Lab 1: Astronomy Skills

This assignment is worth a maximum of 5.0 points, and is due at the end of lab today. Work cooperatively and collaboratively as a team. Each person in your group will be awarded the same points as determined from grading a randomly selected worksheet from your group.

Assemble Your Group

1. [0.4 points.] Find your assigned group members, and have everyone sign each other's worksheets. Credit is awarded for each person (present) that has brought a calculator to lab today.

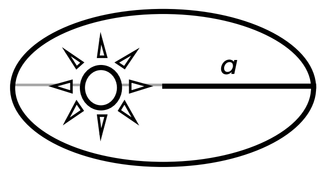
Yourself: __________________ Team member: __________________

Team member: __________________ Team member: __________________

Minimum/Maximum Interval Math

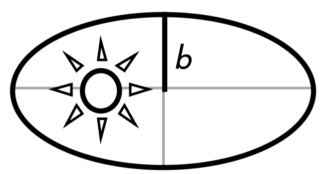
2. [3.6 points.] Your group will be given a scaled orbital diagram of a comet, where 2.0 cm = 1.0 AU (one astronomical unit = average distance from the Sun to the Earth).

(a) Measure the *longest* end-to-end "length" for your elliptical orbit, and draw this line on your diagram. (Hint: this line must pass through the Sun.) *Half* of this end-to-end length is the *semimajor axis a* of the comet's orbit. Record this measurement, and with an uncertainty of 0.1 AU, determine the minimum and maximum experimental value for *a*.



a = (__________ ± 0.1 AU) = [__________ , __________]
ave unc min max

(b) Measure the *shortest* side-to-side "width" for your elliptical orbit, and draw this line on your diagram. (Hint: this line must be perpendicular to the longest end-to-end line, and pass through its midpoint). *Half* of this side-to-side distance is the *semiminor axis b* of the comet's orbit. Record this measurement, and with an uncertainty of 0.1 AU, determine the minimum and maximum experimental value for *b*.



b = (__________ ± 0.1 AU) = [__________ , __________]
ave unc min max

(c) For each of the quantities below, calculate the minimum and maximum experimental values, using the appropriate minimum and maximum values for *a* and *b*. Then express each answer as an average and uncertainty.

1. Circumference (approximate formula), in AU:

$\pi(a+b)$ = [________ , ________] = (________ ± ________)
min, max, ave, unc

2. Area, in AU^2:

$\pi a \cdot b$ = [________ , ________] = (________ ± ________)
min, max, ave, unc

3. "Roundness" ratio, unitless:

$\frac{b}{a}$ = [________ , ________] = (________ ± ________)
min, max, ave, unc

4. Period (round-trip time), in years:

$P = a^{1.5}$ = [________ , ________] = (________ ± ________)
min, max, ave, unc

(d) The instructor will tell you the known period *P* for your comet. Calculate the percent discrepancy, which is used to quantify the ±% difference between your average experimentally determined value, with the expected known value. *Your answer must have a positive or negative sign.*

$$\%\text{ discrepancy} = \frac{\text{experimental average } P - \text{known } P}{\text{known } P} \times 100\% =$$

(e) Calculate the percentage uncertainty of your experimental value for *P* (no ± sign).

$$\% \text{ uncertainty} = \frac{|\text{uncertainty in } P|}{\text{experimental average } P} \times 100\% =$$

(f) *Precision* is the measure of how much uncertainty your data has between its minimum and maximum values—a precise measurement has a small uncertainty; an imprecise measurement has a large uncertainty. If your measurement for *a* (and thus your result for *P*) had been *more* precise, decide whether the percent discrepancy or the percent uncertainty would change, how it would change, and briefly explain your reasoning.

$$\text{A more precise measurement would cause the } \begin{bmatrix} \% \text{ discrepancy} \\ \% \text{ uncertainty} \end{bmatrix} \text{ to } \begin{bmatrix} \text{increase} \\ \text{decrease} \end{bmatrix}.$$

Explanation:

(g) *Accuracy* is the measure of how "close" your value is to the actual value—an accurate measurement is very close to the actual value; an inaccurate measurement is not very close to the actual value. If your measurement for *a* (and thus your result for *P*) had been *more* accurate, decide whether the percent discrepancy *or* the percent uncertainty would change, how it would change, and briefly explain your reasoning.

$$\text{A more accurate measurement would cause the } \begin{bmatrix} \% \text{ discrepancy} \\ \% \text{ uncertainty} \end{bmatrix} \text{ to } \begin{bmatrix} \text{increase} \\ \text{decrease} \end{bmatrix}.$$

Explanation:

Constellation/Star Finding

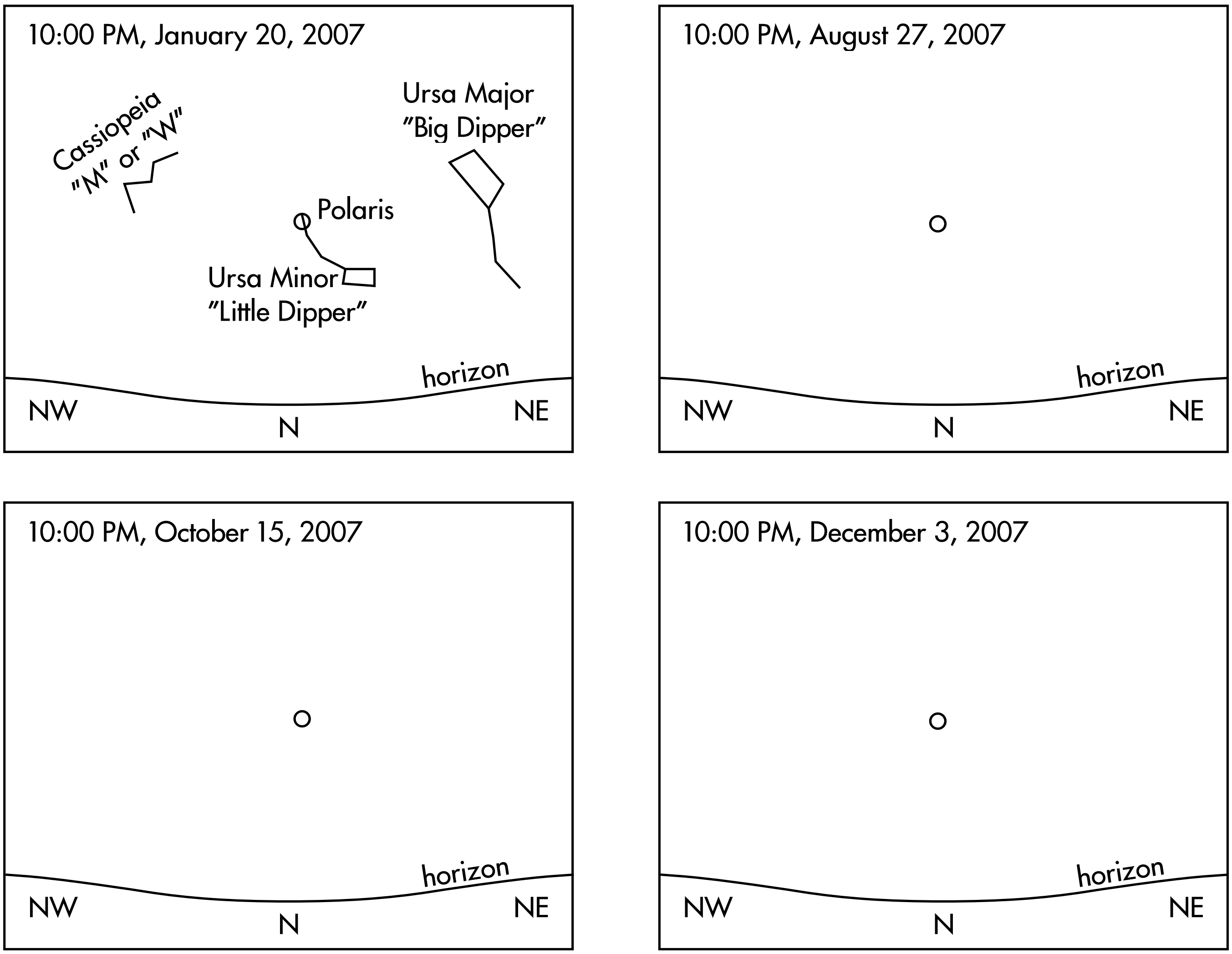
3. [1.0 points.] Use your starwheel to answer the following questions. *(Ignore the fact that your starwheel does not include daylight savings time.)* Examples are given for January 20, 2007 so you can verify that you are using your starwheel correctly.

(a) On January 20, 2007, at 10:00 PM, the constellation Auriga was most nearly at the *zenith* (straight overhead), as seen from San Luis Obispo, CA. On August 27, 2007, at 10:00 PM, describe where the zenith is located on your starwheel, and then determine which constellation is at or most nearly at the zenith.

Zenith constellation: __________.

Location of zenith on starwheel:

(b) On January 20, 2007 at 10:00 PM, Ursa Minor (the "Little Dipper") Ursa Major ("Big Dipper"), Cassiopeia ("M or W") and Polaris ("North Star") appeared as shown below when looking towards the north horizon in San Luis Obispo, CA. On August 27, 2007 at 10:00 PM, sketch the orientation of the Little Dipper, Big Dipper, and Cassiopeia. Do the same for 10:00 PM on October 15, 2007, and for 10:00 PM on December 3, 2007.



(c) On January 20, 2007, the constellation Cancer rose at 5:30 PM, and set at 8:00 AM (the next day). On August 27, 2007, determine the rise and set times (to the nearest half-hour) for the constellation Boötes, and estimate the amount of uncertainty in these times, due to how a rise/set time would be defined for this constellation. (Assume that you would be able to see constellations even during daylight hours.)

Boötes rise time: _________ [AM/PM]; set time: _________ [AM/PM].

Uncertainty in rise/set times ≈ _____ minutes.