YOUR FIRST QUIZ!

A quiz on the first day? Yes. But this quiz doesn't count for anything. It's just for fun!

There are twelve questions. Each is "true" or "false." Here they are—in no particular order . . .

1. There are other worlds revolving around other stars, just as our Earth revolves around the Sun.

2. The positions of the planets in the zodiac (Aries, Leo, Aquarius, etc.), at the time of your birth, have an effect on your personality.

3. The build up of so-called greenhouse gases can make a planet so hot as to become uninhabitable.

4. The absence of ozone in an atmosphere makes life below difficult.

5. The only known crash of a flying saucer occurred at Roswell, New Mexico, in 1948.

6. Huge bodies, called asteroids, have smashed down upon the Earth and caused catastrophic destruction.

7. More people become insane during the Full Moon than at any other time.

8. It would take days, weeks, or even months to travel among the stars.


10. Columbus discovered that the Earth is round.

11. It is possible to see things that happened millions of years ago.

12. There are stars older than everything in the entire Universe.

[Answers appear at the bottom of page 3.]
SYLLABUS

Welcome to EARTHSCI 1100. This is an exciting time to take "Astronomy." Several robot spacecraft are busy at work, one roving the dunes of Mars. New planet-like bodies are being discovered: small ones in the far reaches of our Solar System and huge ones orbiting stars other than the Sun. And evidence mounts for the existence of anti-gravity! We will be learning about all these things and more. First, though, here is your guide to making the course "user friendly."

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Department of Earth Science
office: Latham 112
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if no answer, call: 273-2759 (secretary)
FAX: 273-7124
campus mailing code: 0335
electronic mail: HOCKEY@UNI.EDU (checked once a day at least)

My WWW Page is at http://www.earth.uni.edu/tah.html.
My Blog is at: https://weblogs.uni.edu/hockey/ (non-astronomy).

OBJECTIVE: We will be taking a tour around the Universe, stopping every once in a while to take a look at how we arrive at astronomical knowledge. We will take care to note that astronomy is not a dead body of knowledge, but rather a dynamic on-going process. New discoveries and understandings will be pointed out as will things that remain very much a mystery to us. All this is to say that, far from doing something specific to one narrow discipline, we will be doing what each of us thinking human beings has been doing since the beginning: trying to figure out where we are and what the "rules" are. In this regard, astronomy is a very human endeavor.

On the practical side, astronomy is a liberal-arts course. I will not claim that it will be of vital use to you in day-to-day life, nor do I feel that I need to. While this course may help you to improve your three-dimensional thinking or your reasoning skills, its main function probably will be to help you "tap into" our culture, that is, understand astronomical allusions and concepts that appear in writing, conversation, or the evening news, as well as to aid in your personal maturity of thought.

I have several major goals for this course. There are a number of ideas that I hope that you still will consider even when much of the specifics of 870:010 are forgotten. Whether explicitly or implicitly, we will return to them again and again throughout our semester together. A few of these are:
i. Our senses provide direct information—limited by resolution—in two dimensions. But space is in 3-D! It is often difficult to infer the third dimension. Sometimes we have to use angular measurements when absolute measurements of length, height, and width are unobtainable.

There are two different ways of viewing a thing in the Universe: as an object projected into the sky or as a place in its own right. Our impressions of these things often differ from the two perspectives. Furthermore, because something is impossible to visualize does not necessarily mean that it does not exist.

ii. The story of many natural systems is one of gradual change punctuated by occasional, sudden, course-altering events. Both equilibrium and cycles are common in the Universe.

Objects such as stars and planets are not unchanging; they evolve with time. Their appearances today offer clues as to their histories.

iii. The Earth is one data point. The Sun is one data point. Terrestrial life is one data point. To understand fully our environment and ourselves, we must seek other data points.

Our lives and environment here on the Earth bias us as to what a "typical" place in the Universe is like. Our ability to affect the Universe is minuscule. The world will continue with or without us. It is in our own self interest to maintain the unusual set of conditions that allows life on the Earth. There is no one that we know of to "bail us out" if we fail. And there is no place else on the seeable horizon to go.

iv. Traveling in the Universe is difficult; observing the Universe is comparatively easy.

v. Unlike some other scientific disciplines, significant contributions can be made in astronomy by individuals without elaborate equipment or lengthy academic credentials.

