MiSP Astronomy — Seasons Worksheet #1 L3

Name ______________________________ Date _____________

CHANGING HOURS OF DAYLIGHT ON LONG ISLAND

Introduction

You sometimes hear people say, "Days are longer in the summer and shorter in the winter." That is a silly statement because all days are 24 hours long. What does change is the number of hours of sunlight and the number of hours of darkness. The sun rises earlier and sets later in the summer.

Some places on Earth — the Far North and the Far South — can have days during which nearly all 24 hours of the day are sunlight or darkness.

In this activity and the next, you will use a simulation to study the changing number of daylight hours in a day.

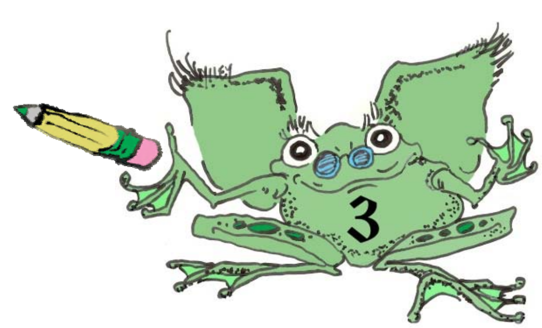
Problem

How do the hours of daylight change from January to December on Long Island?

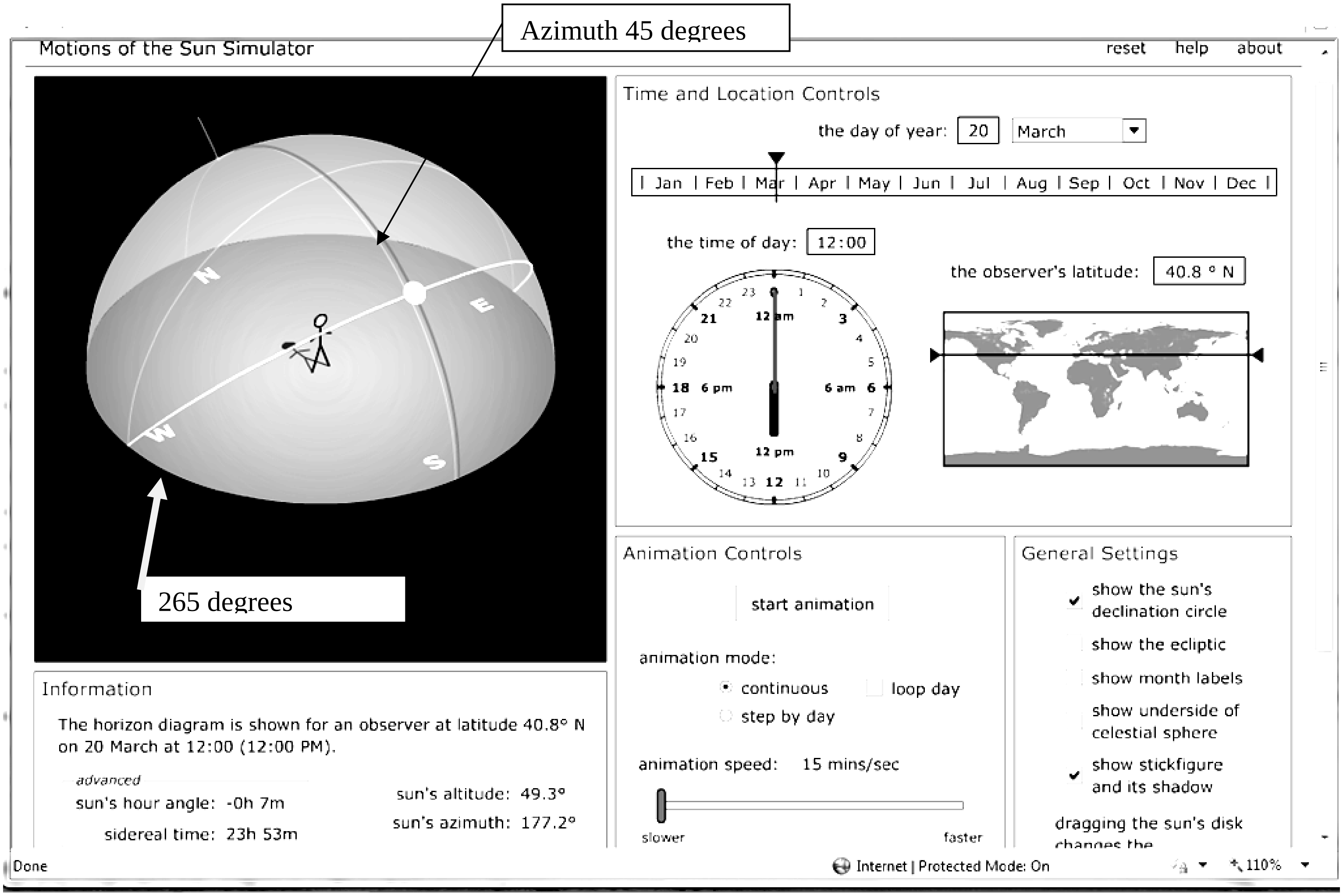
Procedures:

A. Introduction to the simulation and apparent motions of the sun on Long Island

1. Go to the link http://astro.unl.edu/naap/motion3/animations/sunmotions.html.
   It shows an observer in a field with the compass directions indicated and the dome of the sky above. Familiarize yourself with the controls on the right-hand side, and set them as shown in the picture below.
   - Set the date to March 20, the time of day to 12:00 a.m./midnight (0:00 on the 24-hour clock), and the latitude to approximately 41°.
   - Under General Settings, check the boxes for:
     - show the sun's declination circle
     - show stick figure and its shadow
   - Put the animation mode on "continuous" and the animation speed on its slowest setting.



2a. Note in the screen shot below (look on the left-hand side below the sun simulator) that the sun's altitude is shown at 49.3º and the sun's azimuth (177.2º) is almost due south (due south is 180º).



2b. Determining azimuth is a precise way of measuring the position of the sun along the horizon. North is 0º, east is 90º, south is 180º, and west is 270º. (North can also be considered 360º.) Any angle in between can be used to precisely locate the sun's position. For example, northeast (NE) would be 45º, and southeast (SE) would be 135º.

2c. What would the azimuth of 315º be if you used compass directions?

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2d. If the sun's position were southwest (SW), what would be its azimuth in degrees?

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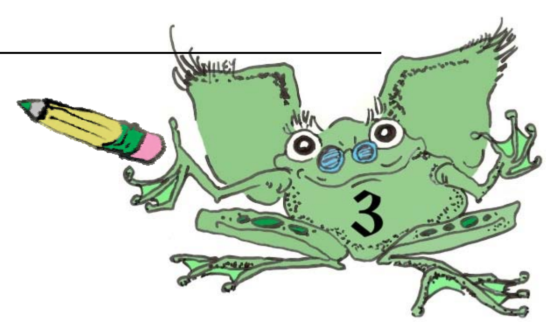

3. Start the animation and notice how the sun moves along its path. The sun rises in the

______________________________ and sets in the ______________________________.

4a. Putting your mouse arrow on the sun, click and drag the sun to the eastern horizon. Start the animation and watch the shadow of the stick figure in the center of the diagram. When is the shadow the longest? (There are two different times.)

______________________________and ______________________________

4b. When is the shadow the shortest?

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4c. When does the shadow point directly north?

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B. Changing hours of daylight on Long Island

5a. Put your mouse arrow on the hour hand of the 24-hour clock (the short hand). Click the cursor and drag the hour hand to 6 a.m. Grab the minute hand and move it until the sun is at an altitude of 0º. What is the time?

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5b. That time is sunrise for March 20. Record it in the chart on page 6 (column C) for March 20. During sunrise and sunset, the altitude of the sun is 0º.

6. Start the animation and watch the sun's altitude and azimuth change. Stop the sun when its altitude is 0º and it is in the west. What time is it now?

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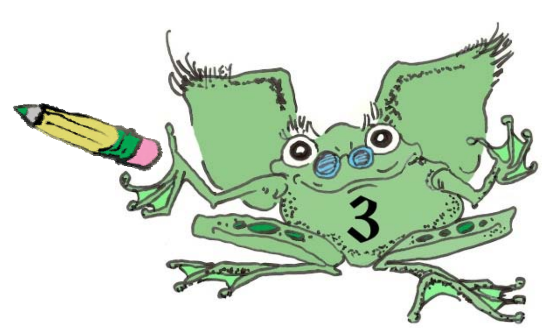
Using the 24-hour clock, record the time in the chart on page 6 (column D) for March 20. (Subtract 12 hours from the time after 12:00 noon to get the time you are familiar with.)



