GUIDED PRACTICE

Class: AST 4240/A
Date assigned: August 23
Date due: August 28
Time estimate to complete this assignment: 1 hour

Overview/Introduction

You are to read and outline Chapters 1 and 2, following the "Chapter Outlines Guidelines" document. By following the guidelines, you should begin class during week 1:

- knowing basic terminology related to ancient and "early modern" astronomical observations
- able to label important features on a heliocentric Solar System diagram
- be able to compute the orbital periods of the planets from Earth-based observations

These concepts form a critical foundation for later in the class (all that "jargon" isn't going away!), and a deep understanding of the heliocentric model of the Solar System is critical for understanding Keplerian orbits (Kepler's Laws) and Newton's Law of Gravity. You will also get your first sneak peak at an extrasolar planet system – which we will return to later in the class!

Learning Objectives

Basic objectives

- Define sidereal and synodic period of a planet's orbit around the Sun
  Sketch the planet-Earth-Sun geometry at different configurations (conjunction, opposition, quadrature)

Advanced objectives

- Contrast the geometries for superior vs. inferior planets and recognize when one form of the equation is appropriate for a given situation
- Illustrate and formulate new forms of the equations for an extrasolar planet configuration List 3-4 learning objectives that you expect students to need help mastering.

Preparatory Activities and Resources:

1. See the “Outlines Guidelines” document for detailed instructions. Your outlines will be checked at the beginning of class on Wednesday. Outlines are graded based on completeness and good-faith effort: a grade of 1 indicates a complete outline, 0.5 indicates partial completion, and 0 indicated incomplete.

2. Chapters 1 and 2 of “Foundations of Astrophysics” by Ryden & Peterson (course textbook). A copy is available at the library and the university bookstore if you have not gotten a personal copy yet.

Exercises: Please complete by Wednesday, August 28

- You must bring your completed outline with you to class.
- Outlines will be checked for completeness and good-faith effort during the first 10 minutes of class. Outlines will be graded with a 1 (complete), 0.5 (partially complete), or 0 (incomplete) as described in the Guidelines document.

Questions?

Come to office hours! Monday from 11a-1p and Tuesday from 2p-4p.

Email is the best way to reach me outside of office hours: babinder@cpp.edu

You can also post questions to the course discussion board on Blackboard.

PROBLEM SET 1

1. The Sun's position at noon on the vernal equinox (approximately March 21 in the northern hemisphere) defines the right ascension zero-point (0^h). Stars with $\alpha = 0^h$, therefore, are visible at night six months later, approximately on September 21. Complete the table below to summarize when a star with $\alpha = 0^h, 1^h, 2^h \ldots, 23^h$ would be at its highest visibility from the northern hemisphere.

Right Ascension	**Visible During…**	**Right Ascension**	**Visible During…**
0^h		12^h	
1^h		13^h	
2^h		14^h	
3^h		15^h	
4^h		16^h	
5^h		17^h	
6^h		18^h	
7^h		19^h	
8^h		20^h	
9^h		21^h	
10^h		22^h	
11^h		23^h	

The table below lists the right ascension and declination of seven stars in the constellation Ursa Major. Use this table to answer questions 2-5.

Star	Right Ascension	Declination
Alkaid	13^h48^m	$+49°19'$
Mizar	13^h24^m	$+54°56'$
Alioth	12^h54^m	$+55°58'$
Megrez	12^h15^m	$+57°02'$
Phecda	11^h54^m	$+53°42'$
Merak	11^h02^m	$+56°23'$
Dubhe	11^h04^m	$+61°45'$

2. For what range of latitudes are *all* the stars in this constellation circumpolar?

3. What is the southernmost latitude from which *all* of these stars can be seen?

4. For what range of latitudes are *none* of these stars ever seen above the horizon?

5. When during the year is this constellation most easily visible?

6. You've been granted access to a large telescope during the last week in September. One of two objects you want to observe is in the constellation Virgo; the other is in the constellation Pisces. You only have time to observe one object. Which object do you observe? Circle one option, and explain why.

   Virgo　　　　　　　　Pisces

7. In *The Old Man and the Sea*, Hemingway described the old man lying in his boat off the coast of Cuba, looking up at the sky just after sunset: "It was dark now as it becomes dark quickly after the Sun sets in September. He lay against the worn wood of the bow and rested all that he could. The first stars were out. He did not know the name of Rigel but he saw it and knew soon they would all be out and he would have all his distant friends." Explain what is astronomically incorrect about this passage.

