The final exam will occur on Tuesday, May 16, from 10:30 AM – 12:30 PM, in Rm. PA 216 (our normal lecture room). Please arrive on time, and bring the following to the exam:

1. A ParSCORE FORM No. F-288-PAR-L scantron form. These may be purchased at the campus bookstore and are pink in color. To save exam time, you may fill in the front and part of the back side of the form ahead of time. This includes:

   (a) **Front side of form**: The ‘Instructor’ (Leonard), ‘Class’ (Astro 101), and ‘Hour/Day’ (T/Th 9:30 – 10:45). Then, write and bubble in your ‘I.D.’ (note the ID section on the form has space for 10 digits, but SDSU IDs only have 9 digits; fill in the first 9 columns and leave the 10th one empty), ‘Last name’, ‘first name’, and ‘middle initial’. Leave the ‘phone number’ and ‘code’ sections blank.

   (b) **Back side of form**: Write and bubble in your ‘I.D.’ number (note the ID section on the form has space for 10 digits, but SDSU IDs only have 9 digits; fill in the first 9 columns and leave the 10th one empty). Leave the ‘Test Form’ and ‘Exam #' sections blank.

2. A number 2 pencil and a good eraser!

3. Your official “Exam cheat-sheet” (to be detached from the end of this packet), with your name at the top, and all the information you want inside the box.

   Note that **no calculators will be permitted** during the exam.

**About this Guide**

This *guide* is intended to assist you with your preparation for the exam. It provides *suggestions* that I hope you will find useful.

—**Disclaimer**: This *guide* is not all-inclusive, and in no way should serve as a substitute for your own, self-directed preparation for the exam.

**Content of the Final Exam**

The final exam will consist of 75 multiple choice questions, similar in nature to the ones that you have encountered on the three midterm exams in this class. The exam is cumulative, and covers the *entire* scope of material that we have studied this semester. To help you organize your studying, here's a listing of the specific sections that we covered from your textbook *Voyages Through the Universe*:

- **Prologue**: Entire section.
- **Chapter 1**: Entire chapter.
- **Chapter 2**: Entire chapter.
- **Chapter 3**: Sections 3.5 and 3.7.
- **Chapter 4**: Entire chapter.
- **Chapter 6**: Sections 6.1 and 6.2.
- **Chapter 14**: Sections 14.1.1, 14.1.2, 14.2.1, and 14.2.2.
- **Chapter 15**: Sections 15.1, 15.2, 15.3.1, 15.3.2, 15.3.3, 15.4.2.
- **Chapter 16**: Entire chapter.
- **Chapter 17**: Entire chapter.
- **Chapter 18**: Entire chapter.
- **Chapters 19 & 20**: You are *only* responsible for the material contained in the two slides discussed in class (and included in the Week 11 handout).
- **Chapter 21**: Entire chapter.
- **Chapter 22**: Entire chapter.
The exam is drawn from the entire course, with no particular emphasis on any one section; that is, everything we have covered this semester is weighted roughly equally on your final.

List of Important Terms, Events, and People Covered in Course

While thumbing through the material that we have covered, I jotted down terms/people/events that struck me as being particularly noteworthy, and I’ve included that list below. **Note, of course, that this list is not all-inclusive, but merely represents what I found to be some of the more important areas that we covered.** Nonetheless, making sure you understand these items will, I think, be a good starting point from which to launch a more exhaustive study program for the exam; the list may also help jog your memory a bit on the material we have covered.