7a. Put the cursor on the months of the year. Click and set the date on June 21. As you did before, put the sun at 0º on the eastern horizon. What is different about where the sun rises on June 21 as compared to March 20?

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7b. Use the same procedure that you used for March 20 to determine the times of sunrise and sunset for June 21. Record the times in the table. Use the 24-hour clock!

8a. Set the date for September 21. What is different about the position of sunrise as compared to June 21?

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8b. Determine sunrise and sunset times for September 21 and record them in the table.

8c. Set and look at the position of the sun at 12:00 noon.

9a. Set the calendar to December 21. Describe how the altitude of the noon sun is different at 12:00 noon compared to the altitude on September 21.

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9b. Compare the sun's position at sunrise and sunset on December 21 with the sun's positions on September 21.

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9c. Determine sunrise and sunset times for December 21 and record them in the tables.

10. Determine and fill in the times for sunrise and sunset for the remaining nine dates listed in the table.

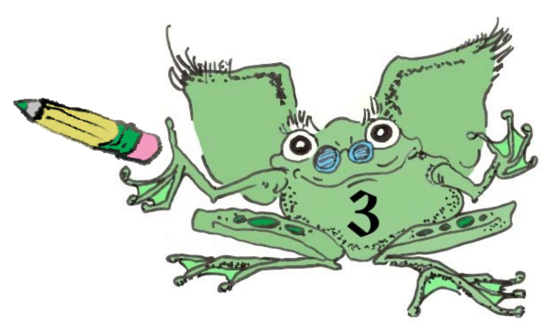
11. Carefully find the hours of daylight by subtracting the time of sunset from the time of sunrise (column D – column C). This can be tricky. Your teacher may give you some help.

For example:	sunset	19:15	change to	18:75
	sunrise	06:27		-6:27
			Hours of daylight =	12:48

12. Convert the hours and minutes of daylight (column E) to the nearest quarter hour. Put in column F.

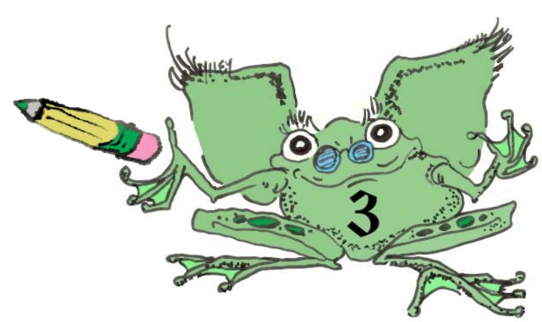
For example:	1:15 = 1.25	**Chart** :minutes = decimal
	1:02 = 1.00	:53 - :07 = .00
	1:08 = 1.25	:08 - :22 = .25
	11:47 = 11.75	:23 - :37 = .50
	13.55 = 14.00	:38 - :52 = .75

This will make it easier to graph the duration (length) of daylight.



Record your data here:

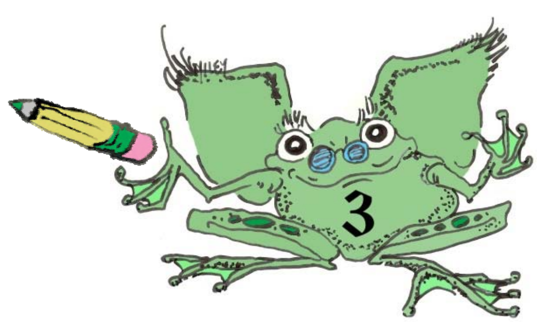
A Date	B Day of the year	C Sunrise	D Sunset	E Hours and minutes of daylight	F Hours and minutes converted to nearest quarter hours
Jan 1	01				
Jan 21	21				
Feb 21	52				
March 20	79				
April 20	111				
May 21	141				
June 21	172				
July 21	202				
August 21	233				
Sept 21	264				
Oct 21	294				
Nov 21	325				
Dec 21	355				



Graph your data:

Graph the data for the dates from January to December on a separate sheet of graph paper to show the relationship between the date/day of the year (column B) and the duration of daylight (column F). Hold the graph paper horizontally (landscape view) and use the data in the columns highlighted in gray.

