ASTR 1050: Survey of Astronomy *Fall 2012*

Practice Exam #3, November 29, 2012 (40 points total)
Instructor: Michael Brotherton
Covers material from Light through Stars and Galaxies

Instructions
This exam is **closed book and closed notes,** although you may use a calculator (much of the math on the exam may be easy enough to work without a calculator, however, but if you want to borrow one please ask!). Formulas and constants you might want during the exam are given on the last page. The exam consists of 40 multiple choice questions. Please mark with a number 2 pencil your answers on a blue 5-answer scan sheet (only one answer per question). Completely erase any stray marks. I have used a number of questions contributed by your classmates, or revised versions of them. In the special code section please fill in "EXAM03". Please don't cheat and make your best effort. Good luck!

Multiple Choice (40 questions)

1. Which is true about radio waves?
a. They travel at the speed of sound.
b. They travel at the speed of light.
c. They don't travel at all, just resonate in infinite space.
d. They have higher energies than gamma rays.
e. They have higher frequencies than X-rays.

2. Which part of the electromagnetic spectrum passes through the atmosphere from space to the ground?
a. Gamma Rays
b. X-rays
c. Far-Ultraviolet
d. Far infrared
e. Radio Waves

3. Which part of the electromagnetic spectrum do YOU emit at?
a. Gamma Rays
b. X-rays
c. Ultraviolet
d. Optical
e. Infrared

4. If two objects have the same temperature, but one has twice the surface area, how much more blackbody radiation does it emit?
a. the same
b. 2x
c. 4x
d. 8x
e. 16x

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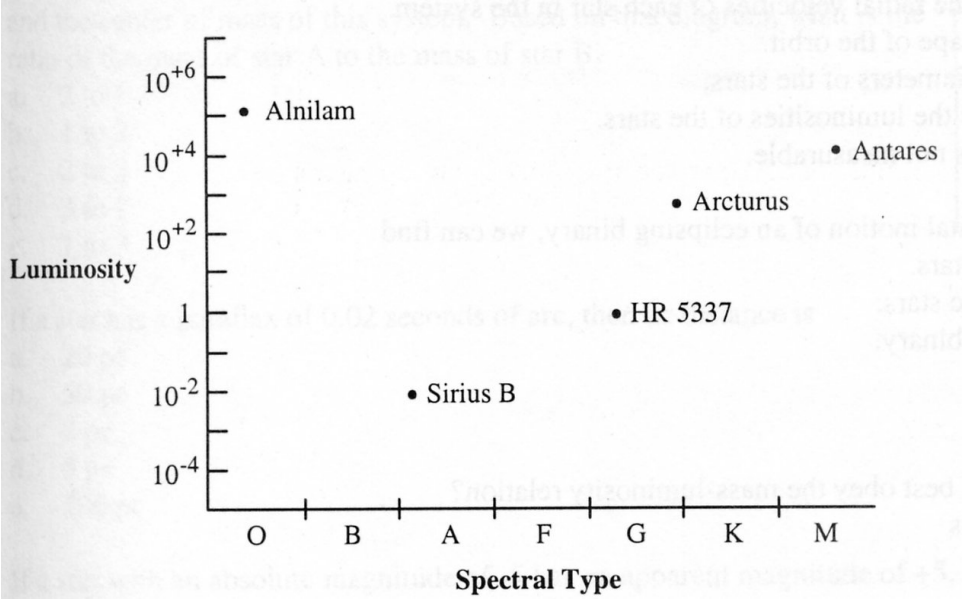
Use the H-R diagram, with luminosities in solar units, to answer the next 5 questions:



6. Which star in the diagram above is most like the sun?
a. Alnilam
b. Antares
c. Arcturus
d. HR 5337
e. Sirius B

7. Which star in the diagram above has the greatest surface temperature?
a. Alnilam
b. Antares
c. Arcturus
d. HR 5337
e. Sirius B

8. Which star in the diagram above has the largest radius?
a. Alnilam
b. Antares
c. Arcturus
d. HR 5337
e. Sirius B

9. Which star is a white dwarf?
a. Alnilam
b. Antares
c. Arcturus
d. HR 5337
e. Sirius B

10. Which star is the largest?
a. Alnilam
b. Antares
c. Arcturus
d. HR 5337
e. Sirius B

11. We know that giant stars are larger in diameter than the sun because
a. they are more luminous but have about the same temperature.
b. they are less luminous but have about the same temperature.
c. they are hotter but have about the same luminosity.
d. they are cooler but have about the same luminosity.
e. they have a larger absolute magnitude than the sun.

12. The net result of a proton-proton chain reaction is the transformation of_____ hydrogen nuclei into one helium nucleus plus energy. (fill in the blank)
a. 1
b. 2
c. 3
d. 4
e. 5

13. Where are the smallest and coldest stars located in the H-R diagram?
a. top left
b top right
c middle
d bottom left
e. bottom right

14. What is the approximate lifetime of a star on the main sequence, in solar lifetimes, if it is three times more massive than the sun?
a. The same as the sun.
b. 1/3 solar.
c. 3 times solar.
d. 6 percent (0.06) times solar.
e. Impossible to say.