At the end of the semester, look back at this short list and reflect on how these ideas have been developed and whether or not you agree with them.

BY THE WAY: Besides fulfilling a Liberal Arts Core requirement, did you know that this course may be applied to several degree programs? See the hall display (between your lecture hall and my office), or me, for details.


This particular text has been chosen because it is readable, well illustrated, and (most importantly in a quickly developing discipline like astronomy) up-to-date. You will find that many of the four-hundred slides that will be presented in lecture also appear as pictures in the textbook.

To guide you in your reading, you are given a list of reading assignments. It will be to your advantage to have read the assignment for a particular day before that day's lecture. In fact, I will assume you have done this. Each lecture will cover a lot of ground and probably will be difficult to follow if the lecture is your first introduction to the material.

While the lectures and textbook readings are intended to complement and reinforce one another, you will be responsible for material in the reading assignments not covered in lectures and, likewise, material presented in the lectures that does not appear in the text.

If you run across an instance where the text and the instructor seem to differ, I will expect you to bring it to my attention as soon as possible. Every textbook almost certainly contains "typos," and both the author and I would appreciate your help in ferreting them out.

Read your text critically, particularly the numbers. You may be surprised to learn that many of the physical quantities we use in astronomy are not well known yet. Often the numbers stated in the book and in class are approximate or a most recent estimate. We will round numbers often to the closest power of ten. These rounded numbers still will give us a good sense of what is going on and will be easier to remember.

In addition to your textbook, I recommend that you purchase a three-ring binder in which to keep exams, homework, and other handouts. These materials will be punched for this purpose.

WHAT TO DO:

By each class day, read that day’s assignment from the textbook. Watch the video that corresponds to that class day. Send to your instructor the answer to that day’s homework question. On test days, take the on-line test.

GRADES: Your grade for the course will be based on your earned percentage (see discussion of exams, homework, and other require-
ments below) and will follow a scheme something like this:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>90% &amp; above</td>
</tr>
<tr>
<td>B</td>
<td>80% &amp; above</td>
</tr>
<tr>
<td>C</td>
<td>70% &amp; above</td>
</tr>
<tr>
<td>D</td>
<td>60% &amp; above</td>
</tr>
</tbody>
</table>

This system has the advantage that it does not require some arbitrary number of "points" for a particular grade (347 points = A, 289 = B . . . that kind of thing)

I reserve the right to change the grading scale by lowering the numbers if I feel that this is necessary. "A"'s will not be easy to get and, hopefully, neither will "F"'s.

(The following standard rounding rule is used . . .

Example: 89.4 = 89%; 89.5=90%)

I do not post grades, for reasons of confidentiality. Just ask.

EXAMINATIONS: There will be four exams given during the semester. There will be no comprehensive "final" per se. Individual requests for rescheduled exams, due to illness, should be accompanied by a physician's note.

Each exam will count as 20% of your course grade.

Each exam will consist of many multiple-choice questions (four possible responses each). While I realize that some people do not feel that they "test" well in this format, it is a necessary one for a class of this size and in order to meet the two requirements for an exam that I believe students desire: rapid turn-around on the exam results and the opportunity to review the exam afterward, explicitly, for future reference.

Example Exam Questions

A theory of the nature of the Universe is termed:

a. a cosmology.
b. a constellation.
c. a deferent.
d. an epicycle.

When light strikes a curved mirror, as in a reflecting telescope, its angle of reflection

a. always equals its angle of incidence.
b. is greater than its angle of incidence.
c. is unpredictable.
d. None of these.

The questions that I ask will require some memorization of facts.
While memorization is considered (by some) a lower-order mental skill, and the very word "memorize" has unpleasant connotations, it is simply impossible to discuss the subject of astronomy without some basic facts at our common disposal.

