

Astronomy 104 Final Exam Study Guide Spring Semester 2009

**Craig (Mon/Wed Lecture) Final Exam Time:
Tuesday, May 12, 3:00 pm – 5:30 pm**

**Cabanela (Tues/Thurs Lecture) Final Exam Time:
Tuesday, May 12, 12:00 pm – 2:30 pm**

A WARNING ABOUT SWITCHING EXAM TIMES:
Students may not switch which final exam they attend without permission of both instructors. You can not switch just for “convenience,” it must be for a documentable reason.

The Most Frequently Asked Question: Is It Cumulative?

This is a **CUMILATIVE FINAL EXAM** although it **focuses more on topics discussed in Lecture and Lab since MidTerm #2** as well as material in Chapters 17 through 20 and 23 of *Bennett et al.*, which covers Stellar Evolution, Stellar Corpses, Our Galaxy, and some cosmology. **This study guide contains only the material we have covered recently (since the last exam) in class.**

- The exam will contain about 30-40 multiple-choice questions
- There will be some short answer/fill in the blank questions.
- **The exam will be roughly one and a half times as long as the previous mid-term exams.**

BIG HINT:

In order to prepare for the older material, **We highly suggest you study the previous quiz solution guides.** We may well pick problems from previous quizzes that students had difficulty with.

This study guide contains only the material we have covered recently (since the last exam). **We strongly suggest you review previous study guides and exams to refresh yourself on the earlier material.** This study guide covers materials from Chapters 17 through 20 and Chapter 23, but as with previous exams, not all topics from each chapter are on the test. The detailed list below was what you should know how to do. A practice exam is attached.

Objectives: On the exam you should be able to	Reading from the textbook
Define the word nebula.	16.1
Explain why a contracting nebula heats up and spins faster.	16.1
Explain what halts the contraction.	16.1
Describe the structure of a typical protostar.	16.2
Explain why the surface of a star or protostar is special and is described as the surface of the surface.	16.2
Distinguish between the life track of a low mass star and a high mass star.	16.2
Describe the demographics (relative numbers) of new stars with different masses.	16.3
explain how the mass of a star affects the rate of nuclear fusion.	Ch. 17.1
define what we mean by “low mass” versus “high mass” stars and know which kind of star the Sun is.	Ch. 17.1
outline the “life stages” of a low mass star.	Ch. 17.2, 17.4
explain why a low mass star goes through those life stages.	Ch. 17.2, 17.4
know the “end states” of low mass stars (when they die, what are you left with as a corpse).	Ch. 17.2, 17.4
outline the “life stages” of a high mass star.	Ch. 17.3, 17.4
explain why a high mass star goes through those stages	Ch. 17.3, 17.4
Know the “end states” of high mass stars (when they die, what are you left with as a corpse).	Ch. 17.3, 17.4
Know which kinds of stars are responsible for the creation of which elements necessary for human life.	Ch. 17.3
describe the future evolution of the Sun.	Ch. 17.1 – 17.2
explain why iron is the heaviest element that can be produced through fusion in stellar cores.	Ch. 17.3
describe what happens inside a star during a core collapse supernova.	Ch. 17.3
describe a White Dwarf and the observational evidence that demonstrates they exist.	Ch. 18.1
explain how mass transfer between a star and a white dwarf can affect the white dwarf.	Ch. 18.1