15. If an interstellar cloud has a blackbody emission spectrum with a peak intensity of 50 microns wavelength, what temperature is the cloud?
a. 60000 K
b. 6000 K
c. 600 K
d. 60 K
e. 6 K

16. What is the most common type of star in the Milky Way?
a. O star
b. Red Giant
c. Red Dwarf
d. White Dwarf
e. Sun-like Star

17. Which one of the following is **not** true of supernova explosions?
a. A neutron star may be left behind.
b. A black hole may be left behind.
c. A white dwarf star may be left behind.
d. White dwarf stars in binary systems may explode as supernovas.
e. Massive stars explode as supernovas.

18. Which sequence below gives a valid evolutionary sequence for a star?
a. Protostar -> Main Sequence Star -> Red Giant -> Planetary Nebula -> White Dwarf
b. Protostar -> Main Sequence Star -> Neutron Star -> Supernovae
c. Protostar -> Planetary Nebula -> Main Sequence Star -> Red Giant -> White Dwarf
d. Protostar -> White Dwarf -> Red Giant -> Main Sequence Star
e. Protostar -> O star -> B star -> A star -> F star -> G star -> K star -> M star

19. What is a planetary nebula?
a. The dusty disk from which planets form around collapsing stars.
b. A fancy term for a cloud in the atmosphere of a planet.
c. A faint, large, and cool supergiant star.
d. A cloud of reflecting dust around a comet when it is being heated by the sun.
e. The hot exposed degenerate stellar core lighting up its expelled outer atmosphere.

20. Neutron stars resist gravitational collapse into black holes up to about a mass of 3 solar masses. What is the approximate Schwarzschild radius (R_s) of a 3 solar mass black hole?
a. About 3 km.
b. About 9 km.
c. About 300 km.
d. About 9000 km.
e. About 30000 km.

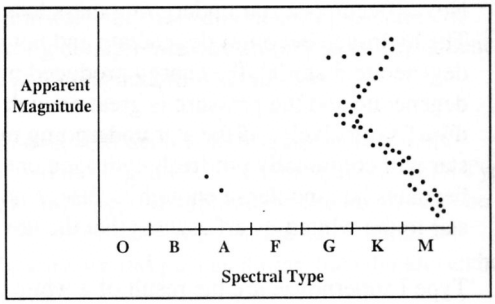
21. Which does **not** occur if we were to watch something fall into a black hole?
a. Time dilates–that is, the object appears to slow down and stop at the event horizon.
b. Light is redshifted–the light the object emits is greatly (infinitely) redshifted.
c. Great tidal forces act–the object is stretched out like taffy.
d. Mass is completely converted to energy–the whole object turns into X-rays.

22. If a young neutron star is the same temperature as a white dwarf, but the neutron star has a radius only 1/1000 that of the white dwarf, by what factor is the white dwarf **more** luminous?
a. 100
b. 1000.
c. 10000.
d. 10^5.
e. 10^6.

23. A star's apparent brightness as seen from here on Earth depends only on the star's:
a. distance and diameter.
b. temperature and distance.
c. temperature and diameter.
d. luminosity
e. luminosity and distance

24. Our galaxy is believed to surrounded by a substantial halo of dark matter because the disk of the galaxy
a. rotates faster than expected in its outer regions.
b. rotates slower than expected in its outer regions.
c. rotates faster than expected in its inner regions.
d. rotates slower than expected in its inner regions.
e. rotates at nearly the same speed, independent of distance from the galactic core

25. Given the H-R Diagram shown below, what is the approximate age of the stars in this cluster?



a. 10 million years
b. 100 million years
c. 1 billion years
d. 10 billion years
e. The age is impossible to tell from this figure!

26. The energy source at the center of our galaxy
a. is not normally visible (with current technology) at optical or near-infrared wavelengths.
b. produces X-rays and radio waves (seen with current technology).
c. must be less than 10 AU in diameter.
d. all of the above.
e. none of the above.

27. The mass of the black hole at the center of the Milky Way is
a. about the same as the sun's.
b. a few thousand solar masses.
c. a few hundred thousand solar masses.
d. a few million solar masses.
e. a few hundred million solar masses.

28. About how far is it across the full visible disk of the Milky Way? Basically, how big is our home galaxy, as seen in starlight, more or less?
a. a thousand light years.
b. five thousand light years.
c. 25 thousand light years.
d. nearly 100000 thousand light years.
e. about a million light years.

29. How was the coorect location of the center of our galaxy <u>first</u> determined?
a. from counting stars in the disk of the Milky Way.
b. from measuring distances and locations of globular clusters.
c. from mapping regions of star formation.
d. from pictures of the Andromeda galaxy.
e. from historical accounts of supernova explosions.

