Week #4 Handout, 2008.02.12
Astronomy 101, Professor Douglas Leonard

Announcements

• **Second on-line Reading Quiz due tonight!** The second on-line reading quiz (“Week3 quiz”) is due tonight, Tuesday, February 12, by 11:55 PM. After that time, this reading quiz will no longer be available, and no late assignments will be accepted for any reason.

• **Reading Quiz solutions available online.** Complete solutions to all reading quizzes are posted to the textbook website ten minutes after the quiz is due, and are called, e.g., “Week2 quiz solutions”. Note that these are complete, worked-out solutions with explanations, not just answers. You can access these solutions by logging onto the textbook website, clicking on the “Assignment/Tests” tab, and then clicking on either the “Print blank assignment” link or the “Take” button. Clicking on the “Print blank assignment” link produces a pdf file of the solutions that can be printed out. Clicking on the “Take” button allows you to “take” the quiz again, but this time with the solutions included. Note that if you “take” the quiz again, your score does not count; re-taking the quiz is just for your own practice.

The quiz solutions are also available at the course website (http://sciences.sdsu.edu/~leonard/astro101) by the end of each week that a quiz is due, and are accessed by clicking on the “On-Line Reading Quiz Solutions” link on the course homepage.

• **First Midterm Exam:** As indicated in the *Course Syllabus*, the first midterm exam will be given in class next week on Thursday, February 21. More information about the exam is contained in your course *Reader* (see reading assignment, below) as well in a handout that will be given out in class this Thursday (February 14).

• **Your professor on TV?** Yes, it’s true. If you subscribe to Cox Cable television and get “Channel 4 San Diego”, then tune in this Sunday evening (February 17) at either 6 PM or 8 PM to watch “San Diego Insider”. It’s a half-hour locally produced show which I’m told (I haven’t actually seen it) will include a small segment about the leap-year for which I was interviewed a couple weeks ago. Hopefully it all came out OK...see for yourself!

Reading Guide and Homework Assignment
(Week #4 On-Line Reading Quiz Due: Tuesday, February 19, 11:55 PM)

This week, we finish up Chapter 2 of your text, and add mathematical meat to the qualitative bones that were assembled last week in the lectures. We also begin our study of the Solar System.

1. **Course Reader:** Pages 179 – 182: *Midterm Exam Guide.* These pages of your *Reader* are designed to help you prepare for your first midterm exam, which will occur in class next Thursday, February 21. They include a description of the exam, exam instructions, as well as sample questions similar to the ones you will encounter on the actual exam. We shall discuss the exam in more detail in class on Thursday, February 14, and Tuesday, February 19.

2. **Text – Chapter 2, §2.2.3 and 2.2.4:** *Mass, Volume, and Density,* and *Angular Momentum.*

   Read here about these important basic concepts that were presented in class.

3. **Text – Chapter 2, Section §2.3:** *Universal Gravity.*

   This describes Newton’s discovery and quantification of the *force of gravity.* Newton’s universal law of gravity is one of the most important equations we shall encounter in the course (and one of the few formulas that you are expected to know). It tells you the force, \( F \), of gravitational attraction that exists between two objects with masses \( M_1 \) and \( M_2 \) that are separated by a distance \( R \):

   \[
   F = \frac{GM_1 M_2}{R^2}.
   \]
Note that \( R \) is the distance between the two objects’ centers, NOT their surfaces. \( G \) is the so-called “gravitational constant,” whose exact value you do not need to know — any problems that you are given concerning this law will involve solving a ratio, and so the actual value of \( G \) will not be needed.

A key thing to understand about this law is that it is an example of an inverse square relation: that is, the gravitational force decreases as the inverse square of the distance between the objects. For instance, if you double the distance between two objects, the force of attraction that they feel towards each other becomes only \( \frac{1}{4} \) as strong as it was before. We shall see that inverse square relations play very important roles in astronomy and physics. Note also Newton’s version of Kepler’s 3rd law on p. 51 of the text. This law is of key value since it allows astronomers to derive the mass of an astronomical object that has another body in orbit around it.

4. **Text – Chapter 2, Sections 2.4 → 2.6. Orbits in the Solar System, Motions of Satellites and Spacecraft, and Gravity with More than Two Bodies.**

This reading finishes off the chapter with a discussion of orbits, asteroids, spacecraft and, finally, the discovery of Neptune – a triumph for Newtonian physics! A key term defined along the way is escape velocity: the speed needed to completely escape the gravitational pull of an object (e.g., the Earth).

5. On-line tutorial: On the “Week4 tutorial” section of the textbook website, start by looking at the Active Figure called “Gravity and Orbits”. This allows you to recreate Isaac Newton’s thought experiment involving firing a cannonball at different velocities. You need only look at the first page of this exercise (pages 2, 3, and 4 present more advanced material for which you are not responsible). Try several different velocities and see what happens. For instance, set the “Initial Velocity” to be 7.8 km/sec, and click “Fire!” Then, up the velocity to 7.9 km/sec and fire away. What difference do you see? 7.9 km/sec is, evidently, very close to the velocity of an object in circular orbit about the Earth close to its surface. Also try the special velocity, called the escape velocity, of 11.2 km/sec. Next, look at the Astronomy Exercise called “Escape Velocity”. This applet is essentially a more detailed version of the Active Figure you already looked at already. Finally, look at the Astronomy Exercise entitled “Orbital Motion”. This allows you to see the effects that changing the Sun’s mass, distance between a planet and the Sun, and/or the planet’s orbital eccentricity has on the planet’s orbit. For instance, set the Sun’s mass to be 0.5 (i.e., half its actual value), and click Start. Then, set it to be 2.0 and click Start. See how much faster the planet orbits when the Sun has more mass!

6. **Text – Chapter 3, Section §3.7. Eclipses of the Sun and Moon.**

We are covering just the final section from Chapter 3 in this class, on solar and lunar eclipses. The key points to take away from this reading are (1) the relative positions of the sun, moon, and Earth for both kinds of eclipses; and (2) the characteristics of both kinds of eclipse (i.e., eclipse duration, region on Earth’s surface from which each is visible, and eclipse frequency).

7. **Course Reader: Pages 151 – 159: Other Worlds: An Introduction to the Solar System.**

This reading comes from a textbook written by the same authors who wrote yours, and includes a broad overview of the solar system. It outlines the major features of the planets, moons, rings, asteroids, and comets that we are discussing in class. Since we shall not be spending much more time on solar system objects, read these sections carefully!

Note: The very last section, §6.2.5, on p. 159 is incomplete; Montezuma Publishing messed up and did not include the last couple of paragraphs in your Reader (hence, why it seems to end mid-sentence!). You are thus only responsible for the portion that is included in your Reader! Note also that a small amount of this reading material may not be covered in class until next Tuesday’s lecture.

8. **On-line reading quiz (Due: 11:55 PM, Tuesday, February 19):** Take this week’s reading quiz by clicking on the “Week4_quiz” assignment at the on-line textbook web-site. The Reading Quiz will become available to you at 12:05 AM, Wednesday, February 13. It consists of 10 multiple choice questions. **You must complete this on-line quiz by 11:55 PM Tuesday, February 19.** As always, you may take the quiz twice.