Welcome to the expansive science of astronomy! From my long experience with this subject and science generally, I know it has the potential to greatly enrich your life. I'm glad you have chosen astronomy as one of the subjects to fulfill your science requirement. A special feature of my approach to teaching is to offer you many perspectives on astronomy and science generally; to fill out your growing picture of the universe, our world, humanity, and you. The most enlightening of them is called “The Cosmic Perspective.” Our world could use more of it.

Course Description: Introduction to the science of the nature and origin of the solar system: the sun and its family of planets, along with comets and asteroids. Includes the history of astronomy and special topics regarding the space program. Also includes scientific thinking as an application of critical and quantitative thinking, and science in contrast to pseudoscience. Also includes in-class measuremental and mathematical exercises, outside observation projects, independent studies, and self-initiated trips to local astronomy facilities.
Information: IN is the integrated version of the course with the lecture and lab taught simultaneously.

Expectation of coursework hours: The federal credit hour definition is one hour of instructor contact and two hours out of class work generated in lecture. The general expectation is a student in a 3-credit lecture course can expect approximately 9 hours of time each week for a 3 credit course.

But Astronomy survey courses are 4 credit hours, 3 for the lecture part and 1 credit for the lab part of the course. Lab work complements the lecture work. One credit for lab adds an implied 3 further hours of work per week, for a total of 12 hours per week of time spent by the student.

Course Meeting Days/Time: Mondays, Wednesdays/09:45am – 12:30pm
Course Delivery/Modality: lecture/lab format

Required Textbook:

Required Textbook(s): *Life in the Universe* 3rd ed., by Bennett & Shostak
Check with Bookstore for e-book alternative to the softbound textbook. Also, the softbound version may be rented.

Other Course Materials:

*Introductory Course Notes for West Campus AST 101IN, AST 102IN, AST 105IN AST 101IN*

Classroom Notes Set

LSW lab packet (plastic bagged, the top lab you can see is #1)

Stapled lab packet (the top lab is “Angular Measurement and You”)

**Student Learning Outcomes**

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

1. Discuss how astronomical observations contributed to the scientific revolution of the 17th century and explain the evidence for a heliocentric model for our solar system.
2. Describe and explain the apparent motions of celestial bodies as seen from an observer on Earth, and apply this knowledge in order to predict positions and appearances of objects on the sky as a function of time and the observer’s
location.
3. Describe current theories of planet formation and relate these to the present-day structure of our own solar system.
4. Recognize the immense spatial and time scales of the solar system, and compare and contrast these with human scales using scientific notation, distance ranking and scale models.

Performance Objectives:
Upon successful completion of the course, the student will be able to:
1. Demonstrate improvement in critical and quantitative thinking by applying the scientific method to fact and theory in classroom learning, activities (some quantitative and mathematical), and assignments (some quantitative and mathematical).
2. Distinguish science from pseudoscience.
3. Describe the overall structure and individual components of the solar system.
4. Describe the solar system’s origin.
5. Explain the historical development and multi-cultural aspects of the practice of science generally, and astronomy, specifically.
6. Outline the technical development of modern astronomy and space exploration.
7. Generate or expand global awareness by integrating astronomy’s cosmic, worldwide and multi-cultural perspective of earth with insights gained from its historical development, and scientific and societal impacts.
8. Demonstrate the improvement in critical and quantitative thinking by analyzing astronomical observations related to specific information covered in lectures.
9. Expand global awareness by identifying aspects of the sky and recording common sky phenomena, utilizing the naked eye or binoculars.
10. Expand global awareness by examining and describing the sky more closely based on at least one telescope viewing experience.
11. Describe astronomical and astronomy-related facilities in the Tucson area.
12. Discuss the Tucson area’s importance to the field of astronomy and astronomy’s role in the local economy.

General Education Learning Outcomes: None

Grade and Instructor Policies

Course Content Outline and Homework Assignments Schedule are also given separately in class and are available online at the West Campus Astronomy Courses Website.

COURSE OUTLINE  A S T  1 0 5 I N  Life in the Universe
Fall 2015 and after
NOTE: In addition to the course contents outline below, I will soon make available to you hard copies of it. Additionally, you will be able to download a copy.