describe steps that lead to a white dwarf (Type Ia) supernova	Ch. 18.1
describe a Neutron Star, including an explanation of the pressure that supports it, and the observational evidence that suggests they exist.	Ch. 18.2
explain how mass transfer between a star and a neutron star can affect the neutron star.	Ch. 18.2
describe a Black Hole is and the observational evidence that suggests they exist.	Ch. 18.3
Know what our galaxy looks like and how we know it looks like that. You should be able to sketch the Milky Way and label its components.	Ch. 19.1
You should know the rough sizes of the components.	Ch. 19.1
describe how we determined the mass of the Milky Way.	Ch. 19.1 (mathematical insight 19.1 as well)
compare and contrast the properties of the three major types of galaxies.	Ch. 20.1
describe the various distance estimation methods we have discussed in class or lab as well as explaining how they are connected together into a “distance ladder”.	Ch. 20.2 and the Parallax, Spectroscopic Parallax (Main Sequence Fitting), Cepheid, and Hubble’s Law labs
describe at least two methods for determining the distances to galaxies.	Ch. 20.2 and the Cepheids and Hubble’s Law labs.
describe Hubble’s Law in words.	Ch. 20.3 and Hubble’s Law lab.
explain why Hubble’s Law implies the entire Universe is expanding explain why it does not mean that we are at the center of the Universe.	Ch. 20.3
describe the Big Bang theory and more importantly, explain how it DOES NOT say the universe began in an explosion!	Ch. 23.1
describe the supporting evidence for the Big Bang theory as an explanation for the characteristics of the early universe.	Ch. 23.2
explain how Hydrogen and Helium were created in the first three minutes of the Universe. [May not end up on exam]	Ch. 23.1
Explain how the existence and properties of the Cosmic Microwave Background provide strong supporting evidence for the Big bang theory. [May not end up on exam]	Ch. 23.2

WARNING!

This practice final contains questions focused only on recent material. The real final will contain material covered on earlier exams. Study those as well!

Astronomy 104 PRACTICE Final Exam **Spring Semester 2009**

[NOTE: This practice mid-term has more questions on the new material than the actual final exam will have, but the actual exam will have 40-50 multiple choice questions!]

DO NOT OPEN THIS EXAM UNTIL TOLD TO DO SO BY INSTRUCTOR.

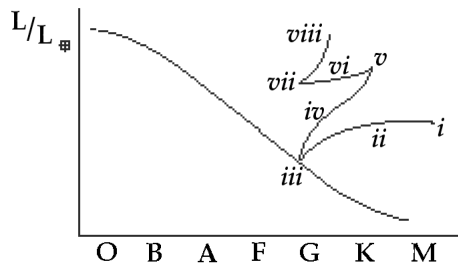
Exam Rules:

1. Exam will start at the beginning of your final exam period and must be turned in 2½ hours after the exam begins.
2. **Bring you student ID to the exam. It will be checked as you turn in the exam.**
3. **Exam is Closed Book and Closed Notes.**
4. **Cell phones must be off and out of sight (not even “vibrate”).**
5. **No electronic devices allowed with exception of a calculator except at discretion of instructor.**
6. I expect everyone to be honorable and not copy answers from someone else's exam. I consider it a personal insult for you to cheat and thus cheating will be dealt with by giving the cheater an “F” for the entire course.

MULTIPLE CHOICE QUESTIONS:

1. What do astronomers mean when they say that we are all "star stuff"?
 - a. that Earth formed at the same time as the Sun
 - b. that the Universe contains billions of stars
 - c. that life would be impossible without energy from the Sun
 - d. that the carbon, oxygen, and many elements essential to life were created by nucleosynthesis in stellar cores
2. Where is the Sun in the range of masses for stars?
 - a. high-mass star
 - b. intermediate-mass star
 - c. low-mass star
3. What happens when a star exhausts its core hydrogen supply?
 - a. Its core contracts, but its outer layers expand and the star becomes bigger and brighter.
 - b. It contracts, becoming smaller and dimmer.
 - c. It expands, becoming bigger but dimmer.
 - d. Its core contracts, but its outer layers expand and the star becomes bigger but cooler and therefore remains at the same brightness.
 - e. It contracts, becoming hotter and brighter.
4. Compared to the star it evolved from, a red giant is
 - a. cooler and dimmer.
 - b. hotter and dimmer.
 - c. hotter and brighter.
 - d. cooler and brighter.
 - e. the same temperature and brightness.
5. Why does a star grow larger after it exhausts its core hydrogen?
 - a. Helium fusion in the core generates enough thermal pressure to push the upper layers outward.
 - b. Hydrogen fusion in a shell outside the core and gravitational contraction of the core generates enough thermal pressure to push the upper layers outward.
 - c. The internal radiation generated by the hydrogen fusion in the core has heated the outer layers enough that they can expand after the star is no longer fusing hydrogen.
 - d. The outer layers of the star are no longer gravitationally attracted to the core.
 - e. Helium fusion in a shell outside the core generates enough thermal pressure to push the upper layers outward.
6. What is a planetary nebula?
 - a. a disk of gas surrounding a protostar that may form into planets
 - b. what is left of the planets around a star after a low-mass star has ended its life
 - c. the expanding shell of gas that is no longer gravitationally held to the remnant of a low-mass star
 - d. the molecular cloud from which protostars form