But just remembering information usually will not be sufficient to adequately choose between the four possibilities on an exam question, and it is not the main purpose of the course. You will need to make judgements about what you remember. The purpose of science is to explain, and explanation requires decision making in the process of sorting out the available facts. I will test you on your ability to render judgements using the proper remembered items at the proper time in the proper pattern. By doing this, you will demonstrate that you understand the purpose of, and have successfully completed, this course.

You will not be asked to work out quantitative problems on the exams. There simply is not time. Instead, you may be given an opportunity to do this on take-home homework assignments.

If you find a test question for which you absolutely cannot choose between two "best" answers, this means that there is a mistake in the test item. In the rare case that you believe this has happened, select one answer to place in the answer blank. (Historically, people tend to choose the intended correct answer.) Then write me a short note citing the number of the offending test item and presenting a brief rationale for there being two equally "best" answers.

Chance of "Accidentally" Passing this Course

Odds = 4:1

based upon random guessing on exams--not recommended

HOMEWORK:

Our way of doing homework is to ask one question from those provided in your textbook most every class period. These questions will be drawn from those that accompany that day’s reading assignment. You will be given one class day to answer the question. Each correct index card will receive one percentage point. Twenty correct will be the equivalent of a perfect score on a test. You will be given many more opportunities than this (20 correct cards) during the semester.

Homework will be returned to you often with the correct solution written out if you have gone astray.

I suggest that you keep handy your old homework assignments, after they are returned to you, and all the lecture notes that you have made during the semester. You may be helped on homework assignments made late in the class by examples and formulae presented early in the class.
COURSE OUTLINE

INT      Introduction
HIS      The Early History of Astronomy
KEP      Tycho, Kepler, and Newton
SKY      Getting Around in the Sky
PLA      - no lecture - Visit the planetarium (Latham 105) at your prearranged time within the lecture hour.
ECT      The Ecliptic
SEA      The Seasons
ASP      Planetary and Lunar Aspects
ECS      Eclipses
ETC      "Etc."

This is a good time to review page 8 of the Syllabus, "Examinations."

EX1      EXAM I
LGT      Light
TEL      The Telescope
OVR      Planets: An Overview
SIZ      On Size and Distance
V&M      Mercury and the Moon
E&V      The Earth and Venus
MAR      Mars
OID      'Oids (Meteor- and Aster-)
ETC      "Etc."
EX2      EXAM II

The course is half over!

JUP      Jupiter
OUT      The Outer Solar System
ICY      Icy Satellites
PLU      Pluto and Stuff
COM      Comets
SPC      Spectroscopy
SUN      The Sun
DIS      Star Distances
STA      Star Light
ETC      "Etc."
EX3      EXAM III

Check to see what other astronomy courses are being offered in the Fall/Spring?

HRD      The H-R Diagram
LIV      The Lives of Stars
DIE      How Stars Die
WAY      The Milky Way
GAL      Other Galaxies
CML      Cosmology
A FEW WORDS ABOUT YOUR READING ASSIGNMENTS

You won’t hear me saying a lot about your textbook reading assignments, but do not make the mistake that a few students do each semester and not read them. Unless you ask questions about the readings (the end of the class period is an excellent time to do so), I will assume that you have them pretty well in hand.

The order of the subjects of the sections assigned is the easiest one to develop in lecture. Occasionally, the assigned text will refer to a passage that you haven not read yet. If this is troublesome, you are encouraged to use the glossary and index and refer to the as-yet-unassigned pages. There is no rule against reading more of the book than you are assigned or past the text you are assigned. Indeed, many of you will want to read the text more than once. For instance, some students find reading the material again in order, chapter-by-chapter, to be useful before exams.

All reading assignments are from Pasachoff & Filippenko 2007. Page numbers refer to the bold-face-titled sections beginning or ending on that page. (Sections also are listed in the “Detailed Table of
In addition to the sections that appear on the reading lists, your text provides "Concept Review," "Questions," and "Topics for Discussion" sections. While unassigned, these are an obvious resource. "Boxes" also are optional reading.

On the bright side, the explicit assignments are not quite as long as they appear. Our text was chosen, partially because of its wise and ample use of photographs, tables, and figures spread throughout its pages!