I. Goals for this course (Intro Notes, Unit I., covered in Foundational Homework Ass’t.)

A. Increase awareness of, and interest in, your celestial neighborhood
B. Improve your “scientific literacy”
C. Instill a “Cosmic Perspective” on your world
D. Contribute to your personal and professional growth through critical thinking

II. Origins of science and astronomy

A. Origin of Astronomy (ca. 550 B.C.E. to ca. 400 C.E.)

B. Origin of science
   1. fundamental importance: a new way to understanding
      a. naturalistic vs. supernaturalistic
      b. Thales
   2. some astronomical contributions
      a. Democritus
      b. Aristotle and geocentrism vs. heliocentrism
   3. The significance of Aristotle’s approach

III. The Scientific (Copernican) Revolution (ca. 1600 c.e.)

A. Nicolaus Copernicus and his challenge to geocentrism
B. Tycho Brahe and his observations of Mars
C. Johannes Kepler and the Three Laws of Planetary Motion
D. Galileo Galilei
   1. Telescopic discoveries
   2. Clash with the Church

IV. Newton and Motion

A. Isaac Newton (ca. 1700 C.E.)
   1. Laws of Motion
   2. Law of Gravity

V. The Introductory Course Notes Set (Notes are already in outline form, so only the major units are given here.)

A. A Personal Statement on Teaching (Intro Notes, Unit II., covered in Foundational Homework Ass’t.)
B. U.S. Scientific Illiteracy (Intro Notes, Unit III., covered in Foundational Homework Ass’t.)
C. Science a learning process (Intro Notes, Unit IV., covered in class)
D. Critical Thinking (CT) Skills (Intro Notes, Unit V., covered in class)
E. Pseudoscience/Superstition/Anti-intellectualism (Intro Notes, Unit VI., covered in class)

F. The Popularity of Pseudoscience (Intro Notes, Unit VII., covered in Foundational Homework Ass’t.)

G. Dangers of Pseudoscience (Intro Notes, Unit VIII., covered in Foundational Homework Ass’t.)

H. Non-psychological Reasons for the Acceptance of Pseudoscience (Intro Notes, Unit IX., covered in Foundational Homework Ass’t.)

I. Psychological Reasons for Acceptance of Pseudoscience (Intro Notes, Unit X., covered in Foundational Homework Ass’t.)

J. Tests of Psychic Claims (Intro Notes, Unit XI., covered in Foundational Homework Ass’t.)

VI. Light

A. Starlight--what the naked eye can see
   1. brightness and magnitudes
   2. color and the electromagnetic spectrum
   3. direction and coordinate systems (brief)

B. Using light to know the universe
   1. Temperature
      a. definition
      b. scales
   2. Kirchhoff’s absorption line spectrum
      a. How and where formed in stars

C. Observing methods
   1. imaging
   2. spectroscopy
   3. photometry

TEST 1 covers to here and Assignments 1, 2–Foundational, 3

Part 2 of 3. The Cosmic Perspective

VII. The Cosmic Perspective

A. Cosmic Perspective—Space
   1. The Solar System
      a. Sun at center
      b. the 8 major planets and their satellites
         (1) the Astronomical Unit distance unit
      c. the minor planets
         (1) asteroids
         (2) comets
   2. Hierarchical structure of the universe
      a. the light year distance unit
      b. VIDEO—“Powers of Ten”
   3. Our Milky Way galaxy--a typical spiral galaxy
      a. size and our location
         (1) activity: the “penny solar system”
4. Galaxies (brief slide show)
   a. morphological types
   b. Most conducive to complex life
   c. clusters and superclusters
b. Cosmic Perspective—Time
   i. Bishop Ussher (17\textsuperscript{th} century)
   ii. The Great 19\textsuperscript{th} century Age of the Earth Debate
   iii. The age of the solar system
   iv. Relative age dating
       (1) crater counts
       (2) surface geological processes
       (3) crustal rock layers
       (4) fossils
   v. Absolute age dating
       (1) radioactive decay of unstable isotopes in rocks
       (2) astrophysical estimates of the age of the sun
           (a) from its gross properties
           (b) from its internal oscillations
   vi. Age of the universe

8. The Universe—setting the stage for life
   a. Setting the 4D space-time continuum “stage” for the matter and energy “actors” of life in the early universe?
   b. A comment on stars.
   c. VIDEO—The “Cosmic Calendar” from Cosmos #1

9. Star basics
   a. Spheres of matter
      i. Chemical composition
      ii. Mass range
      iii. Size range
   b. Temperature—key property
      i. Range
      ii. Luminosity (power)
          (1) Intensity
          (2) Size (specifically, surface area)
      iii. Spectrum—result of
          (1) Temperature
          (2) chemical composition
          (3) Size (atmospheric pressure)
          (4) other properties
   c. The types of stars—Spectral Classification
   d. A quantitative look at the major properties of stars
      i. Masses
      ii. Luminosities
      iii. Temperatures
      iv. Sizes
   e. Double stars physical binaries
      i. astrometric binaries
      ii. spectroscopic binaries and the Doppler Effect
iii. benefits to astronomy of double stars

f. Luminosity Function

g. Stellar populations (brief)
   i. Population 1
   ii. Population 2
   iii. The development of the terrestrial planet class

10. Star & Planet Formation (Pre-main sequence phase)
   a. The role of gravity
   b. Step by step
   c. How stars shine
      i. nuclear fusion and Einstein’s famous equation: $E=mc^2$

11. The Lives and Importance of Stars
   a. Main Sequence Phase
   b. Post-main Sequence Phase
   c. Closer looks at
      i. Heavy-weight stars
      ii. The range of stellar masses
      iii. Range of stellar lifetimes
   d. Astrobiological impacts of stars
      i. Births of stars
      ii. Stellar energies
      iii. Stars and cosmochemistry
      iv. A followup look at Spiral-type galaxies

**TEST 2  covers to here and Assignments 4, 5**

Part 3 of 3. Life!

