The final examination will be comprehensive. It will be held Thursday, December 19, 10:15 AM–12:15 PM, in MH 2002 (our regular classroom). It will be closed book with no notes or calculators allowed.

In the textbook, see, “How To Succeed in Your Astronomy Course,” p. xviii.

The course has a qualitative and a quantitative part. The homework assignments were mainly concerned with the quantitative part and the quizzes with the qualitative part.

**Quantitative**

The examination will not require calculations or problem solving, but it will require that you know the rationale behind the types of problems assigned in the course. That is, you should know the information needed to solve the problem and what is learned by solving the problem. You will not required to know formulas in detail, but you will be required to have a general knowledge of what quantities appear in the formulas that we used in the homework assignments, what they mean, and what their units are. Here is a list of the homework assignments, with needed formulas.

<table>
<thead>
<tr>
<th>Date</th>
<th>Assignment</th>
<th>Formula/Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 5</td>
<td>Problems 13 and 14, p. 37</td>
<td>Unit conversions, ( d = vt )</td>
</tr>
<tr>
<td>September 12</td>
<td>Problems 11 and 12, p. 64</td>
<td>No formulas</td>
</tr>
<tr>
<td>September 19</td>
<td>Problem 19, p. 89</td>
<td>Meridian diagram</td>
</tr>
<tr>
<td>September 26</td>
<td>handout/download</td>
<td>( \rho = M/V, V = (4/3)\pi R^3 )</td>
</tr>
<tr>
<td>October 3</td>
<td>Problem 16 (a) and (e), p. 151</td>
<td>( g = GM/R^2 )</td>
</tr>
<tr>
<td>October 10</td>
<td>Problems 15 (b) and 17 (a), p. 151</td>
<td>Kepler’s 3rd (above), ( v_{esc} = \sqrt{2GM/R} )</td>
</tr>
<tr>
<td>October 17</td>
<td>Problems 12 (a) &amp; (b), 15 (a), p. 170</td>
<td>( E = hc/\lambda, \lambda_{max}T = 2.9 \times 10^6 \text{ nm K} )</td>
</tr>
<tr>
<td>October 24</td>
<td>(no homework due)</td>
<td></td>
</tr>
<tr>
<td>October 31</td>
<td>Problems 9 (b), 16, 17, p. 194</td>
<td>Diffraction limit ( \simeq 2.5 \times 10^5 \text{\lambda/D arcsec} )</td>
</tr>
<tr>
<td>November 7</td>
<td>Problems 15 and 17, p. 223</td>
<td>present/original=(1/2)\text{\frown} \text{\simeq} \text{\celsius} \text{\degree}</td>
</tr>
<tr>
<td>November 14</td>
<td>handout/download</td>
<td>( P^2 = a^3, V = (4/3)\pi R^3 )</td>
</tr>
<tr>
<td>November 21</td>
<td>Problem 10, p. 257</td>
<td>( M = \rho V, V = (4/3)\pi R^3, K = 1/2Mv^2 )</td>
</tr>
<tr>
<td>December 5</td>
<td>Problem 16, page 286</td>
<td></td>
</tr>
<tr>
<td>December 12</td>
<td>handout/download</td>
<td></td>
</tr>
</tbody>
</table>

As an example, consider Kepler’s Third Law,

\[
P^2 = \frac{4\pi^2}{G(M_1 + M_2)} a^3.
\]

You should know that the formula includes the period, the semi-major axis, and the sum of the masses. (In many problems, \( M_2 \) is very small compared to \( M_1 \) and can be neglected.) Knowing
any two of these items would enable you to calculate the third one. $G$ is also important because its units determine what units you need to use for the other quantities: meters, kilograms, and seconds. You will not be required to know the constants in the formula, or where each quantity appears.

You should also know about the simplified form of Kepler’s Third Law, $P^2 = a^3$, which applies to any body in orbit around the Sun if $P$ is in years and $a$ is in AU.

This discussion applies to all the formulas used in the homework.

Certain formulas embody definitions, and they should be memorized. An example is Newton’s Second Law, $F = ma$, which defines inertial mass.

**Qualitative**

It is never possible to devote class time to all the material in the textbook. You can assume that the material covered in class is the most important and is most likely to be on the exam. Here is a short guide.

Know the definitions of the following terms and know how to use them. I have attempted to group the terms by topic, but some could go equally well in other places.