[Following each reading assignment below, I have included an anticipated outline of that day's lecture. Items in italics are sometimes skipped.]
READING ASSIGNMENTS - UNIT I

After some introductory remarks, in this unit we will trace the history of astronomy. We then will take a look at our sky, as seen by the naked eye.

INT  Introduction
Text Sections 1.2, 1.5, 1.6

HIS  The Early History of Astronomy, or "How Astronomy through the Ages Has Been Largely a Search for Our Place in the Cosmos"
TEXT SECTIONS 5.2 & 5.3
I. Observable Facts
II. Peoples' Views of the Universe
   A. Early Civilizations
   B. Eudoxus and Aristotle

KEP  Copernicus, Tycho, and Kepler, or "How a Few Simple Rules Govern the Movement of Just About Everything"
TEXT SECTIONS 5.4 & 5.5
I. Nicolaus Copernicus
II. Tycho Brahe
III. Johannes Kepler
   A. Kepler's First Law
   B. Kepler's Second Law

SKY  Getting Around in the Sky, or "How the Motions in the Sky Are as Regular as Clockwork (Literally)"
TEXT SECTIONS 4.3, 4.6, & 4.7
I. The Appearance of the Sky Throughout the Night
   A. Your "Personal" Coordinate System
   B. The Celestial Sphere
II. The Appearance of the Sky From Different Places on the Earth

ECT  The Ecliptic, or "How the Sun Appears to Move through the Sky"
TEXT SECTION 1.7
The history of astronomy has seen many peoples' attempts to construct a cosmology, or theory of the Universe, that satisfactorily described what they could see in the sky.

Johannes Kepler was able to model a Copernican (heliocentric) cosmology, based on orbital ellipses and planets "sweeping out" equal areas in equal intervals of time, that successfully explained Tycho Brahe's positional observations.

There are two ways of mapping the sky: on the celestial sphere and using a system of coordinates based on one's own zenith and horizon.
The calendar is based on the Sun's and Moon's apparent motion across the sky with respect to the stars, but we now know that it is really the Earth (us!) that is moving in our Solar System, and not the Sun.

The seasons are caused by the obliquity of the Earth and produce longer/shorter "days," require the altitude of the Sun in our sky to vary, and result in greater/lesser warming of the Earth's surface.

The Moon's phases depend upon how much of the lunar nearside is illuminated by the Sun, while eclipses are produced by either the Moon's shadow being cast on the Earth (solar eclipse) or the Moon itself traveling into the shadow of the Earth (lunar eclipse).

The relationship between a planet, the Sun, and the Earth determines how and where the planet will appear in our sky.
We will begin this unit by looking at our principal source of information about the Universe: light. Afterward, we will embark on a tour of the planets, and other bodies, close to the Sun.

[The SPRING semester version of the course will meet one less time during Unit II. This is to accommodate the annual Earth Science Update Conference (for Iowa teachers) in LAT 125. UNI teaching majors are invited to attend; see your instructor.]

**LGT**

Light, or "How Virtually Everything We Know About the Universe Comes to Us via Light"

**TEXT SECTIONS 2.1, 2.2, & 2.3**

I. The Nature of Electromagnetic Radiation
II. When A Ray of Light Strikes A Surface
   A. Reflection
   b. Refraction

**TEL**

The Telescope, or "How and Why Astronomers Greedily Gather Light"

**TEXT SECTIONS 3.1, 3.2 & 3.3**

I. The Refracting Telescope
   A. Light Gathering
   B. Magnification
II. The Reflecting Telescope
III. Examples of Telescopes

**OVR**

Planets: An Overview, or "How Categorizing the Planets Is the First Step Toward Understanding Them"

**TEXT SECTIONS 5.1, 5.6 & 5.7**

I. Kepler's Third Law
II. Properties of Planets
   A. Orbital Distances
   B. Sizes
   C. Density

**SIZ**

Of Size and Distance, or "How Our View of a World from Afar Provides Insight into the View from Up Close"