12. Life on Planets around other Stars
   a. Habitable Zones
      i. Description
      ii. Key roles of water
      iii. The effect of differing stars on HZs
      iv. Possible life outside HZs
   b. Extra-solar planets
      i. How to detect?
      ii. Doppler effect
      iii. The discovery
      iv. What are we learning?
v. Hot Jupiters
vi. Implications for terrestrial planets
vii. Double star planets
viii. Independent confirmation

13. Earth and Moon

a. The Moon
   i. Origin
   ii. History of early solar system
   iii. What roles it might play in life on Earth

b. Planet Earth
   i. Early development and resulting structure
   ii. Its dynamic nature
   iii. Geology and continental drift-plate tectonics
   iv. Atmosphere and climate
   v. “Snowball Earth”
   vi. Rare Earth

14. Life on Earth

a. The nature of life
   i. Physical entity engaged in processes
   ii. What enables the metabolic and other biological processes?
      (1) DNA, deoxyribonucleic acid
          (a) structure
          (b) functions
      (2) Clarification: The role of RNA
   iii. Cells—the basic chemical factory unit
      (1) Three basic levels of life's complexity
      (2) Cell structure
      (3) Cell division—mitosis
   iv. The four compounds of life
   v. Three-part working definition of Life
      (1) bounded micro-environments
      (2) capable of transforming energy and the environment
      (3) capable of information encoding and transmission

b. Origin of Life on Earth—seeking the chemical evolution which led to the biological evolution
   i. one of the fundamental mysteries of life, as it were
   ii. Numerous Creation Myths
   iii. First scientific hypothesis—Spontaneous Generation
   iv. 20th century ideas
      (1) Cool early Earth
      (2) Hot early Earth
      (3) deep in the surface and ocean depths
         (a) hot, dark, no oxygen
      (4) “They came from outer space!”
         (a) Panspermia, in several versions

TEST 3 covers to here and Assignment 6 - 8
c. Evolution of Life on Earth
   i. Two aspects—theory or fact?
   ii. Evidence
      (1) Paleontology
      (2) Phylogeny/cladistics
      (3) Biogeography
      (4) Embryology
      (5) Molecular biology
      (6) The ongoing occurrence of evolution
      (7) Extinctions of flora and fauna
      (8) human-directed evolution
      (9) The development of absolute age-dating of rock strata
      (10) The “meta-proof” of evolution
   iii. The Theory of Evolution
      (1) Charles Darwin and his epochal book is On the Origin of Species by Means of Natural Selection
      (2) “The survival of the fittest.”
      (3) Evolution in thought—a self-demonstration of evolution at work on our minds
   iv. Final point
      (1) The limited role of chance

d. “Scientific” Creationism (SC) and its recent upgrade, Version 2.0, “Intelligent Design”
   i. The “Argument from Design” A theological interpretation of nature
      (1) Rev. William Paley, Natural Theology, 1803
   ii. American Christian fundamentalism
   iii. Reasons why SC and ID are not intellectually respectable
      (1) science, a purely naturalistic pursuit of knowledge and understanding of the physical world, cannot prove nor disprove supernaturalistic claims
         (a) “Scientific” Creationism is an oxymoron
         (b) an example of SC writing on this point
      (2) The either/or fallacy
      (3) The incompetency of their alleged “scientific research”
   iv. Intelligent Design (ID)
      (1) Plus: acknowledges problems with the “argument from design”
      (2) Another plus: accepts scientifically determined ages for the universe and objects within it
      (3) Minus: still has no good science in it
         (a) no real research
         (b) ideas have long been rebutted w/o effective response
         (c) brings up the refuted “watchmaker” analogy of William Paley’s
   v. So how could the eye evolve?

