

Astronomy 1: Introductory Astronomy

Spring 2006

Course Information, Policies, and Syllabus

We'll be meeting in Science Center 128 on Tuesdays and Thursdays, 9:55 to 11:10 for *section 1* and 11:20 to 12:35 for *section 2*. Labs meet every *other* week, starting the *third* week of the semester, on Mondays, Tuesdays, Wednesdays, or Thursdays (depending on lab section). Whether a given lab is indoors or outdoors, we will always meet at 8:00 PM in Science Center 187.

The lists of lab instructors and their office hours can be found on the right side of the class webpage.

Course Content

Astronomy is the oldest science and certainly one of the primal human activities (long before it was a science). We will, especially at the beginning of the semester, look at astronomy from a historical perspective. The two main areas/times we'll focus on are the classical studies of the heavens (mostly the Greeks) and the development, during the 16th and 17th Centuries, of modern astronomy and, indeed, of modern science. As we study this material, we will also be learning about the motions of the sky, as it was understanding these motions that led the Greeks, and later Copernicus, Tycho, Kepler, Galileo, and Newton, to *invent science*.

During the first half of the semester, we will be studying the scale of the universe, the night sky and its motions, the history of astronomy, and the basic physical and scientific principles that describe the workings of the universe. I will always be making an effort to tie this background material – interesting as it is on its own – to modern astronomy

(including discoveries being made right now by the Hubble Space Telescope and the Cassini, Huygens, and Mars Rover spacecraft, for example; see the announcements section of the class website as well as some of the links on the right side of the front page for information and pictures of current astronomical interest). After this portion of the course, we will study several broad topics in modern astronomy (with a brief background in spectroscopy and early 20th Century physics), including planetary science, solar physics, stars, interstellar gas and dust, galaxies, and cosmology.

In addition to teaching you facts about astronomy, I want you to get a feel for how astronomers discover and know things about the universe. We will often be coming back to measuring angles and distances, analyzing the light emitted by stars, etc., and looking for and using *universal physical laws*. We will also explicitly study how science works and the differences between science and non-science.

Contact Information

David Cohen, Science Center 125
dcohen1@swarthmore.edu
(610) 328-8587

Email is the best way to get in touch with me.

Office Hours: Monday 3:00 to 4:00 and Tuesday 3:30 to 4:30.

Contact information for your lab instructor is available on the class website. Note that rooms in the science center starting with an "L" are on the floor directly below the wing with our classroom and my office.

Contacting You

I will use email and the class webpage (not *Blackboard*) to communicate with you and to make assignments and information available to you. You *must* check your email and the webpage sometime after 11 PM the night before/day of class.

Course Materials

We're using *The Cosmic Perspective*, 3rd edition, by Bennett et al. We will supplement this textbook with occasional articles, readings and other resources on the web, and a small book by Edward Tufte called *Visual and Statistical Thinking*.

I will present images and other information in class and will then post these images on our class website. There are other resources – sky maps, lists of physical constants, etc. – that will also be available on our website.

Note that I will use *Blackboard* only very occasionally, but everything will be posted on the website.

Assignments will be posted on the website (lab manuals and homework, as well as solutions to the homework) and from time to time important announcements will also be posted there. Everything that gets handed out to you will also be posted on the website and once something is on the website, it'll stay there the whole semester (note the "archive of old announcements" and "archive of old assignments" pages).

You should have a ruler and calculator and bring them to lecture as well as labs.

The class website is at <http://astro.swarthmore.edu/astro1>

Assignments

We will have six labs over the course of the semester, with each of you in one of four lab sections (M, T, W, or R), and attending lab every other week. Lab manuals will be handed out at the beginning of the semester (for a nominal \$1 fee). We will give you guidelines for writing up labs when you attend your first lab. Lab write-ups will always be due a week after you do the lab. Lab always meets as scheduled, regardless of the weather.

We will also have two observing exercises. These are distinguished from the labs by the fact that you will do them on your own time, and will not do a formal write-up, as you will for the labs. But in both cases you will hand in a neatly drawn sketch of the night sky.