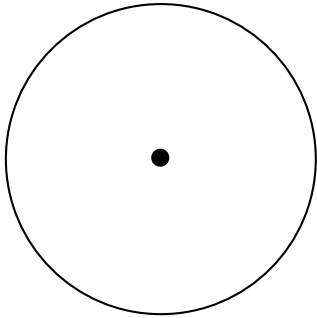
The following questions refer to the H-R diagram below that shows the life track of a 1-solar-mass star, with various stages labeled with Roman numerals.



7. During which stage is the star's energy supplied **only** by gravitational contraction?
 - a. ii
 - b. vi
 - c. v
 - d. iii
 - e. viii
8. Which stage lasts the longest?
 - a. iii
 - b. vi
 - c. viii
 - d. i
 - e. iv
9. What will happen to the 1-solar-mass star after stage viii?
 - a. It will explode in a supernova.
 - b. It will collapse to make a neutron star.
 - c. It will gain mass until it collapses under its own weight.
 - d. It will eject a planetary nebula.
 - e. It will begin burning carbon in its core.

10. Which of the following sequences correctly describes the stages of life for a low-mass star?
 - a. white dwarf, main-sequence, red giant, protostar
 - b. protostar, main-sequence, white dwarf, red giant
 - c. protostar, main-sequence, red giant, white dwarf
 - d. protostar, red giant, main-sequence, white dwarf
 - e. red giant, protostar, main-sequence, white dwarf
11. Which element has the lowest mass per nuclear particle and therefore cannot release energy by either fusion or fission?
 - a. hydrogen
 - b. silicon
 - c. iron
 - d. oxygen
 - e. uranium
12. What types of stars end their lives with supernovae?
 - a. all stars that are red in color
 - b. stars that have reached an age of 10 billion years
 - c. stars that are at least several times the mass of the Sun
 - d. stars that are similar in mass to the Sun
 - e. all stars that are yellow in color
13. Which event marks the beginning of a supernova?
 - a. the onset of helium burning after a helium flash in a star with mass comparable to that of the Sun
 - b. the beginning of neon burning in an extremely massive star
 - c. the sudden collapse of an iron core into a compact ball of neutrons
 - d. the expansion of a low-mass star into a red giant
 - e. the sudden outpouring of X rays from a newly formed accretion disk

14. What happens to the core of a star after a planetary nebula occurs?
- It becomes a white dwarf.
 - It breaks apart in a violent explosion.
 - It contracts from a protostar to a main-sequence star.
 - It becomes a neutron star.
 - none of the above



15. A drawing of a red giant is above. The dot in the center is the core of the star. The amount of hydrogen *in the core* is
- zero
 - small, about 10%
 - large, around 75%
16. The amount of hydrogen *in the outer layers* of the red giant is
- zero
 - small, around 10%
 - large, around 75%
17. White dwarfs are so called because
- it amplifies the contrast with red giants.
 - they are the end-products of small, low-mass stars.
 - they are supported by electron degeneracy pressure.
 - they are both very hot and very small.
 - they are the opposite of black holes.