e. The Geologic Time Scale and the Evolution of Life on Earth—Pre-Cambrian
   i. Four major units of geological time
      (1) eon
      (2) era
      (3) period
      (4) epoch
   ii. Hadean eon—the period of heavy bombardment
   iii. The rise of the Domains and Kingdoms of Earth’s life
      (1) Archaean eon and the rise of
         (a) Prokaryotes
      (2) Proterozoic eon and the rise of
         (a) Eukaryotes
         (b) Archaea
         (c) complex life-rise of the Animal Kingdom
         (d) other eukaryotic Kingdoms
(e) sex at the cellular level
(3) Snowball Earth
(4) ediacaran animals

f. The Geologic Time Scale and the Evolution of Life on Earth—Cambrian and following
i. The Cambrian Explosion of fossilizable animal life and the start of the current eon, the Phanerozoic
   (1) Creation of the phyla
ii. Paleozoic era—“Old life”
   (1) Life changed the atmosphere by creating free oxygen
   (2) Cambrian period
   (3) Ordovician period
   (4) Silurian period
   (5) Devonian, “the age of fishes”
   (6) Carboniferous period
   (7) Permian period
iii. Mesozoic era—“middle life” a.k.a. “The age of the dinosaurs”
   (1) Triassic period
   (2) Jurassic period
   (3) Cretaceous period
iv. Cenozoic era “recent life” a.k.a “The age of mammals”
   (1) Tertiary period
   (2) Quaternary period
      (a) Pleistocene epoch
      (b) Holocene epoch “The age of man”

NOTE: For these last two units, XV and XVI, the textbook input may be greater than the classroom input

15. Life in the Solar System

a. Mars
   i. History of interest
   ii. The “Canals of Mars”
   iii. Atmosphere
   iv. Viking missions
   v. The search for water past and present
   vi. The “Mars Life Rock”
   vii. Methane?

b. Icy Satellites
   i. Europa
   ii. Titan
   iii. Enceladus

16. Life in the Universe

a. What are the odds? The Drake Equation – lab activity
   i. “Rare Earth”
   ii. An estimate for the probability of simple life forms
   iii. An estimate for the probability of complex life forms
   iv. An estimate for the probability of intelligence

b. SETI—the Search for Extraterrestrial Intelligence
   i. History
   ii. Ideas for communication
iii. Current work and future ideas

c. UFOs and Ancient Astronauts
   i. Review of the evidence and claims
   ii. Scientific results

d. Space Travel
   i. Interstellar
      (1) The universal speed limit posed by relativity
      (2) How to?
         (a) future rocketry
         (b) future physics
   ii. Interplanetary
      (1) How to?
         (a) future rocketry

e. The “Fermi Paradox”

f. The Impact of First Contact (Epilogue)

TEST 4 covers to here and Assignments 9, 10, 10N, possibly also 11

Assignment 12—due with Test 4, but not included on it.

HOMEWORK ASSIGNMENTS   AST 105IN   Life in the Universe

Fall 2018 and after

NB: On problems requiring calculations, you must show the calculation setups. The calculations themselves may be done with a calculator. Do you know what “NB” means?

CRN 10698

The reading part of assignments is given in the left column. The written part of assignments is given in the right column.

Note regarding the Quick Quiz questions: **I do not want you to explain why you made your particular multiple choice as the textbook requests. Simply write the letter of your choice.** I know the book says to explain your choice, but ignore the book instruction in this case.

**Assignment 1**

Due date: Wed, Sep 05 12

“How to Succeed...Astrobiology Course” pp. xiv, xv
Ch. 1, “A Universe of Life?” pp. 1-12 RQ. 1,2,4,6,10; QQ.11-20.
Ch. 2.1, “The Ancient Debate about LBE” pp. 16-25 RQ. 1,4,7,10,11,15,17; QQ. 31-34; QP. 52,53,56
Ch. 2.4 “The Fact and Theory of Gravity” pp. 41-44

**Assignment 2 – Foundational Assignment**

Due date: Wed, Sep 12

Introductory Course Note Set

Question sheets (handed out, but also downloadable from Course Documents page)

**Assignment 3**

Due date: Wed, Sep 19

Ch. 2.3, “The Nature of Modern Science” pp. 33-41 RQ. 12-16; S/NS. 20,21,24-27; QQ. 35-38;
Ch. 3.4 “A Universe of Matter and Energy” pp. 80-89 RQ. 17; R?. 26-29; QQ. 44; QP. 58 (Hints: d=rt; Use 300,000 km/s for the speed of light; convert to minutes)

**TEST 1**

Date: Wed, Sep 26

**Assignment 4**

Due date: Wed, Oct 03

Ch. 3 “The Universal Context of Life” pp. 50-95 RQ. 1,4,9,11,13,14,22,24; R?. 30,33; QQ. 35-37,39-43; QP. 60,63
(Read to “The Content of the Universe,” p.58) (Hints: d=rt; Use 300,000 km/s for the speed of light.),66 (Hint: Skip to “We are Star Stuff,” p. 63) the odds of one planet orbiting in a particular sense is one out
Assignment 5

Due date: ____________ Thur, Oct 10

Ch. 11.1 “Distant Suns” pp. 359-368  RQ. 1,4; WB. 17,22,23,26; QQ. 27-29,36
Ch. 11.4 “…Science in Action: Classifying Stars”
pp. 386-391