- Label the *x*-axis with "Time (days)." Each line of the graph paper will probably have to be equal to ten days.
- Label the *y*-axis with "Duration of Daylight (hours)."
- Plot the data points and label each with the date (month and day).
- Connect the data points.
- Make sure your graph has a title.



Title:____

Discussion Questions:

Answer each of the following questions.

1a. When is the duration of daylight

longest? ____

shortest? ____

closest to 12 hours? ______________________________________

1b. You studied the position of the sun at sunrise on various dates with the simulation. How are those observations related to the answers you gave in 1a?

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2. Approximately how many hours of daylight will there be on

April 10 (day 100)?______________________________________

November 5 (day 300)? ___________________________________

3. During what time periods of the year is the amount of daylight changing (increasing or decreasing)

the most? ____

the least? ____

4. How does the angle of the Earth and its path as it revolves around the sun cause changes in the amount of daylight on Long Island?

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5. The graph of the changing length of daylight during a year is not a line. Even so, we can compare parts of the graph by looking at the slopes of lines formed by drawing a line segment between data points. Compare the changes in hours of daylight in two regions of the graph (August 21 to September 21 and November 21 to December 21) by calculating the unit rate of change (slope).

Unit Rate of Change $= \dfrac{\Delta \text{ Duration of Daylight (hours)}}{\Delta \text{ Time (days)}} = \dfrac{\Delta y}{\Delta x} = \dfrac{(y_2 - y_1)}{(x_2 - x_1)}$

Section of Graph	Ordered Pair used for calculation (x_1, y_1) (x_2, y_2)	Δ Duration of daylight (hours) Δy	Δ Mechanical advantage Δx	**Unit Rate of Change (slope)** $\Delta y/\Delta x$
August 21 – September 21 (days 233– 264*)				
November 21 – December 21 (days 325–355*)				

*** Use these numbers to calculate slope!**

5b. To give you a better sense of how the length of day changes during different times of the year, convert the unit rate of change (slope) from hours/day (from the chart above) to minutes per day using the formula below:

Unit rate of change in $\frac{\text{hours}}{\text{day}}$ x $\frac{\text{60 minutes}}{\text{hour}}$ = Unit rate of change in $\frac{\text{minutes}}{\text{day}}$

Section of Graph	**Unit rate of change (slope)** $\frac{\textbf{minutes}}{\textbf{day}}$
August 21 – September 21 (days 233–264)	
November 21 – December 21 (days 325–355)	

6a. During which of the two time periods above (August 21 – September 21 OR November 21 – December 21) does the amount of daylight change the most per day?

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6b. Why is the sign of the unit rates of change (slopes) calculated above negative/-?

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6c. When would the unit rates of change (slope) be positive on the graph? Give a specific date range.

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7a. If the line segment from January 21 to February 21 was extended, it would intersect the *y*-axis. Determine the *y*-intercept for the line for this section of the graph. Use the equation for a line to calculate the *y*-intercept. The unit rate of change (slope) for the line from January 21 to February 21 is .04 hours per day. The equation for a line is

$y = mx + b$
where *m* is the unit rate of change (slope) and
b is the *y*-intercept

Y-Intercept
$m =$ Ordered pair $(x, y) = ($ ___ , ___ $)$ $y = mx + b$ Solve for *b*:

7b. How does the *y*-intercept for the January 21 to February 21 (days 21 –52) line compare to the hours of daylight on January 1? They should be similar. Why?

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8. Based on the unit rate of change that you calculated above and the *y*-intercept, write a linear equation for the January 21 to February 21 (days 21–52) section of the graph. Remember that the equation for a line is $\boldsymbol{y = mx + b}$ and *m* is the unit rate of change (slope) and *b* is the *y*-intercept.

Equation

9. Use the formula you determined above to calculate the length of daylight on February 14 (day 46 — use 46 in your calculation). Show your work.

   x = 46 days

   y = ___________ hours