18. Which of the following is closest in mass to a white dwarf?
- Earth
 - Jupiter
 - the Sun
 - the Moon
19. You discover a binary star system in which one member is a $15M_{\text{sun}}$ main-sequence star and the other star is a $10M_{\text{sun}}$ giant. Why should you be surprised, at least at first?
- A star with a mass of $15M_{\text{sun}}$ is too big to be a main-sequence star.
 - The two stars should be the same age, so the more massive one should have become a giant first.
 - It doesn't make sense to find a giant in a binary star system.
 - The two stars in a binary system should both be at the same point in stellar evolution; that is, they should either both be main-sequence stars or both be giants.
20. Which of the following is closest in size (radius) to a neutron star?
- a basketball
 - the Sun
 - a football stadium
 - a city
 - the Earth
21. What is the basic definition of a black hole?
- any object made from dark matter
 - any object from which the escape velocity exceeds the speed of light
 - a dead galactic nucleus
 - any compact mass that emits no light
 - a dead star that has faded from view
22. _____ stars lose a significant amount of mass after leaving the main sequence.
- No
 - A few
 - All

23. Pulsars are composed of
- hydrogen
 - carbon and oxygen
 - neutrons
 - neutrinos
24. **[This may go beyond what was covered in lecture.]** How does the gravity of an object affect light?
- Light coming from a compact massive object, such as a neutron star, will be redshifted.
 - Visible light coming from a compact massive object, such as a neutron star, will be redshifted, but higher frequencies such as X rays and gamma rays will not be affected.
 - Light coming from a compact massive object, such as a neutron star, will be blueshifted.
 - Light doesn't have mass; therefore, it is not affected by gravity.
 - Less energetic light will not be able to escape from a compact massive object, such as a neutron star, but more energetic light will be able to.
25. Which of the following lengths is closest to the diameter of the disk of the Milky Way?
- 1,000 light years
 - 100 light years
 - 1,000,000 light years
 - 100,000 light years
 - 10,000 light years
26. Approximately how far is the Sun from the center of the galaxy?
- 28 light-years
 - 280 light-years
 - 28 million light-years
 - 28,000 light-years
 - 2,800 light-years
27. Imagine two galaxies, I and II. Galaxy II is twice as far away from us as galaxy I. That means the speed at which Galaxy II is moving away from us is roughly _____ the speed of Galaxy I.
- two times
 - the same as
 - half
28. The Doppler effect is a change in the _____ a spectra caused by the motion of the light source.
- wavelength of spectral lines in
 - apparent brightness of
 - luminosity of
 - speed of the light coming from
29. Why are Cepheid variables important?
- Cepheids are supermassive stars that are on the verge of becoming supernovae and therefore allow us to choose candidates to watch if we hope to observe a supernova in the near future.
 - Cepheids are pulsating variable stars, and their pulsation periods are directly related to their true luminosities. Hence, we can use Cepheids as "standard candles" for distance measurements.
 - Cepheids are a type of young galaxy that helps us understand how galaxies form.
 - Cepheid variables are stars that vary in brightness because they harbor a black hole.