Assignment 6

Due date: ____________ Wed, Oct 31

Ch. 10 “The Nature and Evolution of Habitability”  RQ. 1,2,4,7,13,15-17; S.?.
20,21,23,25,28; QQ. 29-38; QP. 51
pp. 326-354  Hint: Mars distance=1.53 AU;
Venus=0.72 AU
Ch. 11.2 “ExtraSolar Planets” pp. 368-382  RQ. 9,12; QQ. 30-35; QP. 49,51
http://www.seti.org/site/pp.asp?c=ktJ2J9MMIsE&b=178025

Assignment 7

Due date: ____________ Wed, Nov 07

Ch. 4 “The Habitability of Earth” pp. 101-145  RQ. 1,2,5,6,17; S.?; 21-25,28; QQ. 31-
38,40; QP. 49,50a,51a,52
Ch. 11.3 “The Possibility that Earth is Rare” pp. 382-386
http://www.seti.org/site/pp.asp?c=ktJ2J9MMIsE&b=178025

Assignment 8

Due date: ____________ Wed, Nov 14   Veteran’s
Day, Mon, Nov 12

Class)
Ch. 5 “The Nature of Life on Earth,” pp. 150-183  RQ. 1-3,5-8,11,12; QQ. 27-35
except 5.6 “Evolution as Science” covered in next
assignment
“Charles Darwin and...Evolution,” pp. 160,161  List significant points (for 4 pts.) Don’t
miss this! Past students have.
Ch. 6 “The Origin and Evolution of Life on Earth”  RQ. 1-3,6; WB. 23,24,26; QQ. 33-37
through 6.2 “The Origin of Life” pp. 192-207  Rest of chapter covered in next assignment
http://nai.arc.nasa.gov/index.cfm

TEST 3

Due date: ____________ Wed, Nov 21 Thanksgiving, Thur, Nov 22 and Fri, Nov 23
Assignment 9

Due date: Mon, Nov 26

Ch. 5.6 “Evolution as Science” pp. 183-187
RQ. 15,16; QQ. 36
Ch. 6.3 “The Evolution of Life” to Chapter end,
RQ. 8,10,13,18-20; WB? 27,29-31; QQ.
38-42;QP. 52

pp. 208-231
Assignment 10  
Due date: Mon, Dec 03

Ch. 7, "Searching for Life in Our Solar System"  
RQ. 1,4,8,12,13; WB?. 16-18; QQ. 25-34; QP. 41,42 (Hint for both problems: Use the approximation for Newton's version of Kepler's 3rd Law (from the fact that the planet's mass is ignorable) and then see how the orbital period, \( p \propto \) star mass.)

pp. 237-256

Assignment 10N  
Due date: Wed, Dec 05

Ch. 8 “Mars,” pp. 260-289  
RQ. 3,6-10,14; QQ. 31-40

Ch. 9 “Life on Jovian Moons,” pp. 293-321  
RQ. 1,4-6,8,10; QQ. 25-33

Assignment 11  
Due date: _____?

Ch. 12 “The Search for Extraterrestrial Intelligence”  
RQ. 1-3,5,6,13,14; EP. 15,16,19,21,23; QQ. 25-34; QP. 43

pp. 396-430

Ch. 13 “Interstellar Travel & Fermi Paradox,” pp. 435-465  
Q. 2,7,8,10,11,14-16; QQ. 31-38

Skip the last section 13.4 “Einstein’s Theory of Relativity”

TEST 4  
Date: Wed, Dec 12

Assignment 12  
Due date: Wed, Dec 12

“Epilogue: Contact—Implications of the Search and Discovery,” pp. 477-484

"Never regard study as a duty but as an enviable opportunity to learn...for your personal joy and to the profit of the community to which your later works belong."

Albert Einstein
Other Policies Concerning Withdraw, Audit, Incompletes:

Students may self-initiate withdrawal ("W" grade) from a course up to Thursday, April 05. After that Self-Withdrawal Deadline, you need to come to me to discuss your situation. If I agree to award you a W or I grade, then you must write me in a couple of sentences (email is fine) a request to be awarded a W or I grade. I will respond in writing. That’s all. W means you’re done with this course and are free to have a clean start in a subsequent offering.

After that deadline, you may request to receive an I grade or W grade, but these grades are granted at my discretion.

Sometimes students simply disappear near the end of the semester without any consultation with me. In those cases, I am obliged to calculate their Final Course Average based upon the information in the grading spreadsheet, as I do normally for everyone. This typically results in an F grade. Occasionally a “disappeared” student has done well enough before leaving to obtain a D grade.

For awarding the Incomplete grade (“I” grade) my two criteria are whether you have completed the first two tests and their attendant work and your current grade situation assures me that you have a reasonable expectation of completing the course with a C or better. If I agree to awarding you an Incomplete, I then fill out an Incomplete Grade form that lists all work needed to be done to complete the course. For this grade, I require that the Incomplete be made up with me as Instructor.

Do note that Incomplete grade must be completed within one year or the grade automatically converts to an F.

