Astronomy 102: Stars and Galaxies
Final Exam Review Problems
Revision 2

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. As observed from the northern hemisphere (e.g. from Nashville), a star which is *south* of the Celestial Equator will:
 (a) be circumpolar, and always visible.
 (b) set 12 hours after it rises.
 (c) set less than 12 hours after it rises.
 (d) cross the celestial equator at midnight.
 (e) rise exactly perpendicular to the horizon.

2. The Moon shows phases because:
 (a) as the Moon goes around the Earth, different parts of it fall into Earth's shadow.
 (b) the same side of the Moon is always facing at the Earth, but as the Earth rotates during the day we see the Moon lit differently.
 (c) as the Earth goes around the sun, the tilt of its axis changes.
 (d) as the Moon goes around the Earth, the side we're looking at is at differening angles to the side lit by the Sun.
 (e) of an atmospheric effect on Earth.

3. An astronomer observes two planets. Over the course of the year, at least on some nights both planets are visible at midnight. Also over the course of the year, Planet A moves relative to the background stars *more* than planet B does. Planet A has the same measured angular diameter as Planet B. Which of the following statements can the astronomer make?
 (a) The two planets have the same physical size.
 (b) Planet A is larger than Planet B.
 (c) Planet A is smaller than Planet B.
 (d) Planet B is likely to be orbiting another star.
 (e) Planet A will escape the Sun's gravity once the Sun loses some of its mass as a red giant.

4. An astronomer observes the orbit of a binary star system, and labels the two stars Star A and Star B. She notices that Star A orbits in a larger circle than does Star B. From just this information, what else can the astronomer conclude about this star system? (**More than one may be correct. Circle as many as apply.**)

(a) Star A is moving with a faster orbital velocity than Star B.
(b) Star A is moving with a slower orbital velocity than Star B.
(c) Star A is more massive than Star B.
(d) Star B is less massive than Star B.
(e) If the system experiences a supernova, Star A will supernova before Star B.
(f) If the system experiences a supernova, Star B will supernova before Star A.

5. An ultraviolet photon has more energy than a radio photon. Which of the following are true? **More than one may be correct. Circle all that apply.**

(a) The ultraviolet photon has a longer wavelength than the radio photon.
(b) The ultraviolet photon has a higher frequencey than the radio photon.
(c) The ultraviolet photon moves faster than the radio photon.
(d) The ultraviolet photon can be seen, but the radio photon can only be heard.
(e) If both photons were emitted by other galaxies and then observed at Earth, the ultraviolet photon must come from a much closer galaxy than the radio photon.

6. A binary star system consists of two stars orbiting each other. Both stars are observed to be the same brightness. One is red, one is blue. Which of the following is true?

(a) The two stars are the same size.
(b) The red star is closer to us than the blue star.
(c) The red star is farther from us than the blue star.
(d) The red star is bigger than the blue star.
(e) The red star is smaller than the blue star.
(f) We cannot conclude any of (a) through (e) with the information provided.

7. You discover a young open cluster of stars in the disk of a distant galaxy. The resolution of your telescope isn't high enough to get the spectrum of the individual stars, but only a combined spectrum from the whole cluster. What is this spectrum most likely to resemble?

(a) The spectrum of a high-mass main sequence star (a B star)
(b) The spectrum of a more common low-mass main sequence star (a K or M star)
(c) The spectrum of a globular cluster
(d) The spectrum of dark matter

8. A star moving toward the Sun shows:
   (a) A shift in the spectral lines toward the blue end (as compared to the laboratory positions of these lines)
   (b) A shift in its position in the sky
   (c) A shift in the spectral lines toward the red end (as compared to the laboratory positions of these lines)
   (d) A significant increase in its apparent brightness
   (e) The stars are so far away that we cannot measure any change with present instruments.

9. Why do all stars spend most of their lives on the main sequence?
   (a) Because the neutrinos created inside the star do not carry any energy away with them.
   (b) Because during this stage the star contracts from enormous size to a relatively small ball; this takes a long time.
   (c) Because the fuel for energy production in this stage of the star's life is hydrogen; and that is an element every star has lots and lots of.
   (d) Because at this stage, the processes inside the star do not generate any energy; thus the star can continue in this stage indefinitely.
   (e) This is an unsolved problem in astronomy, and an important project for the Hubble Space Telescope to work on.

10. Suppose your astronomy professor told you he had discovered an O-type main-sequence star in our Galaxy composed entirely of hydrogen and helium. You should:
   (a) Not believe him. Because O stars have short lifetimes, therefore the star must be young, and if the star is young, it must have formed from material which has been "polluted" by ejecta from previous generations of massive stars which will also contain elements heavier than H and He.
   (b) Not believe him. Because O stars are massive enough to fuse H and He into heavier elements, which we should then see in this star.
   (c) Believe him. Because professors are never wrong.
   (d) Believe him. Because if the star formed shortly after the Big Bang, there would not have been an heavy elements around for it to form from.

11. As the Sun approaches the end of its life, it will swell into a red giant. During these late stages of its life, it will lose a reasonable fraction of its mass (something less than half) by shedding it out into the interstellar medium. When this happens:
   (a) The planets will spiral in closer to the Sun due to the change in gravity.
   (b) The planets will spiral out to larger orbits due to a change in gravity.
   (c) As the gravitational force due to the Sun's reduced mass goes down, the Sun will lose its grip on the planets and they will go flying off into interstellar space.
   (d) The surface temperature of all the planets will go down due to the lower temperature of the redder Sun.