- 30.** What is Hubble's law?
- The faster a spiral galaxy's rotation speed, the less luminous it is.
 - How fast a galaxy is moving away from us is directly proportional to its distance from us.
 - The longer the time period between peaks in brightness, the greater the luminosity of the Cepheid variable star.
 - The faster a spiral galaxy's rotation speed, the more luminous it is.
 - The recession velocity of a galaxy is inversely proportional to its distance from us.
- 31.** What is the most accurate way to determine the distance to a nearby star?
- main-sequence fitting
 - Hubble's law
 - radar ranging
 - stellar parallax
 - using Cepheid variables
- 32.** What is the most accurate way to determine the distance to a nearby galaxy?
- stellar parallax
 - radar ranging
 - using Cepheid variables
 - Hubble's law
- 33.** What is the most accurate way to determine the distance to a distant galaxy (farther than 50 million parsecs)?
- stellar parallax
 - radar ranging
 - using Cepheid variables
 - Hubble's law
- 34.** What kinds of atomic nuclei formed during the era of nucleosynthesis in the very early universe?
- only hydrogen
 - hydrogen and helium and trace amounts of lithium, beryllium, and boron
 - roughly equal amounts of each of the following: hydrogen, helium, lithium, beryllium, and boron
 - nuclei of all the chemical elements
 - only helium
- 35.** Which of the following statements about the cosmic background radiation is not true?
- It has a temperature of about 3 degrees K above absolute zero.
 - It appears essentially the same in all directions (it is isotropic).
 - It was discovered by Penzias and Wilson in the early 1960s.
 - It is the result of a mixture of radiation from many independent sources, such as stars and galaxies.
 - It had a much higher temperature in the past.
- 36.** What are the two key observational facts that led to widespread acceptance of the Big Bang model?
- the cosmic background radiation and the expansion of the universe
 - the predominance of matter over antimatter and the near-critical density of the universe
 - the cosmic background radiation and the near-critical density of the universe
 - the predominance of matter over antimatter and the large scale structure of galaxies
 - the cosmic background radiation and the high helium content of the universe

37. **[This one may go a bit beyond what we covered in class]** Evidence that the cosmic background radiation really is the remnant of a Big Bang comes from predicting characteristics of remnant radiation from the Big Bang and comparing these predictions with observations. **Four of the five statements below are real. Which one is fictitious?**
- a. The cosmic background radiation is expected to have a perfect thermal spectrum, and observations from the COBE spacecraft verify this prediction.
 - b. The cosmic background radiation is expected to contain spectral lines of hydrogen and helium, and it does.
 - c. The cosmic background radiation is expected to look essentially the same in all directions, and it does.
 - d. The cosmic background radiation is expected to have a temperature just a few degrees above absolute zero, and its actual temperature turns out to be about 3 K (actually 2.7 K).
 - e. The cosmic background radiation is expected to have tiny temperature fluctuations at the level of about 1 part in 100,000. Such fluctuations were found in the COBE data.

Discussion Questions for PRACTICE Final:

(Turn this section in with “computer graded” sheet)

On the actual final exam, there will be several (less than four) short answer questions. We haven't yet decided how many. Answer the questions below as fully and clearly as you can. You will be graded both on clarity (using full sentences that make sense) and on completeness and correctness.

1. Answer these questions about stellar evolution.
 - a. Briefly summarize the stages of life for a low-mass star.
 - b. Briefly summarize the stages of life for a high-mass star.
 - c. Briefly explain why high-mass stars have shorter lifetimes than low-mass stars.
2. Suppose you discovered a star made purely of hydrogen and helium. Would the star be young (like the stars in the disk of the Milky Way), old (like the stars in the halo of the Milky Way), or very old (very old meaning almost the age of the universe)? How old do you think it would be? *Explain.*
3. Imagine you observe a white dwarf supernova.
 - a. What kind of spectrum (continuous, emission, absorption, or a combination) do you think you will observe, and why? Assume there is nothing between you and the white dwarf.
 - b. How would your answer change if there was a cloud of cold hydrogen gas between you and the supernova?
4. Do you think it is possible that a 10-solar-mass main-sequence star could harbor an advanced civilization? *Explain your reasoning.*
5. Explain how it is possible to determine the shape of the Milky Way galaxy when we reside inside it and can't travel outside it.
6. Summarize the links in the distance ladder that allow us to estimate distances to the farthest reaches of the universe.
7. Explain how the existence of Hubble's law leads us to argue for the existence of a Big Bang or at least for a period where the Universe was much denser than it is today.
8. Where did the hydrogen in your body (in the water molecules, mostly) originate and how did it get in your body? How is this story different for carbon? How about for the iron in your blood?