For the Audit Grade, This grade is only for those who seek a stimulating intellectual experience, without all the workload required. The potential student must see me at the start of the semester, preferably the first class meeting, 2nd at the latest. Any questions, see me, but this is not a common grade. In my career spanning five decades, I think I was approached by two people.

Attendance Requirements/Active Participation

A failure to participate as required may result in loss of financial aid and failure in the class. For every credit hour of your classes you should plan to spend approximately two to three hours outside of class studying each week. Attendance requirements (https://www.pima.edu/programs-courses/credit-programs-degrees/attendance.html)

Course-specific attendance and participation

**ATTENDANCE:** As indicated previously, 50 points of your Incentive Score is made
by your fulfilling the basic requirement of attending class. Your Attendance Score will be some proportion of the 50 maximum credit toward your Incentive Score. You will be given three full-period grace absences—I know bad things can happen to the best of students.

So, for example, suppose you miss 6 classes out of 32 by the end of the semester. The first three absences are not counted, so the scoring of your attendance is (6 - 3) = 3 absences taken into account. Your Attendance Score is then calculated to be ((32 - 3)/32) x 50 = (29/32)x50= 45.3 points out of 50 possible that go towards your Incentive Score. For those who complete the course, Attendance Scores are typically good, above 45 out of the 50 points possible.

**HOMEWORK:** Important, too, for your understanding is the reading of assigned material (almost entirely from the textbook) and the answering of questions at the end of each chapter. The purposes of this written homework is to help you to think about the chapter material you've just read and, along with attendance sign-in sheets, document your continuing efforts. Your answers will be spot checked and score recorded. Try to work independently; poor answers copied mindlessly may be given extra penalty. See "Grading" Section, "Incentive Score".

**TESTING:** There will be four tests in each course covering the lecture material. (Any quizzes on lab material will go on your lab score.) The tests will tend to emphasize the material presented in class, but the book remains important to you in your test preparation.

I use my math background to offer all students some benefit of the doubt regarding their test average at the end of the course. Instead of taking the usual straight average of the four tests, **I half-weight the lowest test.** This is nothing you have to request. It automatically cuts you some slack for a weak test result. And the worse you score on that lowest test, the more you are helped. And if you have no score that is very much less than the others, then the benefit naturally is very little. Elegant.

There is also a comprehensive (covering the entire course material) FINAL EXAM, **BUT IT IS USED ONLY AS A MAKE-UP FOR A MISSED TEST.** Its use will affect the weighting of the individual tests. (See "Grading" Section, "Final Exam".) A second missed test receives an automatic zero. The Final Exam is not an optional replacement for your lowest test score.

**OUTSIDE ACTIVITY (OA) CREDIT**
Astronomy is a subject that can be approached in a variety of ways. And because we live in what is sometimes referred to as the "Astronomy Capital of the World", we should take advantage of some special opportunities here. Each Outside Activity you do can account for up to about 15%, depending on the event, towards your Incentive Score. (See "Grading" (page 3), "Incentive Score"). You have your choice from the list below:

If a report for a talk is required, I am expecting 500-800 words describing what was presented as well as your personal impressions of the talk (speaker, content, etc.) Your effort in writing the report will be reflected in the points your are awarded.

FLANDRAU PLANETARIUM — Because of the large reduction in state support, the public programming at the Flandrau Science Center has been reduced. Call 621-star for information on shows available to the public (but NOT laser shows!). The very nice 16" telescope is open to the public at no charge. Again call 621-star for availability. Be sure to thank the telescope operator; he/she is not paid.

KITT PEAK NATIONAL OBSERVATORY — Small donation. (318-8726) Take the guided tour on weekends at 10:00 a.m., 11:30 a.m., or 1:30 p.m. Document your visit by having the tour guide sign, stamp, and date a Kitt Peak brochure following the tour. The docents are instructed not to sign a brochure for anyone who has not participated in their tour. Be sure to sign your name too. No report is required. Your visit is worth 10% OA credit, less if you do not do all required.

MAGAZINE ARTICLE LIST — Enlightening articles are offered you in a Magazine Articles List, found in the links table on the “Course Documents” page. I prefer you do a structured outline. Summarizing or listing significant points will earn you less credit than good outlining. Do not outline articles not found in the list before checking with me.

