Astr 150 Assignment 10: Kepler’s method for determining the orbit of Mercury
due before 5pm Thurs March 31, 2011

Word limit: 250

Inclusion of references for this assignment is mandatory.

You will be graded on the correctness and precision of your work.

<table>
<thead>
<tr>
<th>Date</th>
<th>Elongation</th>
<th>Date</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Feb 16, 1967</td>
<td>18° east</td>
<td>Sep 20, 1968</td>
<td>26° east</td>
</tr>
<tr>
<td>Mar 31, 1967</td>
<td>28° west</td>
<td>Oct 31, 1968</td>
<td>18° west</td>
</tr>
<tr>
<td>Jun 12, 1967</td>
<td>25° east</td>
<td>Jan 13, 1969</td>
<td>18° east</td>
</tr>
<tr>
<td>Jul 30, 1967</td>
<td>20° west</td>
<td>Feb 23, 1969</td>
<td>26° west</td>
</tr>
<tr>
<td>Oct 09, 1967</td>
<td>25° east</td>
<td>May 06, 1969</td>
<td>21° east</td>
</tr>
<tr>
<td>Nov 18, 1967</td>
<td>19° west</td>
<td>Jun 23, 1969</td>
<td>23° west</td>
</tr>
<tr>
<td>Jan 31, 1968</td>
<td>18° east</td>
<td>Sep 03, 1969</td>
<td>27° east</td>
</tr>
<tr>
<td>Mar 13, 1968</td>
<td>27° west</td>
<td>Oct 15, 1969</td>
<td>18° west</td>
</tr>
<tr>
<td>May 24, 1968</td>
<td>23° east</td>
<td>Dec 28, 1969</td>
<td>19° east</td>
</tr>
<tr>
<td>Jul 11, 1968</td>
<td>21° west</td>
<td></td>
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</tbody>
</table>

1. The table, above, lists the dates of maximum elongations of Mercury for the three years 1967-69.
2. Start with a clean sheet of paper. Place a small dot near the center. This dot represents the location of the Sun.
3. Draw a circle of 8 cm in radius; this circle represents the Earth’s orbit. The Earth’s orbit is less than 2 percent non-circular, or about the width of your pencil, so it is ok to approximate the shape of the Earth’s orbit using a circle.
4. Choose a location on Earth’s orbit to represent January 1st.
5. Choose the first elongation from the table, February 16, 1967. Locate February 16 on the Earth’s orbit. To do so, recall that the Earth moves in its orbit 1 degree per day. Knowing that February 16 is the 47th day of the year, therefore February 16 must be located 47 degrees counterclockwise from January 1. Place a small dot on Earth’s orbit at 47°, and label it.
6. Draw a light pencil line from the Sun to February 16. This line is the Earth-Sun line.
7. Using a protractor, draw in Mercury’s maximum elongation direction. To do so, note on the table that the value is 18° east. Using the Earth-Sun line as zero, draw a line 18° from the Earth to the left of the Sun. It is recommended that you refer to the in-class handout of Earth-Sun-planet triangles to see the difference between east and west elongation.
8. Following all the steps above, draw in the remaining elongations. Remember that east elongations pass to the left of Sun, and west elongations pass to the right. If you make a mistake, you will know it by the end of the exercise.
9. After every elongation is completed, you will see an oval-shaped region in the center of the diagram that is outlined by the maximum elongation lines. Sketch in an oval shape that just touches the insides of these lines. This oval shape represents Mercury’s orbit.
10. Draw in the major axis of Mercury’s orbit; it will be the longest line you can draw from end-to-end that passes through the Sun. Measure the length of the major axis and divide it by two; this number is the semi-major axis length. Convert your answer to astronomical units (AU) using the scale of 8 cm equals 1 AU.
11. Use Kepler’s 3rd law to find Mercury’s period (i.e., time for one complete orbit) using the value you found for the semi-major axis length.
12. Use the example ellipses on page 145 of the Lecture-Tutorial book to estimate, by eye, the eccentricity of Mercury’s orbit.
13. Compare your values of semi-major axis length, period, and eccentricity with the accepted values; it is ok to use the values from the wikipedia article on Mercury.

Requirements for assignments

- Submit assignments to the slot labeled “Astr 150” in the wooden cabinet located in the Webster building tower, 3rd floor, at the far end of the corridor away from the elevators.
• At the top of your assignment goes your name, SID, the assignment number, and a word count. Count only those words in your answer, not in the question or references. [2]

• All assignments are graded out of [20] points. All assignments are weighted equally.

• All assignments must be typed and single-spaced [10]; double-sided printing is preferred but not required. Equations and diagrams can be hand-written.

• All responses must be arranged in a numbered answer format. Do not write an essay. [2]

• Failure to obey the word limit results in a [10] point penalty.

• Failure to include references and citations results in a [2] point penalty. Web sources must be referenced formally. Acceptable citation styles include (but are not limited to) APA, MLA, and Chicago styles. Examples:

• Use simple language. Be descriptive and conceptual, not terse and abstract. Define all jargon [2]. Use of quotations is forbidden [5]. With the single exception of critical corroboration, all quoted material will be treated like plagiarism (even if it is cited).

• These assignments are not group projects. You must submit your own work. You can discuss the assignments with your classmates and share ideas, but you are forbidden from sharing wording. In other words, if you and a classmate write down answers together and then one of you re-arranges the words then this situation will be treated as plagiarism.

• A first case of academic dishonesty results in a grade of zero on the work in question. Subsequent cases will result in a failing grade in the course. In all cases a report is submitted to the Office of Student Conduct.

• Be professional in your presentation, e.g., no ragged ends, creases, ink blobs.

• In all ways show pride in your work.