**TEXT SECTIONS 5.8, 9.2 & 9.3**

I. Physical Measurements of Objects that can be Made From the
Earth
A. Planetary Distances
B. Astronomical Diameters

M&M  Mercury and The Moon, or "How Planetary Astronomy Shows Us Other (Failed) Worlds with which to Compare the Changing Environment on the Earth"

TEXT SECTIONS 6.2 & 6.3
I. Mercury: An Example of a Terrestrial Planet
II. Planetary Satellites: Rotation Period = Revolution Period
III. The Moon
   A. Seen from the Earth
   B. Lunar Exploration

E&V  The Earth and Venus, or "How Planets, Like Living Creatures, Evolve with Time"

TEXT SECTIONS 6.1 & 6.4
I. Venus
   A. Planetary Rotation
   B. The Interior of Venus
   C. The Atmosphere of Venus
   D. The Surface of Venus
II. The Earth: An Active Planet
   A. Planetary Differentiation
   B. Geologic Activity
   C. The Earth Seen from a Planetary Perspective
III. How Venus, Mercury and the Earth Differ

MAR  Mars, or "How Life is the Product of Specific Astrophysical and Geological Processes"

TEXT SECTION 6.5
I. The Present State of Mars
   A. Similarities Between Mars and the Earth
   B. Differences Between Mars and the Earth
   C. The Interior State of a Planet
II. The History of Mars
   A. Evidence for Water
   B. Evidence for a More-extensive Atmosphere
   C. The Search for Life
III. The Future of Mars
IV. Mars: A Lesson for Observers
"Oids (Meteor- and Aster-), or "How Astronomical Objects May Have an Impact on You (Literally)"

TEXT SECTION 8.4 & 8.5

I. "Smaller" Terrestrial Bodies in Space
A. Asteroids
B. Meteoroids
C. Micrometeoroids

II. Planetary Impacts (e.g., on the Earth)
A. Results of
B. Evidence for

MAJOR CONCEPTS - UNIT II

Light travels in a straight line unless it is absorbed, reflected, or refracted.

A telescope gathers light with an objective lens or mirror—the greater the objective area, the brighter an object will look in the eyepiece of the telescope.

The planets can be classified according to whether they orbit the Sun close to each other in the inner Solar System or are spread out in the outer Solar System, or whether they are large or small, but the most physically significant way to classify the planets is according to their densities: low (jovian) or high (terrestrial).

The major terrestrial planets consist of a metal core (probably), surrounded by a dense rocky mantle, surrounded by a less-dense rocky crust. The inner layers may be solid or liquid depending upon the internal temperature.

Signs of geologic activity within the Earth include plate tectonics, volcanism, and the presence of a planetary magnetic field.

The Moon, as well as certain other planetary satellites, rotates once in the same time it takes to revolve once around its planet. The result is that any inhabitants of the planet only have the opportunity to see one half of the satellite, the nearside, without traveling into space.

Mars is very cold. Venus, on the other hand, is unduly hot because of a significant greenhouse effect operating there. Neither planetary neighbor has much oxygen, or liquid water, to support life.

If a meteoroid strikes the Earth—a common event, it may produce a meteor or end up on the ground as a meteorite. But if an
asteroid strikes the Earth—an uncommon, but possible, event, there could be worldwide devastation.
READING ASSIGNMENTS - UNIT III

In this unit, we complete our tour of the Solar System with those bodies far from the Sun. We then introduce an important astronomical tool called "spectroscopy." This leads us to an examination of objects that produce their own light: stars.

**JUP**  
Jupiter, or "How a Planet May Be Constructed Out of Materials Other Than Rock and Metal"

TEXT SECTION 7.1 (skip material on satellites and rings)

I. Jovian Planets  
II. The Internal Structure of Jupiter  
III. The Physical Appearance of Jupiter  
   A. Belts and Zones  
   B. Atmospheric Features

**OUT**  
The Outer Solar System, or "How What a Planet Is Made Out of Affects What We Can See"

TEXT SECTIONS 7.2, 7.3 & 7.4 (skip material on satellites and rings)

I. Saturn  
   A. Appearance  
   B. Structure  
II. Uranus  
   A. Structure  
   B. Obliquity  
   C. Appearance  
III. Neptune