30. How do astronomers think spiral arms form?
a. From the propagation of spiral density waves which set off star formation in the arms.
b. From self-sustaining star formation combined with differential galactic rotation.
c. From the concentration of dark matter in rotating, spiral patterns.
d. a and b.
e. b and c.

31. If a galaxy (A) has a recessional velocity twice that of another galaxy (B), then according to Hubble's law it (galaxy A) must be
a. half as far away.
b. twice as far away.
c. four times as far away.
d. a hundred times as far away.
e. a hundred-forty-four times as far away.

32. The rotation curve of a galaxy (plot of velocity vs. radius) can be used, along with Newton's laws of Gravitation, to determine
a. the relative number of hot young stars in the galaxy.
b. the relative amount of gas and dust in the galaxy.
c. the radius of the galaxy.
d. the luminosity of the galaxy.
e. the mass of the galaxy.

33. Based on the galaxies found in the Local Group of galaxies, the most common type of galaxy in the universe is expected to be
a. the spiral galaxies.
b. the barred spiral galaxies.
c. the dwarf elliptical galaxies.
d. the irregular galaxies.
e. the giant elliptical galaxies.

34. What do astronomers believe does <u>not</u> happen when two large spiral galaxies collide?
a. spiral structure is preserved since the stars themselves don't actually collide.
b. stars may becomes pulled out into long structures called tidal tails.
c. large amounts of star formation occur.
d. an elliptical galaxy is formed.
e. nuclear activity can be ignited (e.g., a quasar or Seyfert galaxy).

35. Quasars must be physically small because they
a. have large redshifts.
b. are very luminous.
c. are surrounded by "fuzz" in the best images.
d. radiate energy in every part of the electromagnetic spectrum.
e. fluctuate rapidly in brightness.

36. Centaurus A is a radio galaxy, which appears to be an elliptical encircled by a ring of dust. The elliptical galaxy rotates about an axis that is in the plane of the dust ring. The dust ring rotates about an axis that is perpendicular to the axis of rotation of the elliptical galaxy. What does this suggest about the nature of Centaurus A?
a. The radio jets have caused the dust disk to be driven around the elliptical galaxy.
b. There are at least two black holes at the center of the elliptical galaxy.
c. Centaurus A is likely the result of a merger between an elliptical and a spiral galaxy.
d. Dust is produced as the radio jets interact with the intergalactic medium.
e. Elliptical galaxies often contain dust that forms a disk along their rotation axis.

37. Quasars are most common with redshifts
a. less than 0.5
b. 0.5 to 1
c. about 2 or 3
d. greater than 4 but less than 6
e. greater than 6

38. Tidal forces tend to try to pull objects into what shape?
a. Spheres
b. Frisbees
c. Teardrops
d. Strings
e. Ovals

39. Which is NOT a method used to measure distances in astronomy?
a. parallax
b. Cepheid variable period-luminosity relation
c. Supernova 1a as a "Standard Candle"
d. All of the above
e. None of the above

40. A galaxy is observed at a distance of one billion light years. Which of the following is true?
a. We see the galaxy the way it will be in one billion years.
b. We see the galaxy the way it was one billion years ago.
c. We see the galaxy the way it was when the universe was one billion years old.
d. We see what our galaxy will be like in one billion years.
e. We see infrared light shifted into the optical part of the spectrum.

Potentially Useful Relationships/Formulae

$$\frac{\text{Angular diameter}}{206265 \text{ arcsec}} = \frac{\text{linear diameter}}{\text{distance}}$$

Kepler's third law: P^2 is proportional to a^3

Newton's Constant of Gravitation: $G = 6.67 \times 10^{-11}$ m^3/s^2kg

Circular Velocity: $V_c = (GM/R)^{0.5}$

Newton's Law of Gravitation: $F = -GMm/r^2$

Photon Energy: $E= hc/\lambda$, where Planck's Constant is $h = 6.63 \times 10^{-34}$ J s

Classical Doppler shift: $V_r/c = \Delta\lambda/\lambda_0$, where λ is wavelength

Wien's Law: $\lambda_{max} = 3000000/T$ (λ in nm, T in degrees Kelvin)

Steffan-Boltzmann Law: $E = \sigma T^4$ ($J/s/m^2$), where $\sigma = 5.7 \times 10^{-8}$ $J/m^2s\ deg^4$

c = speed of light = 3×10^8 m/s

Einstein's Mass-Energy relationship: $E = mc^2$

Distance in pc: d = 1/p where p is the parallax in arcseconds

Stellar Luminosity $L = 4\pi R^2\sigma T^4$

Binary star version of Kepler's 3rd Law: $M_A + M_B = a^3/P^2$

Mass-Luminosity Relation for Stars (using solar units): $L = M^{3.5}$

Stellar Lifetimes in solar units (solar lifetime is about 10 billion years): $Time = 1/M^{2.5}$

Schwarzschild Radius, $R_s = 2GM/c^2$

Mass of the sun: 2×10^{30} kg