8. What angular distance does the Sun appear to move in the sky in one hour?

9. The Sun appears to move eastward by about 1 degree per day over the course of a year. Explain why this approximation makes sense.

10. You observe five stars from Earth, and measure the following parallax angles. a) Compute the distance to each star in pc. b) Create a mathematical rule for directly computing distances (in pc) from parallax angles (in arcsec).

Star	**Parallax Angle (arcsec)**
A	0.0410
B	0.0137
C	0.0746
D	0.0167
E	0.0059

The table on the right lists the orbital periods of the planets in our Solar System. You may need this data to answer questions 11-13.

Planet	**Orbital Period**
Mercury	88 days
Venus	225 days
Earth	365 days = 1 year
Mars	687 days = 1.9 years
Jupiter	12 years
Saturn	29 years
Uranus	84 years
Neptune	165 years

11. Mercury will pass through inferior conjunction on November 11, 2019. On what day, approximately, will Mercury *next* be visible at inferior conjunction (after November 11)?

12. Would a Martian observer record a longer or shorter synodic period for Saturn than an Earth-based observer? Explain.

13. Which planet has the *shortest* synodic period as observed from Earth? Explain why; a calculation without a physical explanation is *not* sufficient.

14. You are transported to the TRAPPIST-1 planetary system, which is located 12 pc away ($\alpha = 23^h06^m29.3^s$, $\delta = -05°02'28.5''$). This system is composed of a small star (only 9% the mass of our Sun) and seven planets (creatively named TRAPPIST 1b, 1c, 1d, 1e, 1f, 1g, and 1h). You are standing on TRAPPIST-1e, which has an orbital period of 6.10 days (because the parent star is so much smaller and cooler than the Sun, this is actually within the TRAPPIST-1 habitable zone!). From the surface of TRAPPIST-1e, you can measure the synodic periods of the other six planets in the system. Use this information to calculate the orbital periods of the planets.

Planet	Type	Synodic Period (days)	Orbital Period (days)
1b	inferior	2.01	
1c	inferior	4.01	
1d	inferior	12.05	
1e	…	…	6.10
1f	superior	18.06	
1g	superior	12.05	
1h	superior	9.04	

Flipped IN-CLASS Lesson Plan for AST 4240/A

Topic or concept:
The heliocentric model of the Solar System

Basic objectives for preparatory work:	Advanced objectives for classwork & after class work:
Outline Chapter 2 (see "Chapter Outline Guidelines" document for detailed instructions) • Define sidereal and synodic period of a planet's orbit around the Sun • Sketch the planet-Earth-Sun geometry at different configurations (conjunction, opposition, quadrature)	• Contrast the geometries for superior vs. inferior planets and recognize when one form of the equation is appropriate for a given situation • Illustrate and formulate new forms of the equations for an extrasolar planet configuration

	Time planned	Activity and rationale	Resources needed
Beginning of class period	10 mins	Instructor will post a list of terms that students should be able to define or identify on a diagram after reading the chapter. Students will form small groups and compare their outlines. Students are encouraged to add any content they missed to their outlines (in a different color pen/pencil) after comparing with their peers.	Paper; power point slide with list of terminology from the chapter

	Time planned	Activity and rationale	Resources needed
Middle of period	30 mins	Mini-lecture with fill-in-the-blanks to encourage student participating and engagement. Highlight most important aspects of the chapter. Clarify misconceptions and offer new info.	Lecture prep/slides
Remainder of class time	35 mins	Students begin advanced problem set covering material from chapter 2.	Problem sheets
End of period	2 mins	Clear-muddy-cool notecards. Students jot down 1-2 sentences describing what topic was clear (easy to understand), muddy (they are still confused about), and cool (most interesting or relevant)	3"x5" notecards

Flipped AFTER CLASS Work Plan Template

Advanced learning objective	Activity and rationale	Instructions to students
Contrast the geometries for superior vs. inferior planets and recognize when one form of the equation is appropriate for a given situation	Compute sidereal and/or synodic periods of the planets in our Solar System. Explain, both quantitatively (with numerical or mathematical expressions or evidence) and qualitatively (in words) how sidereal and synodic periods relate to one another *for an observer on Earth*.	Questions 11-13 on problem set. Students may begin work in small groups during class, but any parts not finished must be completed outside of class.