TUCSON AMATEUR ASTRONOMICAL ASSOCIATION (TAAA) — Monthly meetings in the new auditorium (room N 210) at the U of A’s Steward Observatory (933 N. Cherry Ave.) 6:30 p.m. on the first Friday of most months. This is for 8-12% OA credit, with a report as described above for planetarium visits. Check the following Website for scheduled talks: http://www.tucsonastronomy.org/

STEWARD OBSERVATORY PUBLIC EVENING SERIES — Monthly meetings in the new auditorium (room N 210) at the U of A’s Steward Observatory (933 N. Cherry Ave.) 7:30 p.m. on various Monday evenings during the semester. Check the following Website for schedule: http://viking.as.arizona.edu/~taf/pubeve/pub_lect.html This is for 8-12% OA credit, with a report as described above for planetarium visits and TAAA meetings. For map and link online, see 2nd table at our astronomy
LUNAR AND PLANETARY LAB (LPL) EVENING LECTURE SERIES — Monthly meetings in the Kuiper Space Sciences Lecture Hall, room 308, 7:30 p.m. on various Tuesday evenings during the semester. Check the following Website for schedule: http://www.lpl.arizona.edu/COLPL/ This is for 8-12% OA credit, with a report as described above for planetarium visits and TAAA meetings. For map and link online, see 2nd table at our astronomy classes website http://wc.pima.edu/~gmechler/ http://wc.pima.edu/~gmechler/

There may be other activities announced thru the term which are acceptable for credit. For example there is usually a short-term lecture series or just individual talks that can be very rewarding by introducing you to the intellectual life. They will be announced in class and on the website.

IMPORTANT: Outside Activity (OA) credit reports etc. may be handed in at any time in the semester, without penalty, up to the end of the last class period (when you take the last test). The class period of the last test marks the end of the course. I refer to this not as a due date, which carries the implication of lateness allowed, but as the Final Deadline for ALL work due or previously due. This is the end of this class’s time. There is no “late” after it, with the exception of an I (Incomplete Grade being awarded, for which I expect you to ask.) I will ignore any work handed in after the class period or emailed to me with a time after the class period. I recommend you earn most of your Outside Activity credit during the first month or two of the course. Save 5-10 to be done near the end to encourage you to take advantage of good talks or planetarium programs offered then. Things pile up near the end of the semester.

INCENTIVE SCORE: This score is compiled from credit summed from your attendance, homework, and outside activities.

GRADING: The grading scale is as follows:

A: 90s%
B: 80s
C: 70s
D: 60s
F: below 60 (“high F” 59 – 50; “low F” 49 and below

**GRADING PHILOSOPHY**
The bottom line regarding grades is that it will be determined by your performance. The structure of my grading system has as its purpose to encourage you to strive for excellence. In addition to testing your comprehension ability, this system will also grade you on related success traits: perseverance, initiative, effort, accepting responsibility, and ability to follow instructions. (See "Incentive Score"). The grade you receive at the end of the semester is the grade you will have earned.

It is my hope you will leave this course a better student, more understanding of science, more capable of thinking critically, having a broader perspective on the world, open and yet more skeptical of the many claims you will hear. I assert that these abilities and attitudes gained from an introduction to science will serve you well in meeting the challenges of career and life and will increase your ability and willingness to be a conscious contributor to society. Science is not just for scientists.

**LECTURE PORTION of the Course Grade**

Weighted Average = sum of the three higher test scores + ½ of the lowest test score, the sum divided by 3.5 (the sum of the weights).

TESTS: The 4-credit astronomy "IN" courses (lecture-lab integrated) comprise 3 credit-hours for the Lecture portion and 1 credit-hour for the Lab portion. The four tests together contribute ⅔ of the Lecture portion of the Course Grade. When averaging these test scores at the end of the term, your lowest score will be averaged with half-weight, as I described above. Weighting is affected if you have to take the Final Exam to make up a missed exam--see "Final Exam" Section above.

**INCENTIVE SCORE:** The remaining ⅓ of the lecture portion of your course grade assesses your qualities as a learning-centered student and future employee. It is the summation of the following activities:

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>MAXIMUM POINT VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attendance</td>
<td>50</td>
</tr>
<tr>
<td>Homework</td>
<td>50</td>
</tr>
<tr>
<td>Outside Activity</td>
<td>15 extra credit</td>
</tr>
<tr>
<td>TOTAL</td>
<td>115%</td>
</tr>
</tbody>
</table>
The points you earn in these activities are simply added to determine your score for this third of your lecture score. Your effort on Outside Activity credit work is low stress, yet can tell me something of your initiative and make or break you at the end of the semester.

To give a grading example for the lecture portion of the course, let’s take a student whose Attendance Score of 42 (out of 50) is added to her Homework Score of 39 (out of 50) and to her Outside Activity Score of the full 15 points to result in her Incentive Score of 96. Her four tests average 65%, even with the half-weight of her lowest test score. A possible D grade. The Lecture portion of her Course Grade is \( \frac{2}{3} \times 65 \) + \( \frac{1}{3} \times 96 \) = 75%.

**LAB PORTION of the Course Grade**

As 1 credit of this 4-credit course, the Lab portion is worth 25% of your Course Grade. Your Lab Score will be determined from the exercises and activities. It is more straightforward to calculate. The lowest score is dropped at the end of the semester. “Lowest” is defined as the activity in which you lost the most points. The Lab portion of your Course Grade is simply the sum of the points earned divided by the maximum possible points (after dropping out that worst score to cut you some slack).