**ICY**  
Icy Satellites, or "How Most of the Worlds in the Solar System Are Actually Moons"

PREVIOUS SUBSESSIONS ON ICY SATELLITES AND RINGS

I. The Galilean Satellites  
   A. Icy Satellites  
   B. Io

II. The Satellite Systems of the Outermost Planets  
   A. Saturn's  
   B. Uranus's  
   C. Neptune's
PLU  Pluto and Stuff, or "How Ice Is the Common Denominator in the Outer Solar System"
TEXT SECTIONS 8.1 & 9.1
I.  Pluto
II. Planetary Rings
   A.  Saturn's
   B.  Those of Jupiter, Uranus, and Neptune
   C.  Solar-system Cosmogony

COM  Comets, or "How Objects that Appear Very Different in the Sky May Really Be Quite Similar"
TEXT SECTIONS 8.2 & 8.3
I.  The History of Cometary Observations
II. The Orbits of Comets
III. The Structure and Composition of Comets
IV. Where Comets Come From
V.  Recent Comets
   A.  Comets of the Sixties and Seventies
   B.  Comets of the Eighties and Nineties

SPC  Spectroscopy, or "How Things Tell Us About Themselves by the Light They Produce"
TEXT SECTIONS 2.3 & 2.5
we’ll use some of this in the next unit)
I.  Dispersion causes different wavelengths to be refracted through different angles.
II. The Black Body Spectrum (Wien's Law)
III. Spectral Lines
   A.  The Absorption Spectrum
   B.  The Emission Spectrum

SUN  The Sun, or "Our Star"
TEXT SECTIONS 10.1, 10.2, & 10.3
I.  The Interior of the Sun
   A.  Energy Generation
   B.  Structure
II. The Visible Layers of the Sun
   A.  The Photosphere (and Sunspots)
   B.  The Chromosphere
   C.  The Corona

SOL  [not included every semester]
DIS

**Star Distance**, or "How We Must Change Our Strategy When Studying Bodies for which We Cannot Discern Size or Shape"

**TEXT SECTIONS 1.4 & 11.2**

I. Measuring the Distances to Stars
   A. Trigonometric Parallax
   B. The Parsec and Light-year

STA

**Star Light**, or "How Brightness, Luminosity, and Distance are Inexorably Linked"

**TEXT SECTIONS 11.1 & 11.3**

I. The Inverse Square Law
II. Magnitudes
   A. Apparent
   B. Absolute
III. Star Colors

**MAJOR CONCEPTS - UNIT III**

Jupiter, the largest, most-massive planet in the Solar System, is an oblate sphere of mostly fluids. Only Saturn has a lower density.

The jovian planets are composed largely of hydrogen. The hydrogen may be gaseous, liquid, or (in the case of Jupiter) metallic.

The Galilean satellites are archetypal of a third class of planetary bodies that includes Pluto and the ring particles of Saturn: objects made largely of medium-density ice.

The surface of a planet or satellite tells the story of how much geologic activity it has experienced during its existence. Evidence includes crater density, texture, and variety of terrains.

Comets are icy bodies that orbit the Sun in very eccentric orbits. When they approach the Sun, their nuclei are heated so as to produce a gaseous coma and tail.

Spectra provide information about objects that produce light. A spectrum may be continuous, emission, or absorption, depending on the conditions under which it is produced.

The Sun illuminates and heats the Solar System. We see the Sun's photosphere; the chromosphere and corona are normally invisible to us.
In order to interpret the nature of things in the sky (such as stars), we must know their distance from us.

A star's apparent brightness is governed by its intrinsic luminosity and its distance from us. Only if one of these two quantities is known can we, based on the inverse square law of light, compute the other.
READING ASSIGNMENTS - UNIT IV

We see how stars change with time in this last unit. Following, we study groups of stars and the large-scale structure of the Universe.