*Scale of the universe*

- astronomical unit (AU)
- light-year

*The celestial sphere*

- celestial equator
- celestial sphere
- circumpolar star
- ecliptic
- fall or autumnal equinox
- spring or vernal equinox
- latitude
- longitude
- north celestial pole
- meridian
- sidereal time
- solar day
- summer solstice, winter solstice
- zenith

*Motions of the Moon and planets*

- apparent retrograde motion
- conjunction
- ecliptic plane
- eclipse: solar, lunar
- eclipse: total, partial, annular
- lunar phase
- nodes (of Moon’s orbit)
- opposition
- precession
- sidereal period
- synchronous rotation
- synodic period
- tidal force
- tidal friction
- tidal heating
- total lunar eclipse, total solar eclipse
- totality
- umbra
**Laws of motion and gravitation**

- acceleration
- acceleration of gravity
- angular momentum
- escape velocity
- ellipse
- force
- free fall
- gravitational constant
- gravity
- Kepler’s first, second, and third law

- mass
- Newton’s first, second, third law of motion
- parabola
- semimajor axis
- velocity
- weight: gravitational force on an object, or the sensation of weight (the definition in the textbook’s glossary is not very good)

**Matter and energy**

- atomic mass
- atomic number
- atoms
- Celsius
- compound
- density
- electrons
- element
- energy
- gas
- isotopes
- joule
- kelvin
- kinetic energy
- molecule
- nucleus (of an atom)
- opaque (material)
- phase (of matter)
- potential energy
- power
- pressure
- protons
- sublimation
- temperature
- thermal energy

**Light**

- Doppler effect / Doppler shift
- electromagnetic spectrum
- electromagnetic wave
- frequency
- gamma rays
- infrared light
- photon
- radio waves
- reflection
- speed of light
- thermal emitter
- thermal radiation
- transparent (material)
- ultraviolet light
- wavelength
- visible light
- X rays
Telescopes, instruments, and spacecraft

- angular resolution
- angular size
- arcminutes
- arcseconds
- CCD (charge coupled device)
- diffraction limit
- flyby
- focus
- light-collecting area
- orbiter
- primary mirror
- reflecting telescope
- refracting telescope
- secondary mirror
- spectroscopy

Solar system overview

- age of a rock
- asteroid
- asteroid belt
- half-life
- inner solar system
- jovian planets
- Kuiper belt
- Oort cloud
- outer solar system
- radioactive dating
- radioactive element
- rocks
- rotation
- satellite
- terrestrial planets

Theory of solar system origin

- accretion
- comet
- condensation
- frost line
- ices
- meteorite
- primitive meteorite
- nebular capture
- nebular theory
- planetesimals
- solar nebula

Interior structure of planets

- conduction
- convection
- core
- crust
- differentiation
- mantle
- lithosphere
- magnetic field lines
Terrestrial planets’ surfaces

- age of a planetary surface
- erosion
- eruption
- hot spot
- impact basin
- impact crater
- impact cratering
- impactor
- spreading center
- shield volcano
- stratovolcano
- subduction
- subduction zone
- tectonics
- plate tectonics
- volcanism

Terrestrial planets’ atmospheres

- atmospheric pressure
- aurora
- Coriolis effect
- corona (solar)
- evaporation
- exosphere
- gas pressure
- greenhouse effect
- outgassing
- runaway greenhouse effect
- solar wind
- stratosphere
- thermal escape
- thermosphere
- troposphere

Be able to answer the following Review Questions from the end of the chapters in the textbook, listed according to chapter number and question number. Chapter 3 was not covered in class. The final exam will ask similar questions, but they will be broader in scope, not focused so much on the content of a single chapter.

Chapter 1, p. 36  7, 8, 13, 14, 15
Chapter 2, p. 63  2, 3, 5, 6, 7, 8, 9, 10, 11, 12
Chapter S1, p. 88  1, 4, 9, 12, 13, 14, 15, 20, 21, 22
Chapter 4, p. 122  1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14
Chapter 5, p. 149  1, 2, 3, 5, 6, 7, 8, 9, 10, 13, 15, 16, 17, 18, 19, 20, 21, 22
Chapter 6, p. 169  1, 2, 3, 4, 5, 6, 8, 9, 12, 15
Chapter 7, p. 191  2, 3, 4, 5, 6, 7, 8, 15, 16, 18
Chapter 8, p. 222  2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 15, 16, 17, 18, 19, 20, 22
Chapter 9, p. 256  3, 5, 6, 7, 8, 9, 11, 13, 14, 16, 19, 20, 21, 22
Chapter 10, p. 284  1, 2, 3, 4, 5, 6, 7, 11, 13, 14, 15, 18, 20, 21
Chapter 11, p. 321  2, 3, 4, 5, 6, 7, 8, 10, 12, 13, 14, 16, 17

The question list for chapter 11 is subject to revision according to how far we get into this material in class during the last week of the semester.