Astronomy 110 Review, Spring 2015

We have covered the following topics from the 10th, 9th, and 8th editions: Chapter 10-7 through 10-9 (details of fusion in the Sun, held over from the last test), Ch. 11, Ch. 12, and Ch 13 (sections 13-1 and 13-2 for now; the rest on the final.). Note, in Ch. 11, we're skipping the details of calculating magnitudes from luminosity or brightness, but you need to know what the magnitudes mean and that they are backwards! We are also skipping the Roman numeral names of the luminosity classes. In Ch. 12, we are not paying much attention to very low mass stars (section 12-8). Also, we will skip sections 12-12, 12-13 (Cepheid variables, until later), and 12-15. Do not consider this a list of definitions to memorize. Understand the meaning, use, and importance of all these topics and ideas as well as memorizing any necessary definitions. The list is fairly complete, but it is not guaranteed to be 100% inclusive. That doesn't mean you should forget everything else, you've learned, though. The exam will have around 65 questions, including multiple-choice questions, "fill in the blanks," and short answer questions.

You need the same grademaster form as before.

Details of the interior of the Sun:

- What is nuclear fusion?
- What are the conditions required for nuclear fusion?
- The proton-proton cycle (hydrogen $\longrightarrow$ helium)
  - How do you overcome the repulsion of two positive nuclei?
  - Where do the neutrons come from?
  - Antimatter. What happens when it comes in contact with matter?
  - Where does the energy come from?
- How (roughly) to model the solar interior
- ~~Solar Oscillations~~
- Neutrinos and their importance for understanding the Sun
  - The solar neutrino problem and its solution

Properties of stars and how to determine them. (skipping the *details* of spectroscopic binaries)

- What is luminosity and how is it determined?
  - What are magnitudes? What numerical order do magnitudes follow?
  - What is the difference between absolute and apparent magnitude?
- What are two ways of determining a star's temperature?
- How are absorption lines formed?
- Do you know why absorption lines tell you about temperature? Composition?
- Ionization
- Parallax
- What are two ways of determining a star's size?
- Binary stars – visual and spectroscopic
  - What do we learn from binary stars orbits?
- What do we learn from an eclipse in a binary star?
- Spectral types (what do OBA… indicate?)
- Why do M stars have molecules in their atmospheres, but A stars do not?
- Approximate numerical ranges of properties of stars (as given on the board)

The H-R diagram

A graph of temperature (or spectral type) vs. luminosity (or magnitude)

What is luminosity?

Sizes, temperatures, and colors of stars and the relationship of those properties to the positions of the stars on the H-R diagram.

Where do different types of stars fall on the H-R diagram?

Main sequence
Giants
Supergiants
White dwarfs

} Which are the most and least common?
What is the evolutionary state of these stars?

Lifetimes of stars: which stage lasts longest?

How does the mass of a main sequence star relate to its luminosity? Why?

How does the mass of a main sequence star relate to its life (long/short)? Why?

How long will the Sun last on the main sequence?

Stellar evolution

This is summarized ***for a star like the Sun*** on the sheet I handed out. There is no need to know exact times, temperatures, and sizes, but you should know what is happening when for each stage (and the name of the stage, of course). You should know precisely what the source of the energy is and precisely where in the star it is generated at each stage. Know when the star is luminous or dim. Know when the star is big or small. When are the stars very stable? When is the core contracting?

Where do the different stages fall on the H-R diagram? Trace out the evolutionary path of the Sun from stages 1 through 10.

Protostars and pre-main sequence stars – what powers them? When will a cloud collapse to form a protostar?

Main sequence stars (nuclear reactions – which ones?)

Giants– what powers them?

When do stars first lose large amounts of mass? Why?

He burning and the triple alpha process

Horizontal branch stars – what powers them?

Supergiant stars – what powers them?

Planetary nebulae

White dwarfs – what powers them?

Why are most stars stable? What is the "feedback" mechanism?

What happens to the core of a star when it uses up the element that it is fusing?

What happens to the exterior at that time?