**HRD**

**The H-R Diagram**, or "How Stars Come in Varying Temperatures, Luminosities, and Sizes"

TEXT SECTION 11.4

I. *Stellar Spectra*
II. The Hertzsprung-Russell Diagram  
   A. The Sizes of Stars  
   B. Groupings on the H-R Diagram

**LIV**

**The Lives of Stars**, or "How Stars, Like People, Are Born, Grow Up, Age, and Die"

TEXT SECTIONS 12.1, 12.2 & 13.1

I. Star Formation  
II. The Main Sequence  
   A. Energy Production  
   B. Lifetime  
III. Giants and Supergiants  
   A. Variables  
   B. Energy Production  
IV. Mass Loss  
   A. Planetary Nebulae  
   B. Supernovae

**DIE**

**How Stars Die**, or "How Many of those Exotic Objects in Science Fiction May Really Exist!"

TEXT SECTIONS 13.3 & 14.1

I. White Dwarfs  
II. Neutron Stars  
   A. Spinning Up  
   B. Pulsars  
III. Black Holes  
   A. Characteristics of  
   B. Detection of  
   C. Effects of
WAY
The Milky Way, or "How Everything We Have Talked About so Far Is distributed in Space"

TEXT SECTIONS 2.5, 11.5 & 15.1

I. Groups of stars
II. Motions of Stars
   A. Proper Motion
   B. Transverse and Radial Velocity
   C. The Doppler Principle
   D. Space Velocity
III. The Galaxy
   A. Interpretation of the Milky Way
   B. Description of

GAL
Other Galaxies, or "How Ours Is but One Ordinary Galaxy in a Vast Sea of Galaxies"

TEXT SECTIONS 16.1, 16.2 & 16.3

I. External Galaxies
   A. Properties of Galaxies
   B. Classifying Galaxies
   C. Galaxy Collisions
II. Light Pollution
III. Clusters of Galaxies

CML
Cosmology, or "Why Our Place Can Never Be the Center of the Universe"

TEXT SECTIONS 16.4, 16.7 & 17.2

I. Large-scale Structure of the Universe
II. The Expanding Universe
   A. The Cosmological Redshift
   B. Quasars
CMG

Cosmogony, or "How Our Universe Not Only Differs Greatly
Over Tremendous Expanses of Space, But Also Over
Tremendous Periods of Time"

TEXT SECTIONS 18.5, 18.6 &
19.2

I. The Big Bang
   A. Description of
   B. Consequences of
   C. Evidence for

II. History of the Universe

III. Vastness of the Universe in Time and Space

ETI

The Search for Extraterrestrial Intelligence, or "Are We
Alone?"

TEXT SECTIONS 2.1, 2.2 & 2.3

[not included every semester]

I. Where to Look
II. The Greenbank Equation
   A. Star Production
   B. Planets
   C. Habitability
   D. Life
   E. Intelligence
   F. Technology
   G. Survival
III. Means of Communication
   A. Travel
   B. Radio

IV. Consequences

MAJOR CONCEPTS - UNIT IV

The H-R diagram is a plot of luminosity (absolute magnitude)
versus spectral class (temperature) for a sample of stars.

Stars spend most of their lives on the Main Sequence, fusing
hydrogen into helium for power, with very little mass loss.

White dwarfs, neutron stars, and black holes represent end-states
for stars of low, medium, and high final mass, respectively.

All the stars in the sky are moving. The general pattern is that
of elliptical orbits about the center of our Galaxy.

Galaxies may be classified according to their appearance and to
the age of the stars that comprise them.

The Big Bang attempts to explain the observed property of
the Universe, that all objects in it seem to be receding from us
and that the more distant an object is, the more rapidly it is
receding, by invoking a universal expansion.

Two possible fates of the Universe await us: continued expansion
and cooling ("heat death") or collapse into another primordial
atom.

Contact with extraterrestrial intelligence, if such intelligence
exists elsewhere in the Galaxy, is most likely to occur through
the interception of radio signals rather than through space
cravel.
VOCABULARY

Here are some vocabulary terms you should be familiar with when preparing for your Exams. A study suggestion: Define each term to yourself, and then, to test your definitions, try putting each term into a sentence.