- Circumference of circle, surface area of sphere, volume of sphere
- “Crab” supernova of 1054 AD
- Hubble Space Telescope
- Hubble Deep Field
- Celestial sphere: Horizon, zenith, North celestial pole, constellations, zodiac, ecliptic
- Retrograde motion
- Eratosthenes measures the Earth
- Astrology vs. astronomy
- Aristarchus: Heliocentric cosmology
- Ptolemy: Geocentric cosmology, epicycles
- Copernicus
- Galileo: telescopic observations (phases of Venus, sunspots, lunar craters, Milky Way)
- Galileo: achievements in physics (falling objects, inertia)
- Tycho Brahe
- Kepler: Laws of planetary motion (especially the 3rd!); desire to know Divine Plan
- Ellipse
- Astronomical unit
- Isaac Newton: Laws of motion, universal law of gravitation
- Mass, volume, density
- \[ F_g = \frac{GM_1M_2}{R^2} \]
- Conservation of angular momentum
- Newton’s version of Kepler’s Third Law
- Escape velocity
- Solar system: Sun, Earth, moon, planets, asteroids, comets
- Discovery of Neptune
- Phases of the moon
- Mass of Sun compared with planets and comets
- Giant planets and terrestrial planets
- Eclipses: Solar and lunar
- Light: Speed (same for all wavelengths), refraction, dispersion
- Spectroscopy: continuous/emission/absorption spectrum, Kirchoff’s Laws
- Properties of waves and particles
- Wavelength, frequency
- Electromagnetic spectrum
- Atoms: protons, neutrons, electrons; nucleus
- Element, isotope, ion
Birth of quantum mechanics
Bohr’s atomic model: Ionization, quantum leaps, energy level diagram
Production of spectral lines
Power
Energy flux
Standard candle (or “bulb”)
Magnitude scale, photometry
OBAFGKM: Spectral classes of stars as representing a temperature sequence
Color index
“Hotter means bluer and brighter”
Apparent brightness, luminosity
Photon
Definition of the Angstrom unit, Å
Stefan-Boltzmann Law
Wien’s Law
Doppler effect and radial velocity
Proper motion
Solar photosphere
Composition of Sun: H and He, mainly
Sunspots; sunspot cycle
Nuclear binding energy
Nuclear fusion: Proton-proton cycle
Hydrostatic equilibrium
Neutrino
\[ E = mc^2 \]
Antimatter
Mass-luminosity relation
Binary stars: Usefulness for determining masses
Center of mass
Stellar evolution: H-R Diagram, main-sequence, red giant, stellar mass-loss, planetary nebula, supergiant, white dwarf
Chandrasekhar limit
Ranges of stellar properties: Mass, luminosity, temperature, radius
Supernova: Gravitational collapse (Type II), thermonuclear runaway (Type Ia)
Betelgeuse
SN 1987A
Star clusters: Globular, open, stellar associations, and their usefulness
Degeneracy pressure (electron, neutron)
Neutron star/pulsar (Jocelyn Bell)
Black hole: event horizon, singularity, photon sphere, tidal force
General Theory of Relativity: curved space, distorted time; tests of the theory
Principle of Equivalence
Arcsecond/arcminute
Embedding diagram
Gravitational lensing, gravitational redshift, and gravitational time dilation
“Space-time”
Accretion disk (discovering black holes)
Henrietta Leavitt and the Cepheid period-luminosity relation
Edwin Hubble
Trigonometric parallax
Interstellar dust: absorption and reddening of light
Galaxy
Spiral, elliptical, and irregular galaxies
Milky Way, Andromeda, Magellanic Clouds
Rotation curves of spiral galaxies
Dark matter (Fritz Zwicky and Vera Rubin)
Mass-to-light ratio, and what it tells you
Vesto Slipher, Milton Humason
Hubble’s Law: \( v = H_0 d \)
Expanding universe paradigm
Hubble time
Big Bang cosmology
Cosmological principle: isotropy and homogeneity
Meaning of cosmological redshift
Critical density
Cosmological constant
Determining the dynamical state (accelerating, coasting, decelerating) and fate (expands forever, recollapses) of the Universe
The discovery of the accelerating Universe
Dark energy

What Should I Study?

Everyone has their own best method for preparing for an exam. Here is my suggestion for a useful way to prepare for this particular test.