Electron degeneracy (pressure does not respond to changes in temperature.)

How does high mass star evolution differ (roughly) from the evolution of the Sun?

Different kinds of gas clouds

Reflection nebulae – why are they blue?

H II regions – why do they glow? Why are they red?

Giant molecular clouds – what makes them dark? Stars form in them.

The Chandrasekhar limit. White dwarfs are held up by electron degeneracy.

Determining the ages of stars.

Open clusters and globular clusters: number of stars, metal abundance, and age.

Useful review questions from the book.
10^{th}, 9^{th}, and 8^{th} editions.

Ch. 10: What DYT? 5 and 6 (8^{th} edition does not have #6)
Review Questions: 11,12,13,15

Ch. 11: 8^{th} and 9^{th} eds: Ch. 11, What did you think? 2, 3, 4, 5, 6.
Rev. Questions:1,3,4,5,6,7,8,9,10,12,14,16,17,19,20,22,23,25,26,27,28,35,36,37.

Ch. 11 10^{th} ed: Ch. 11, What did you think? 2, 3, 4, 5, 6.
Rev.Que.:1,3,4,5,6,7,8,9,10,12,13,14,16,17,19,20,22,23,25,26,27,28,35,36,37,47,49,50.

Ch. 12: What DYT? 1, 2, 3, 4 (8^{th} edition does not have #4).
Rev. Q. 1 – 10, 12 – 16, 22, 30.

Ch. 13: What DYT? 1,
Rev. Q. 1, 2, 5, 6, 7, 8, 13, 23.

Here are some homework problems from previous years.

1) Why are very high temperatures necessary for nuclear fusion to occur?
2) The temperature of the solar corona can reach several million K. Why does nuclear fusion not occur there?
3) Why do neutrinos tell us what is happening near the center of the Sun now, while the photons that we see tell us what was happening a long time ago?
4) Write down with symbols the three fusion reactions by which H (hydrogen) is turned into He (helium) near the center of the Sun. Briefly describe in words what is happening in each step. Mention each item (either particle or energy) that is involved in the reactions and what happens to it.
5) Would it be easier to measure the parallax of a star if we lived on Mars instead of the Earth? Why? (Think about the effect on the "parallax" of your finger seen at arms length if your eyes were closer together or farther apart.)
6) A 10,000 K star (surface temperature) has very strong absorption lines of H. Stars of 3,000 K and 100,000 K surface temperature show weak or no lines of H. Why? (The answer is different in each case.). Your answer can either be fairly general or very specific.)
7) Explain (briefly) how an emission or absorption line spectrum is related to the structure of the atom. Why are the spectra of elements different from each other?
8) What does a star's luminosity measure?
9) How can we measure the distance to the nearest stars?
10) How do you determine the luminosity of a star?
11) Describe two ways of measuring the temperature of a star.

12) What do we need to observe to determine the composition of a star?

13) How can we determine the size (radius) of a star (not a member of a binary star system)?

14) What kind of star or stars must we observe to measure the mass of stars?

15) What law do we need to apply to determine the stellar mass if we make the observation of the question above this?

16) Use figure 11-14 to estimate the **luminosity** of a star whose mass is 1/10 that of the Sun. From the same figure, estimate the **mass** of a star with luminosity 10,000 times that of the Sun.

17) What is the Hertzprung-Russell Diagram?

18) Compare the mass, luminosity, and surface temperature of the Sun with the range of possible properties for other main sequence stars.

19) Describe in detail the evolution of a star of one solar mass. Trace the evolution on an H-R diagram.

20) Describe the feedback mechanism involving temperature, pressure, and nuclear energy generation that keeps the Sun stable during its main sequence lifetime. How does electron degeneracy in the core of a giant star disrupt this feedback mechanism?

21) Know how to plot an H-R diagram for **nearby stars** (that includes young, old, luminous, and faint stars). Indicate the regions of the diagram where you can find these different types of stars

22) Sketch the H-R diagrams for a young cluster (30 million years), a middle-aged cluster (2-5 billion years), and a very old cluster.