12. If you observe an astrophysical gas with an emission-line spectrum, which of the following is most likely to be true?

(a) The gas has very high density

(b) The gas is ionized by the ultraviolet light of a nearby star.

(c) Those lines will be blueshifted, because the gas is hot and hot particles move with high speed.

(d) The gas you are looking at must be dark matter.

(e) The gas you are looking at must be very cool.

13. Which of the following statements about the similarities and differences between thermonuclear (Type Ia) supernovae and core collapse supernoave (Type II) is correct?

(a) Both types of supernoave are similar because they release a similar amount of energy over a simlar period of time; they are differnet because they are very different types of stars exploding with very different mechanisms.

(b) Both types of supernovae are similar because their energy comes from gravitational potential energy; they are differnet because they show very different features in their spectra (e.g. one type has Hydrogen lines, the other doesn't, etc.).

(c) Both types of supernoave are similar because they only occur in sprial galaxies; they are different because thermonuclear supernovae are many times more common than core collapse supernovae.

(d) Both types of supernoave are exploding stars; they are different because a star can become a thermonuclear supernova after having been a core collapse supernova, but it can never become a core collapse supernova after having been a thermonuclear supernova.

14. If you observe a spiral galaxy, what differences do you see in the color and brightness of the spiral arms and the regions of the disk between the spiral arms, and why?

(a) The spiral arms are much brighter than the regions in between because all the stars are in the arms, and the regions in between are filled with dark matter.

(b) The spiral arms are redder than the regions in between because of all the dust in the spiral arms.

(c) The spiral arms are bluer than the regions in between because that's where most star formation is happening, so that's where you find short-lived massive blue stars.

(d) The spiral arms are redder than the regions in between because most of the red giants congregate in the spiral arms.

(e) The spiral arms are brighter than the regions in between because globular clusters are found in the spiral arms, whereas open clusters are found only in the intraarm disk regions, and globular clusters are much more luminous than open clusters.

15. Astronomy is (circle only one):

(a) Cool.

(b) Potentially either cool or not cool, and we can tell by observing whether it is more reddish or more bluish in color.

(c) Bitterly cold (if we're talking lab in January).

(d) That thing in the newspaper next to the comics.

(e) What Prof. Knop spends enough time doing such that he's unable to come up with a reasonable 15th multiple choice question for the review final.

(f) Zero or more of the above.

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 a few sentences of explanation, and others will require a calculation. **Be brief and to the point.**

16. You wake up in the middle of the night and forget where you are. You go outside and observe the constellations, hoping to get your bearings.

(a) The constellation of Orion, which you know is near the celestial equator, is much higher in the sky than you are used to observing it from where you live. What can you conclude about where you are on Earth compared to where you live?

(b) You find the constellation of Orion hovering over the horizon at about the right hight as it crosses your meridian, but it's *upside down*, with Rigel at the top and Betelgeuse at the bottom. What can you conclude about where you are on Earth?

17. You are in Nashville (latitude=+36°), and you are looking at the night sky. You observe three stars. Star B is *due north* of Star A, and Star C is *due west* of Star A. For each of the following, sketch the three stars and indicate which is which.

(a) You are facing the horizon to the *east*, and the three stars have recently risen.

(b) You are facing the horizon to the *south*, and the stars are crossing your meridian.

(c) You are facing the horizon to the *west*, and the stars will set shortly.

18. Consider two stars of the same luminosity. Star A has a surface temperature which is twice that of Star B.

(a) What is the ratio R_B/R_A of the two stars' sizes?

(b) Suppose that a future extreme high resolution telescope observes the two stars, and determines that they have the *same* angular diameter. What is the ratio d_B/d_A of the distance to the two stars?

(c) What is the ratio F_B/F_A of the observed flux from the two stars?

19. The gas in ellpitical galaxies is very hot and ionized. However, there are no hot massive young stars in these galaxies (which have no active star formation) to ionize that gas. What could be providing the energy that keeps this gas hot and ionized?

20. Given that (a) the universe is undergoing a uniform expansion, and that (b) we do see a reasonable number of merging galaxies, would you expect that if we were able to measure the average mass of a galaxy showing a high redshift, would it be greater or lower than the average mass of a galaxy showing a low redshift? Why?

21. High mass stars, after their life is done, leave behind a neutron star (or, rarely, a black hole), whereas low mass stars leave behind a white dwarf. Low mass stars are much more common than high mass stars. However, if you estimate the number of neutron stars and white dwarfs there should be in our galaxy, you find that the ratio of the number of neutron stars to white dwarfs is *larger* than the ratio of the number of high mass stars to low mass stars. How can you explain this disparity?

22. The Universe is undergoing a uniform expansion with rate $H_0 = 72 \frac{\text{km/s}}{\text{Mpc}}$. An astronomer observes the Hα line (emitted wavelength 6563Å) in a Galaxy, and finds it at 6694Å.

(a) What is the redshift z of this galaxy?

(b) What is the recessional velocity v of this galaxy?

(c) How far away is this galaxy?

23. Most extrasolar planets are found by looking at the spectrum of the star, and looking for the characteristic signature of the changing gravitational attraction of an unseen planet as it orbits the star.

(a) What changes in the spectrum do you look for to see this characteristic signature?

(b) This method is most sensitive to planets of a certain range of size (i.e. more massive or less massive) at a certain distance from their star (i.e. closer or further). (In other words, it's easier to find planets of that size and distance than planets of other sizes or at other distances.) What is this method most sensitive to? Give two reasons why.