Advanced learning objective	Activity and rationale	Instructions to students
Illustrate and formulate new forms of the equations for an extrasolar planet configuration	Apply the concepts of sidereal and synodic periods to the TRAPPIST-1 system. Explain, both quantitatively (with numerical or mathematical expressions or evidence) and qualitatively (in words) how sidereal and synodic periods relate to one another *for any arbitrary location of the observer*. At the Friday activity section, students will play with an interactive simulator to demonstrate the motions of the stars/planets from the perspective of an Earth-based observer.	Question 14 on problem set. Students may begin work in small groups during class, but any parts not finished must be completed outside of class. At the Friday activity section, students will play with an interactive simulator to demonstrate the motions of the stars/planets from the perspective of an Earth-based observer.

CHAPTER OUTLINE GUIDELINES

Outlines will be checked for completeness at the beginning of class, **typically on Monday**. Note that we have two Monday holidays this semester, so some of your outlines will be checked on Wednesday. The exact due dates and required chapters/sections are listed on the next page.

OBJECTIVES

There are three major objectives that you should aim to accomplish with your chapter outlines:

- <u>Define</u> the major terminology in the chapter
- <u>Interpret</u> mathematical expressions as real relationships between physical parameters
- <u>Distinguish</u> between intermediate steps and major results of mathematical derivations

Achieving these objectives will be a work in progress. You may find some chapters easier to understand than others. Hopefully, you will find it gets increasingly easier to achieve these three goals as the semester progresses (and you've had more time to practice writing effective outlines).

REQUIREMENTS

There are no strict formatting requirements for your outlines. You may prefer to write your outlines in paragraph form, or in bullet points, or some combination of the two. Do whatever makes sense to you, and helps you organize your thoughts. **You are strongly encouraged to read (or at least skim) each chapter first *before* you start outlining**.

Your outlines may be either handwritten or typed. You may edit your outlines in class as we discuss and review the material – I strongly recommend making additions or amendments in a different color.

The following items are **required** for your outlines:

- the section titles for all the required sections.
- definitions for any terminology shown **in bold text**.
- a brief description of the main, important equations in each section. You should write down anything that will help you when it comes time to review for the exam – for example, if you don't know what the constant k represents, jot down a note about it in your outline to remind yourself!
    - Comment: you may find it difficult, especially at first, to figure out what is an important equation and what is not. Your book does a lot of derivations, and provides supporting equations to "show its work" – these intermediate steps are often not relevant. Look for equations that are at the *end* of a derivation, as those are usually the most important. If you notice the same equation coming up repeatedly (like hydrostatic equilibrium or scale height) then it is *definitely* important!
- your own sketch of any figures that you find especially helpful for understanding the main topic of each section or chapter
- any questions you think of or confusion you had when reading through the section

Outlines will be reviewed for completeness and good faith effort at the beginning of class and assigned one of three grades: full credit (1), half credit (0.5), or no credit (0).

The due dates and required chapters/sections for your outlines are:

WEEK 1	Wednesday, Aug. 28	Chapters 1, 2	pages 1-19 (stop after equation 1.5), 1.6, 2.3, 2.5
WEEK 2	no outline due		
WEEK 3	Monday, Sep. 9	Chapter 5	5.1-5.4, 5.7
WEEK 4	Monday, Sep. 16	Chapter 6	all
WEEK 6	Monday, Sep. 30	Chapters 4, 9	4.1-4.3, 9.2, 9.4, 9.5, and the appendix
WEEK 7	Monday, Oct. 7	Chapters 8, 12	all, 12.1 and 12.1
WEEK 8	Monday, Oct. 14	Chapter 12	12.3 and 12.4
WEEK 10	Monday, Oct. 28	Chapter 13	all (no appendix)
WEEK 11	Monday, Nov. 4	Chapter 14	all
WEEK 12	Wednesday, Nov. 13	Chapter 15	all (no appendix)
WEEK 13	Monday, Nov. 18	Chapters 17, 18	17.2, 18.1-18.3
WEEK 14	no outline due		
WEEK 15	Monday, Dec. 12	Chapter 16	all