1. **Review the list of terms/people/events contained in this packet.** As stated above, the list of items is not all-inclusive. However, a good starting point for your studying, I think, will be to review these terms first and flag any that are unfamiliar to you. As you proceed with your review, you can then check off the unfamiliar terms as you encounter them.

2. **Gather together all course handouts and weekly assignments.** This includes, especially, all of the weekly assignments. If you are missing any, they may be found at the course website: [http://sciences.sdsu.edu/~leonard/astro101](http://sciences.sdsu.edu/~leonard/astro101)

   You can also get them from the reserve book room at the library (just ask for the Astronomy 101 binder).

3. **Review the textbook readings.** We have covered a lot of material in here! While reading these sections, you may wish to also review the “reading guides” provided in the weekly handouts, as they give some indication of what I felt were the most important ideas contained in the assigned sections.

4. **Review the on-line help.** Go to the course textbook’s website at:

   [http://ace.brookscole.com/voyages](http://ace.brookscole.com/voyages)

   and review the material for each of the chapters. Take a look especially at the “glossary” and “flashcards” that are available for each chapter, and make sure you can define/explain most of the terms. These terms are similar to those that have been put on the board at the start of each class, and many are also included in the list given in this packet. If you haven’t already done so, be sure to take the “Post-tests” for the chapters we have covered. Note that, even if you do not have an on-line account, you can still access the chapter Post-tests, as well as some other ancillary material – see the Week 17 Handout for details on how to do this!

5. **Review the homework solutions.** Note that some of the homework assigned during the semester consisted of essays; you may find it helpful to check out the student responses that I felt were particularly well done by looking in the course binder on reserve at the library.
6. **Review the Powerpoint slides from the lectures.** These are available at the course web site. Viewing the slides again may stimulate your thinking about the material we covered, although many of the slides are just pictures (and thus somewhat difficult to follow without the lecture to go along with them).

7. **Review the list of terms again.** Now, having thoroughly reviewed the course’s material, take a look again at the list of terms given in this Review Guide (above); if there are still any that you do not know, try to track them down – you may also ask me about them during office hours or during the question and answer session the evening before the exam.

8. **Take the sample exam questions.** A sample of 5 questions is included in this guide that are indicative of the difficulty and content of the actual exam (in fact, an exam with 80 questions was written, and then 5 questions were randomly picked out of it to form the sample questions in this guide, with the remaining 75 serving as the exam itself). While 5 questions can’t encompass the full scope of the test, they should give you a sense of the types and level of difficulty of the questions that will be asked.

9. **Review past midterm exam questions.** Although you do not have copies of the midterm exam questions taken in this course (and, of course, the questions on the final will be different!), you may find it useful to look at these past questions again. Come by my office during office hours to review the exams at your leisure; they will also be available for you to look at during our question-and-answer session the evening prior to the exam.

**Where Can I go for Help?**

Help is available before the exam through:

- **My office hours:** Tuesday May 9 and Thursday May 11, 2-4 PM (Rm. 238 physics building).

- **Last-minute question-and-answer session.** On Monday May 15 (the evening before the exam), an extra help session will be held in our regular classroom (Rm. 216 physics-astronomy building) from 6:00 - 7:00 PM. I will be there to answer any questions that you may have; note that this is NOT a formal “review session”; no additional information about the exam or its contents will be given at this session. Rather, it is provided solely as last-minute help to answer any questions that may have cropped up during your studying.

