29:50 Stars, Galaxies, and the Universe
Second Hour Exam
November 10, 2010
Form A

There are 20 questions (**Note:** There will be 32 on the real thing). Read each question and all of the choices before choosing. Budget your time. No whining.

Walk with Ursus!

1. In class I discussed an observation which shows that the temperature in the interior of the Sun is higher than on the "surface", i.e. the layer in the atmosphere we see as the disk of the Sun. What is this observation?
   (a) granulation
   (b) oscillations in the Sun's diameter
   (c) solar flares
   (d) coronal mass ejections
   (e) a periodic variation in the Sun's color with a period of 3.4 years

2. The *Chandrasekhar Limit* refers to
   (a) the maximum mass that a star can have
   (b) the maximum mass of a white dwarf
   (c) the limit to the speed at which an object can travel
   (d) the outer extent of the Milky Way Galaxy
   (e) the shortest possible time a star can stay on the Main Sequence

3. At one phase in its lifetime after the Main Sequence, a star like the Sun produces a luminous cloud consisting of the matter that was once the outer layers of the star. The name for this class of objects is
   (a) planetary nebula
   (b) supernova remnant
   (c) Herbig-Haro object
   (d) spiral galaxy
   (e) supernova

4. In class I spent a lot of time talking about the way in which the radius of a white dwarf depends on its mass. The most important aspect of this relationship is that
   (a) the radius decreases with increasing mass
   (b) the radius increases with increasing mass

(c) the radius is a constant 6750 km, irrespective of mass
(d) mathematically, the radius becomes infinite at finite mass
(e) at masses greater than 8.0 $M_\odot$, the radius no longer depends on rotation

5. What are pulsars?
   (a) rotating neutron stars
   (b) rotating white dwarf stars
   (c) oscillating black holes
   (d) eclipsing binary stars with short periods
   (e) vibrations of very massive white dwarf stars

6. What is the object that is the remnant of a supernova about 1000 years ago, and which contains a famous pulsar?
   (a) 18 Scorpii
   (b) M27, the Dumbbell Nebula
   (c) M31, the Andromeda Nebula
   (d) NGC 1342, an open star cluster
   (e) M1, the Crab Nebula

7. The objects called HII regions are
   (a) dark, cold regions in space between the stars
   (b) glowing clouds of gas around hot, luminous stars
   (c) white dwarf stars that have cooled to very low temperatures
   (d) distant objects similar in mass and content to the Milky Way
   (e) clouds of neutral hydrogen that will produce stars in the near future

8. In an open discussion in class, we decided (based on what had been discussed to that point) that more massive stars should shine longer than less massive stars. It turns out that this is *not* true. The reason is a scientific fact which had not been discussed until that point. That fact is
   (a) The luminosity of stars increases drastically with increasing mass.
   (b) The luminosity of stars decreases drastically with increasing mass.
   (c) Massive stars don't shine for the same reasons that smaller mass stars do.
   (d) Massive stars are made of different elements than less massive stars.
   (e) The most massive stars are made of antimatter rather than ordinary matter.

9. Which of the following is a famous equation of physics which is crucial in understanding the power source of stars?
   (a) $E = mc^2$
   (b) $I = \frac{V}{R}$
   (c) $P = \sigma T^4$

(d) $\nabla \times \vec{E} = -\frac{1}{c}\frac{\partial \vec{B}}{\partial t}$
(e) $PV = nRT$

10. Virtually the only way to measure the mass of a star other than the Sun is to
(a) measure the gravitational redshift of the star.
(b) measure the spectral type of a star, then apply a formula presented in class to get the mass.
(c) measurable the gravitational pull of the star on all the other stars in the Milky Way galaxy.
(d) measure the modes of vibration of a star, and use those modes to give the mass.
(e) measure the properties of a binary star.

11. In class and in the book, we discussed three main classes of binary stars. These are
(a) visual, eclipsing, and spectroscopic
(b) visual, gravitational, and radiational
(c) eclipsing, radiation-dominated, and electromagnetic
(d) giant, bright giant, and supergiant
(e) spectroscopic, neutronic, and Alfvénic

12. Which of the following is an odd (but true) property of white dwarf stars?
(a) More massive white dwarfs are larger in size than less massive ones.
(b) White dwarf stars emit radiation only at x-ray wavelengths.
(c) White dwarf stars emit radiation only at radio wavelengths.
(d) All known white dwarf stars are located in the outer solar system, in what is called the "Kuiper Belt".
(e) More massive white dwarfs are smaller in size than less massive ones.

13. A white dwarf star can exist as a stable object for an infinite period, whereas the Sun has a finite main sequence lifetime. A major reason for this, which was discussed in class, is the fact that
(a) the force of gravity is much weaker for a white dwarf than it is for the Sun.
(b) white dwarf stars do not emit electromagnetic radiation, and so are not losing energy to space.
(c) the gas in the interior of a white dwarf is "degenerate", meaning that the pressure does not depend on the temperature.
(d) time runs more slowly in the vicinity of a white dwarf than a solar type star.
(e) white dwarfs are made of antimatter rather than normal matter.

14. The astronomical search for black holes consists of finding an object with one of the following sets of characteristics. Which is it?
(a) a binary star with a main sequence star and a red giant star possessing an apparent magnitude brighter than 5.0
(b) a binary star containing a nonluminous, nonstellar companion with a mass in excess of 3 solar masses
(c) a dark, roughly circular region of no light seen against a bright nebula such as the Orion Nebula
(d) a binary star containing a nonluminous, nonstellar companion with a mass less than 1.4 solar masses
(e) two solar-type stars surrounded by a cloud of intense radio emission

15. Think about a star cluster. Let's say you get the data you need and plot up a Hertzsprung-Russell diagram for a star cluster. You notice that the Main Sequence only extends to a certain point on the graph, then "disappears". What does this tell you about the star cluster.
(a) limits in the sample of stars it formed with
(b) its age
(c) its distance from us
(d) its absolute magnitude
(e) the probability that binary stars occur in the cluster

16. The post main sequence evolution of a star varies drastically depending on one of the stellar parameters listed below. Which one is it?
(a) age
(b) chemical composition
(c) mass
(d) location in the Milky Way
(e) apparent magnitude

17. Neutron stars exist as one of the following types of astronomical object. Which is it?
(a) pulsars
(b) quasars
(c) radio galaxies
(d) asymptotic giant branch stars
(e) spectral class B main sequence stars

18. Physically, supernovas correspond to
(a) the collapse of a core of a massive star.

(b) a flaring of an accretion disk around a white dwarf.
(c) gigantic versions of solar flares that occur on RS Canum Venaticorum stars.
(d) release of energy by the gravitational collapse of a star cluster.
(e) annihilation of matter and antimatter in the center of the Milky Way.

19. The reason that HII regions are seen around hot, bright stars is that
(a) the gas comes in contact with the hot stellar surfaces and begins to glow
(b) the gas in the HII regions reflects the starlight and creates a halo around the star
(c) hot bright stars produces high energy proton radiation that ionizes the hydrogen
(d) such stars produce many photons that can ionize hydrogen
(e) these are the only places in the galaxy where there is gas as well as stars

20. Which of the following is a physically correct description of a black hole?
(a) an object that has a temperature of absolute zero, so it emits no light
(b) a large concentration of mass in a small volume of space, such that there is infinite curvature of spacetime
(c) an object where the magnetic force is so strong that no light is emitted from it, or its nearby surroundings
(d) any star with a mass greater than 3.25 solar masses
(e) the region between the Milky Way and M33