UNIT I

Names

Eudoxus
Nicholas Copernicus
Tycho Brahe
Johannes Kepler

Places

Sun
Moon
Universe
Polaris
Arctic Circle
Antarctic Circle

Words

star
planet
cosmology
concentric spheres
uniform circular motion
geocentric
heliocentric
eclipse
focus (of an ellipse)
major axis / semimajor axis
eccentricity
Kepler's First Law
Kepler's Second law
perihelion
aphelion
constellation
Celestial Sphere
horizon
altitude
meridian
Celestial Equator
Celestial Hemispheres (North and South)
Zenith
nadir
circumpolar
Celestial Poles (North and South)
rotation
revolution
ecliptic
obliquity
Summer (Summer Solstice)
Winter (Winter Solstice)
Fall (Autumnal Equinox)
Spring (Vernal or Spring Equinox)
terminator
sidereal month
synodic month
New Moon
crescent Moon
First Quarter Moon
gibbous Moon
Full Moon
Third Quarter Moon
waxing
waning
inferior planet
inferior conjunction
superior conjunction
superior planet
conjunction
opposition
total solar eclipse
node
partial solar eclipse
annular eclipse
total lunar eclipse
partial lunar eclipse
UNIT II

Names

Galileo Galilei
Isaac Newton
Mariner 10
Magellan
Vikings 1 & 2

Places

Mercury
Caloris Basin
Venus
Maxwell Montes
Earth
Luna (the Moon)
Mars
Olympus Mons
Valles Marineris
Ceres
Phobos
Deimos
Barringer Crater

Words

electromagnetic radiation
wavelength
Law of Reflection
Law of Refraction
convex lens
focus (of a lens or mirror)
objective
eyepiece
magnification
focal length
refracting telescope
concave mirror
reflecting telescope
Kepler's Third Law
period
Astronomical Unit
density
terrestrial planet
crater
carbon dioxide
runaway greenhouse effect
resolution
crust
mantle
core
differentiation
volcano
lava
plate tectonics
aurora
nitrogen
oxygen
satellite
lunar nearside
lunar farside
albedo
highlands
mare
ray
terraforming
asteroid
meteoroid
meteor
meteor shower
meteorite
Tunguska Event
UNIT III

Names

Voyager 1 & 2
William Herschel
Clyde Tombaugh
Christiaan Huygens
Edmund Halley
Wilhelm Wien
Heinrich Schwabe
Hipparchus

Places

Jupiter
Great Red Spot
Saturn
Uranus
Neptune
Great Dark Spot
Galilean Satellites
Callisto
Ganymede
Europa
Io
Titan
Pluto
Oort Cloud
Kuiper Belt
Pleiades
Sirius

Words

hydrogen
helium
jovian planet
metallic hydrogen
zone
belt
ammonia
barge
white oval
methane
sulfur
shepherd satellites
spokes
brown dwarf
short period comet
long period comet
nucleus (of a comet)
coma
tail
solar wind
dispersion
infrared
ultraviolet
spectroscope
black body
Wien's Law
continuous spectrum
absorption spectrum
emission spectrum
core (of a star/the Sun)
photosphere
sunspot
sunspot cycle
chromosphere
spicule
corona
prominence
trigonometric parallax
parsec
light-year
binary star
visual binary
Inverse-square Law
luminosity
apparent magnitude
absolute magnitude
UNIT IV

Names

Ejnar Hertzsprung
Henry Russell
Albert Einstein
Christian Doppler
Harlow Shapley
Edwin Hubble

Places

Cygnus X-1
Milky Way
Local Group
Andromeda Galaxy
Large Magellanic Cloud
Small Magellanic Cloud
Local Supercluster

Words

H-R Diagram
main sequence
giant branch
nebula
stellar evolution
nuclear fusion
electron
proton
neutron
red giant
variable star
Cepheid variable
iron
planetary nebula
supernova
degenerate matter
white dwarf
neutronium
neutron star
pulsar
black hole
singularity
escape velocity
event horizon
open cluster
globular cluster
proper motion
transverse velocity
radial velocity
Doppler shift
"The Objects which astronomy discloses afford subjects of sublime contemplation, and tend to elevate the soul above vicious passions and groveling pursuits." Thomas Dick (nineteenth century)