We will have five or six homework assignments, consisting mostly of problems from the textbook. These will always be assigned at least a week before they are due. They will generally be due on Tuesdays. David's office hours are on Monday and Tuesday afternoons, and the department's "Physics and Astronomy clinic" will be held on Monday night (and two other nights each week, from 8PM to 10PM – you are welcome to drop in for help anytime), so you should have plenty of opportunity to get help on your homework assignments.

All assignments will be turned in in the designated box outside my (or, in the case of labs, outside of your lab instructor's) office.

Homework and lab write-ups are usually due by 5:00 PM.

Lateness, etc. Policy: If you miss a lab without talking to your instructor ahead of time, you will not be allowed to make up the lab and will get a zero. Extensions will

generally *not* be granted for lab write-ups and homework assignments. Only in extraordinary circumstances or in the case of serious illness (accompanied by a note from your doctor or Worth), will they be, and in those cases, every effort must be made by you to talk to me before the assignment is due.

If you hand in an assignment up to three days late, it will be graded, but 20% of the total possible points will be deducted from your score. For assignments handed in more than three days late but less than a week late, I reserve the right to not grade them. Instead, I will check them for completeness and you will get half credit, if the problems are done well. Assignments later than one week are not accepted, so that I can post the solutions for the class to see in a timely fashion.

Your lab instructor will let you know about his or her lab grading and lateness policies at your first lab meeting.

Plagiarism and academic honesty

It goes without saying, of course, that all students will observe the highest standards of academic honesty – presenting only your own work as your own, attributing sources when you use them, and of course not cheating on exams.

We are not writing papers in this class this semester, but you will be writing lab reports, making sketches for your observing assignments, and writing up your solutions to the homework assignments.

I strongly encourage students to work together. You can discuss your ideas for solving homework problems together; you can discuss the questions you have to answer in your lab write-ups and the ideas and concepts involved in them;

you can make your sky observations together and discuss how best to sketch the objects you observe. But, when it comes time to write down your answers for a homework assignment, write up your lab report, or make your observing sketches, *the work must be your own*. The writing must be in your own words and sketches, diagrams, algebra, etc. must not be copied from your lab partner or other classmates.

If, at any point, you have questions about these guidelines, please ask me or your lab instructor.

Grading

We will have an in-class midterm and a final exam. Your final grade will be based on the following breakdown:

Homework and observing exercises: 30%
Labs: 25%
Midterm: 20%
Final: 25%

Tentative Syllabus (subject to change!)

Week 1: Scale of the universe (Ch. 1 and begin Ch. 2)

Class 1 – Tue., Jan. 17: General information about the class, the sky and types of objects we'll be studying, principles, scale of the universe

Class 2 – Thu., Jan. 19: Scale model, $v=d/t$, angular measure, small angle approximation, hand measurements, terms: zenith, etc., diurnal motion, Polaris, introduction to top-view and observer's view sketches

Week 2: The night sky (finish Ch. 2, start Ch. 3)

Class 3 – Tue., Jan. 24: More angles, Yearly motion, zodiac, tilt of the Earth's axis and seasons

Class 4 – Thu., Jan. 26: Moon's motion, combining diurnal plus other motions, moon phases

Week 3: More night sky – esp. moon phases, and beginning of ancient astronomy: the Geocentric system (finish Ch. 3)

Class 5 – Tue., Jan. 31: Moon phases (with diagrams), intro to retrograde motion (two models), parallax (Greek context), beginning of ancient astronomy

Class 6 – Thu., Feb. 2: More on retrograde motion and parallax, Greek astronomy, Eratosthenes, Ptolemaic synthesis and epicycles, Copernicus

Week 4: Scientific ideas and history of astronomy, the nature of science, data, information display (review Ch. 3, *Tufte* reading)

Class 7 – Tue., Feb. 7: Tycho, Kepler, Galileo

Class 8 – Thu., Feb. 9: The nature of science

Week 5: Begin energy, motion, orbits (start Chs. 4, 5)

