photons.

(d) The red and blue photons are at the same frequency.

(e) The red photons must be coming from a closer star than the blue photons.

8. Which statement explains why more massive main sequence stars are shorter lived than less massive main sequence stars?

(a) More massive main sequence stars are bluer, and thus hotter. Because they are hotter, they are radiating energy at a higher rate, and hence are cooling off faster. Thus, they won't last as long as less massive and cooler stars.

(b) The most massive main sequence stars are about 100 times as massive as the sun, but can be millions of times as luminous. Because all main sequence stars generate energy through Hydrogen fusion, even though more massive stars have more fuel (Hydrogen) they are using that fuel at a proportionately higher rate to maintain their much higher luminosity, and thus will use up their fuel faster.

(c) More massive main sequence stars are made up of primarily heavier elements, whereas the sun is 90% Hydrogen and 10% Helium. Because main sequence stars generate energy from Hydrogen fusion, less massive stars have more Hydrogen and thus will last longer.

(d) More massive main sequence stars are not only bluer and hotter than less massive main sequence stars, but also larger (i.e. have a larger radius). This means that more of the star will transport energy through convection, which is always more efficient than radiation and therefore will use up the star's energy faster.

Short Answer Questions: Answer questions in the space provided. Indicate clearly if you must continue on the back of the page. Include any calculations or diagrams necessary. Some questions require only a word or a few words, others will require a sentence or two of explanation, and others will require a calculation. **Be brief and to the point.**

9. Astronomers can detect gaseous hydrogen in the galaxy by observing the 21cm ($\lambda =$ 21 cm) line of Hydrogen with radio telescopes.

(a) What is the frequency of a 21cm photon?

(b) What is the energy of a 21cm photon?

(c) What is the ratio of the energy of a 21cm photon to a blue photon ($\lambda = 4500$Å)?

9. A star which has a measured parallax of $1''$ (1 arcsecond) is at a distance of 1 pc (1 parsec). The Andromeda Galaxy is about 0.8 Mpc (0.8 million parsecs) away; what would be the measured parallax of a star in the Andromeda Galaxy?

10. Star A is the same temperature as Star B, but Star A's radius is twice Star B's radius.

(a) What is L_A/L_B, the ratio of Star A's luminosity to Star B's luminosity?

(b) If Star A and Star B appear equally bright to an observer on earth, what is the ratio d_A/d_B between the distance to Star A and the distance to Star B?

11. Consider two binary star systems, System A and System B. Both binary systems have been measured to be at the same distance from us, and the distance between the two stars in System A is the same as the distance between the two stars in System B. However, System A has a *longer* period, i.e. it takes longer for the stars in System A to complete one orbit around each other than it does for the stars in System B. Which binary system has more total mass (i.e. the mass of the two stars added together), and why? One way to measure more distant stars is to be able to measure smaller angles. Suppose, however, that you've pushed angle measuring technology as far as you've been able to, and cannot measure even smaller angles. If budgetary considerations weren't a worry, how might you be able to measure the distance to further stars than currently possible using the method of parallax?

12. From our consideration of thermal equilibrium, we decided that the average surface temperature of an object closer to the Sun will tend to be higher than the average surface temperature of an object further from the Sun.

(a) From this, can we conclude that the Earth is closer to the Sun in the winter (when temperatures are colder) than in the summer (when temperatures are warmer)? Why or why not?

(b) Can we conclude the the total albedo of the Earth is higher in the winter than it is in the summer? Why or why not?

13. A certain white dwarf star as a surface temperature of 10,000K and a radius equal to the radius of the Earth. What is the luminosity of the white dwarf in units of solar luminosity? (I.e., what is the ratio of the white dwarf's luminosity to the Sun's luminosity?)