Study Guide for Exam 1, Ast 309N (47760), Fall 2012 (Dinerstein)

The first hour exam will be Thurs., Oct. 4. It will be closed-book, closed-notes, and will include 24 multiple-choice questions plus 3 short essays similar to those on the quizzes. It will cover material discussed in class through Thurs., Sep. 27, through the topic of how ages of star clusters are determined from their HR Diagrams. Relevant readings are pages 1 – 29 in Kaler's "Extreme Stars," and pages 1 – 10 and 16 – 26 in Wheeler's "Cosmic Catastrophes." However, you ought to put more emphasis on the materials on the class website, *including Card and Quiz feedback files* as well as the Class Slides. (Be sure that you understand the correct answers to these questions!) Below we give an outline of the main topics covered so far, and **key terms and concepts** you ought to be familiar with. One useful study strategy is for you to make **your own glossary** of these terms. You also should look at Brian's postings from his Help Sessions, which are posted on **Blackboard.**

Topic	Class Dates	Cards	Quizzes
I. The Sun, Our Star	8/30, 9/4, 9/6, 9/11	8/30, 9/4, 9/6	1

Solar surface activity: solar storms, coronal mass ejections (CMEs), the solar wind, sunspots, the solar cycle, magnetic fields, aurorae (Northern Lights), convection
Solar structure: core, random walk (of photons), radiative zone, convective zone, hydrostatic equilibrium, helioseismology, photosphere, corona
Solar energy production, neutrinos: fusion, deuterium, positrons, proton-proton chain, Davis experiment, Kamiokande, SNO, neutrino "oscillations" (metamorphosis)

II. Review of Physics	9/11, 9/13, 9/18, 9/20	9/13, 9/18	2, 3

Properties of Light: electromagnetic waves, wavelength, frequency, photon energy, the electromagnetic spectrum from gamma rays to radio waves, the Doppler effect
Types of Spectra: thermal ("blackbody") emitters, Wien's Law, Stefan-Boltzmann-law, Kirchhoff's Laws, emission lines, absorption lines, electron energy levels
Forces: electromagnetic, strong nuclear force, weak nuclear force, gravity; gravity as an inverse-square law, center-of-mass for orbits of two bodies
Energy: gravitational potential, kinetic, thermal, electromagnetic, mass-energy
Conservation laws of energy, angular momentum

III. Measuring Star Properties	9/20, 9/25, 9/27	9/20, 9/25, 9/27	3

Properties related to total light output: luminosity, apparent brightness, inverse-square law of light, apparent and absolute magnitudes, distance, parallax
Properties related to surface temperature: continuous spectrum, wavelength of peak intensity, color, spectral type (O through M)
Radius: from luminosity and temperature (Stefan-Boltzmann law, surface area)
Mass from the law of gravity applied to binary stars; types of binary stars (visual, spectroscopic, eclipsing) – what is measured, what it depends on
Mapping star properties: The Hertzsprung-Russell (HR) Diagram
The Main Sequence: significance; mass-luminosity relation, mass-lifetime relation
Ages of star clusters from their HR diagrams: the Main Sequence "turn-off" method

Study Questions (not guaranteed to cover all possible questions on the exam!)

1. What is meant by "solar activity"? Give some examples of phenomena that fall under this label. How does solar activity affect the Earth?
2. How and where does the present-day Sun produce its energy, and how does it get to the Sun's surface, from where it radiates into space?
3. What kinds of particles are involved (are used up or produced) in the proton-proton chain?
4. Briefly name and describe conditions in the major layers of the Sun, from inside outwards. Roughly how do temperature, density, and pressure change as you go from center to edge?
5. What was the fuss about solar neutrinos? Why did there appear to be a "problem" with them, and how was the problem ultimately resolved?
6. Explain why scientists say that light has properties of both waves and particles. Describe the wave characteristics of light. In what way does light act like a particle?
7. Cite the major regions of the electromagnetic spectrum, in order of increasing frequency. Would the order be the same if you sorted them by increasing wavelength or energy? Explain.
8. Name the three types of spectra according to Kirchhoff's laws, and state what kinds of sources and circumstances produce each kind of spectrum.
9. Explain what happens inside an atom when a photon is absorbed; when a photon is emitted.
10. What is the Doppler shift, and what property of a source does it tell you?
11. List the four fundamental forces of nature, and rank them according to strength. Where does gravity fit: is it the strongest, weakest, or in the middle?
12. When a slowly rotating interstellar cloud is contracting to become a star, its rate of spin speeds up. What principle does this illustrate?
13. How do you measure the following quantities for a star picked at random on the sky? What observations must you make, and what principles do you use, to derive the properties?
    Distance *Luminosity*
    Radius *Mass*
    Surface temperature (multiple methods)
14. How do you determine the spectral class of a star? To what property of the star is it related, and why is it related to this property?
15. What is the Hertzsprung-Russell, or HR, Diagram? Where does the Sun lie in it? In what other regions of the HR diagram do we see significant numbers of stars?
16. What is the nature of a Main Sequence star? What determines exactly where on the Main Sequence a specific star lies?
17. How is it possible for a star to be both cool and very luminous?
18. How do the HR diagrams of old star clusters differ from those of younger ones? Explain why this difference is related to, and can be used to determine, the age of the cluster.