Class 9 – Tue., Feb. 14: Catch up/review...begin discussion of the concept of energy

Class 10 – Thu., Feb. 16: Newton's falling apple – worked example of acceleration of the moon; Circular motion (centripetal acceleration), gravity, Newton's laws. How $F=ma + F_{\text{gravity}}$ gives the independence of acceleration on mass, Newton's basis for Kepler's third law

Week 6: Energy, Dynamics, Newton – esp. orbits and Newton's version of Kepler's third law (Finish Chs. 4 and 5)

Class 11 – Tue., Feb. 21: Circular motion, weightlessness, angular momentum, conservation laws; Review: Kepler's 3rd law (touching on gravity, mechanics...worked example – Kepler's version vs. Newton's version; satellite in low Earth orbit)

Class 12 – Thu., Feb. 23: **midterm**

Week 7: Light (Ch. 6; Sec. 16.2)

Class 13 – Tue., Feb. 28: The nature of light – waves and particles; spectroscopy and Kirchoff's laws (relation to atomic physics)

Class 14 – Thu., Mar. 2: More light: blackbody radiation, Doppler shift, inverse square law, non-optical light

Spring Break!

Week 8: Telescopes and detectors (Ch. 7)

Class 15 – Tue., Mar. 14: telescopes: collecting area and resolution; detectors: exposure time and sensitivity

Class 16 – Thu., Mar. 16: review, catch-up, answer questions

Week 9: Solar System and its formation (Ch. 8; Ch. 9)

Class 17 – Tue., Mar. 21: characteristics of the solar system: patterns in planet/moon spacing, orbits, rotation; terrestrial vs. Jovian; comets and asteroids; example of angular size of Mars (planets as worlds not just lights in the sky) and telescope resolution; dominance of Sun in the solar system and example of center of mass

Class 18 – Thu., Mar. 23: Nebular hypothesis as explanation for key characteristics of the Solar System; more on angular momentum

Week 10: Other planetary systems and beginning of unit on stars: Structure of the Sun, Basics of stellar properties, (Ch. 15, begin Ch. 16)

Class 19 – Tue., Mar. 28: finish up solar system formation: computer simulations (moon formation too), other planetary systems and binary stars

Class 20 – Thu., Mar. 30: Sun – structure, HSEQ (pressure-gravity balance) and self-regulation, fusion (and lifetimes)

Week 11: More Stars: Properties, Hertzsprung-Russell diagram, stellar evolution (star birth and death, remnants of stars) (finish Ch. 16, Ch. 17)

Class 21 – Tue., Apr. 4: Stars: parallax and inv. sq. law review, $L=4\pi R^2\sigma T^4$, spectral types, HR diagram, ...using Sirius as an example for many of these concepts

Class 22 – Thu., Apr. 6: HR diagram (more), stellar masses, stellar evolution, end states (anticipate with mass of Sirius B)

Week 12: Wrap up stars – end states (Ch. 18); begin Galaxies: The Milky Way (Ch. 19)

Class 23 – Tue., Apr. 11: pre-main-sequence and post-main-sequence evolution; low-mass stars vs. high-mass stars; white dwarfs and neutron stars

Class 24 – Thu., Apr. 13: Milky way, role of supernova – star-gas-star cycle; intro to the rotation curve

Week 13: Other galaxies and the expansion of the universe (Hubble's law) (Ch. 20)

Class 25 – Tue., Apr. 18: Catch-up/review; rotation curves and dark matter, interstellar gas and dust

Class 26 – Thu., Apr. 20: Galaxy types, galaxy clusters and more dark matter, Hubble law

Week 14: Intro to cosmology, the Big Bang, and the big picture (Ch. 23)

Class 27 – Tue., Apr. 25: The cosmic background radiation, evidence for the Big Bang model, the history and fate of the universe

Class 28 – Thu., Apr. 27: Summing it all up, loose ends, and review