Suppose the hypothetical student at the end of the semester has earned 323 points out of 362 maximum possible. And her worst single activity score was worth 30 points for which she earned only 18. 18 points are therefore subtracted from the points she earned while 30 are subtracted from the maximum possible points. With these subtractions taken, her resulting Lab Score is 305 ÷332 = 92%.

**COURSE GRADE**

Your Course Grade is the result of adding your Lecture and Lab portions, weighted by their credit-hour portions. Adding the lecture and lab scores together, weighted by their portion of the 4 credits, her Course Grade results from the following calculation:

\( \left( \frac{3}{4} \times 75 \right) + \left( \frac{1}{4} \times 92 \right) = 79\% \). Promise yourself not to get the worst course average. That’s not the lowest score in the class. It is 69%. How mediocre… Just a little more effort, say, with that Outside Activity credit or with those homework scores, in which you didn’t even do several homeworks. And the semester has been largely wasted. You might have learned more than your grade makes it apparent, but in regard to progressing through your academic career and transferring credit from Pima to a university, a student with a score of 69% has wasted a semester of science credit. 69%, not 59%, is the worst score you can earn. Almost as bad are any course scores ending in 9. Just a little more effort…
Miscellaneous Course Policies and Procedures

Late Homework & Lab Exercise Policy: The course load for you and me can tend to build up and it is important for all of us to see that work is turned in on the due date. On the other hand, I realize events beyond the student's control may on rare occasion prevent an assignment from being handed in on time. I therefore will accept with no penalty homework handed in anytime on the due date. If you cannot hand the assignment in until after class time, you need to hand it into my office Room 228 on the 2nd floor of the Tortalita building (“E”).

A small, but growing, late penalty of 2 pts @ school day (Mon—Fri, except holidays) will be assessed until the assignment is handed in or the penalty grows equal to the maximum possible score. This penalty applies even if just part of the homework is handed in late, though at a reduced rate. NB: If you cannot be in class on the due date, then you have options to mail or e-mail me. I will go by the envelope post date (or e-mail date/time) to determine the late penalty, if any. This is a reasonable with flexibility built into the policy. Do not ask for favors because you have already been given favor automatically. My mailing address: See below.

Dr. Gary Mechler
Physical & Earth Sciences Dept.
Mail Stop WC 0290
Pima Co. Community College
2202 W. Anklam Rd.
Tucson, AZ 85709-0001

The Final Exam. This comprehensive (covers entire course) exam is given more weight. With the normal weight equaling 1; the Final Exam's weighting is therefore 2, unless it is the lowest score of the four tests, which half-weights it weight, resulting simply in a straight average of the four tests taken. Note that the tests altogether will still comprise ¾ of the lecture score (and ½ of the Course Grade (= ¾ x ¼)).

AND FOR THE SOCIALLY AND ETHICALLY CHALLENGED: Pima College and this professor view cheating as a serious ethical failure. If you have an opportunity to cheat, just don’t do it. If you see someone else cheating; report it. It is a part of your growth as a student and person, growth needed in your future profession and personal affairs. It's called integrity, character, backbone. Cheating is not fair to others; it is simply not acceptable behavior. Unchecked, this weak mindedness can lead to evil. Why should any of us put up with that poor behavior? A student charged with cheating is subject to
appropriate penalty up to and including dismissal from the course, with either a withdrawal (W) grade or an F and perhaps also a note added to your student record. If particularly egregious, a student may be expelled from Pima College for some length of time. A test score which has been affected by a cheating penalty will not be given half-weight should that test turn out to be the lowest score.

Less serious, but still of concern is inappropriate, disruptive behavior—irrelevant conversing, for example. The usage of cell phones in class or leaving class (defined by me) to attend to telephone calls. These behaviors and activities maybe a cause for penalty, at my discretion. A verbal courtesy warning will be given before any penalty is exacted. Penalty points will be applied to the student’s Class participation score. I do realize that emergencies do occasionally arise; keep me informed.

**Key Dates**

For class add, drop, and withdrawal dates, go to the “My Schedule” section of MyPima, found on the Students > Academics MyPima page. Additional semester [Key Dates and Deadlines](https://www.pima.edu/calendars/key-dates-and-deadlines/2018-fall.html) are on the Calendar link at the top of PCC webpages.

Student self-withdrawal deadline is Thur, November 08.
Last day of class, Wednesday, December 12

**Student Resources and Policies**

**Student resources:** tutoring, libraries, computer commons, advising, code of conduct, complaint process. [Student resources](https://www.pima.edu/current-students/index.html)

**Student policies:** plagiarism, use of copyright materials, financial aid benefits, ADA information, FERPA, and mandatory reporting laws at: [Policies](www.pima.edu/syllabusresources)