- **TA help room hours** (Rm. 215, physics-astronomy building):

  Tuesday, May 9: 4-6 PM  
  Wednesday, May 10: 12-2 PM

  → There will be no TA help available after the last day of classes, May 10.
DOE, JOHN

Sign your name: __________________________

Print your student identification number: ________________

Astronomy 101: Final Exam
May 16, 2006
Professor Douglas Leonard

CLOSED BOOK, NO CALCULATORS

• Print your name and ID number on the SCAN-TRON FORM No. F-288-PAR-L. Use only the first 9 columns for your ID number, leaving the 10th column blank. Please make sure you put your ID number on both the front and back of the form.
• Mark all answers on SCAN-TRON FORM No. F-288-PAR-L. Use a #2 pencil. Completely fill in the appropriate bubble. Be sure to thoroughly erase all altered answers and stray marks! If the SCAN-TRON machine rejects your form for any reason, you will lose one point (of the 75 that are possible) from your test score.
• For true-false questions: mark bubble A if the statement is true, and bubble B if false.
• For multiple choice questions: mark the bubble corresponding to the single best answer.
• All questions carry equal weight. Read each question very carefully before answering.
• There is no penalty for guessing. Be sure to answer all questions! (Note that the SCAN-TRON machine will reject a form for which an answer is not recorded for every question.)
• Time limit: 120 minutes – budget your time appropriately! Don’t spend too much time agonizing over a tough question. Make a note of it on your exam and return to it after you have finished the others.
• So: No stray marks, one answer per question, and all questions answered!

DO NOT OPEN THIS EXAM UNTIL TOLD TO DO SO!!

When you are finished, simply leave the following THREE things in a stack on your desk:
• Test booklet (TOP of stack)
• Cheat-Sheet (MIDDLE of stack)
• SCAN-TRON (BOTTOM of stack)

GOOD LUCK!!!
Astronomy 101 – Final Exam (Sample Questions), Spring, 2006

Multiple Choice/True-False

Select the best answer for each of the following questions, and indicate your choice by filling in the appropriate bubble on your SCAN-TRON form. Be sure to read all answers before making a selection. For true-false questions, mark bubble A if the statement is true, and bubble B if it is false.

1. Andromeda is the nearest large galaxy to our home galaxy, the Milky Way. The distance of Andromeda from us is believed to be most nearly:
   (a) 2 LY.
   (b) 10 LY.
   (c) 100 LY.
   (d) 2 million LY.
   (e) 14 billion LY.

2. The “Hubble Deep Field”
   (a) is a very deep and detailed image of a small patch of sky taken by the Hubble Space Telescope.
   (b) is a marshy swamp located in Hubble, WI.
   (c) is an image of the Andromeda galaxy taken by Edwin Hubble in 1929.
   (d) is a quick “snapshot” of the Milky Way Galaxy taken with the Keck telescope in 2004.
   (e) is the name given to a mysterious force that is causing the universe to accelerate in its expansion.

3. Star ‘A’ has twice the radius of star ‘B’. The ratio of the volume of star ‘A’ to the volume of star ‘B’ is equal to:
   (a) 1/8.
   (b) 4.
   (c) 2.
   (d) 8π.
   (e) 8.

4. Which of the following is NOT a correct way that Jovian (giant) planets differ from the terrestrial planets in the solar system?
   (a) Jovians have more mass than terrestrials.
   (b) Jovians are further from the Sun than terrestrials.
   (c) Jovians are made of lighter elements on average than terrestrials.
   (d) Jovians have rings while terrestrials do not.
   (e) Jovians rotate on their axes significantly more slowly than terrestrials.

5. T or F. By studying distant Type Ia supernovae, Edwin Hubble discovered that the expansion of the Universe is presently accelerating.

(Answers - 1: D; 2: A; 3: E; 4: E; 5: B (false).)
NAME: ________________________________

Official Exam Cheat-Sheet

Below is a box within which you may write anything you would like to have access to while taking the exam. Please observe the following rules:

• Write your name at the top of this sheet, and detach it from the rest of the packet.

• All information must be written inside the box below. *Nothing* else is allowed to be written on this sheet (except for your name!). Nothing may be written on the back of the sheet.

• *All information must be handwritten.* It cannot be typed or zerographically reproduced.

• You will turn in this sheet along with your exam booklet and scantron at the conclusion of the test; it will be returned to you along with your graded scantron.

All writing must be contained within the box above!