MiSP Astronomy — Seasons Worksheet #2 L3

Name ______________________________ Date _____________

WHERE'S THE MOST SUNLIGHT?

Introduction:

If you travel today to another location on planet Earth (unless it is the fall or spring equinox), you will find that some places have the same number of daylight hours as Long Island, some places have more hours of daylight, and some have fewer hours of daylight. As you saw in Worksheet #1, the number of hours of daylight on Long Island changes during the year. That is true of most places on the planet. The exception is places on the equator. They always have 12 hours of daylight. How boring! In addition, the height of the sun (altitude, which is measured in degrees) above the horizon may be different from place to place around the globe.

Problem:

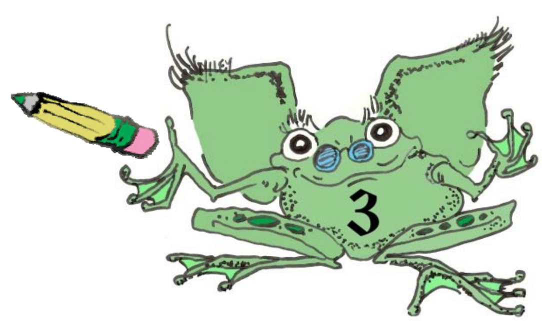
On a particular day, how do the sun's altitude above the horizon at 12:00 noon and the number (duration) of daylight hours compare at different latitudes?

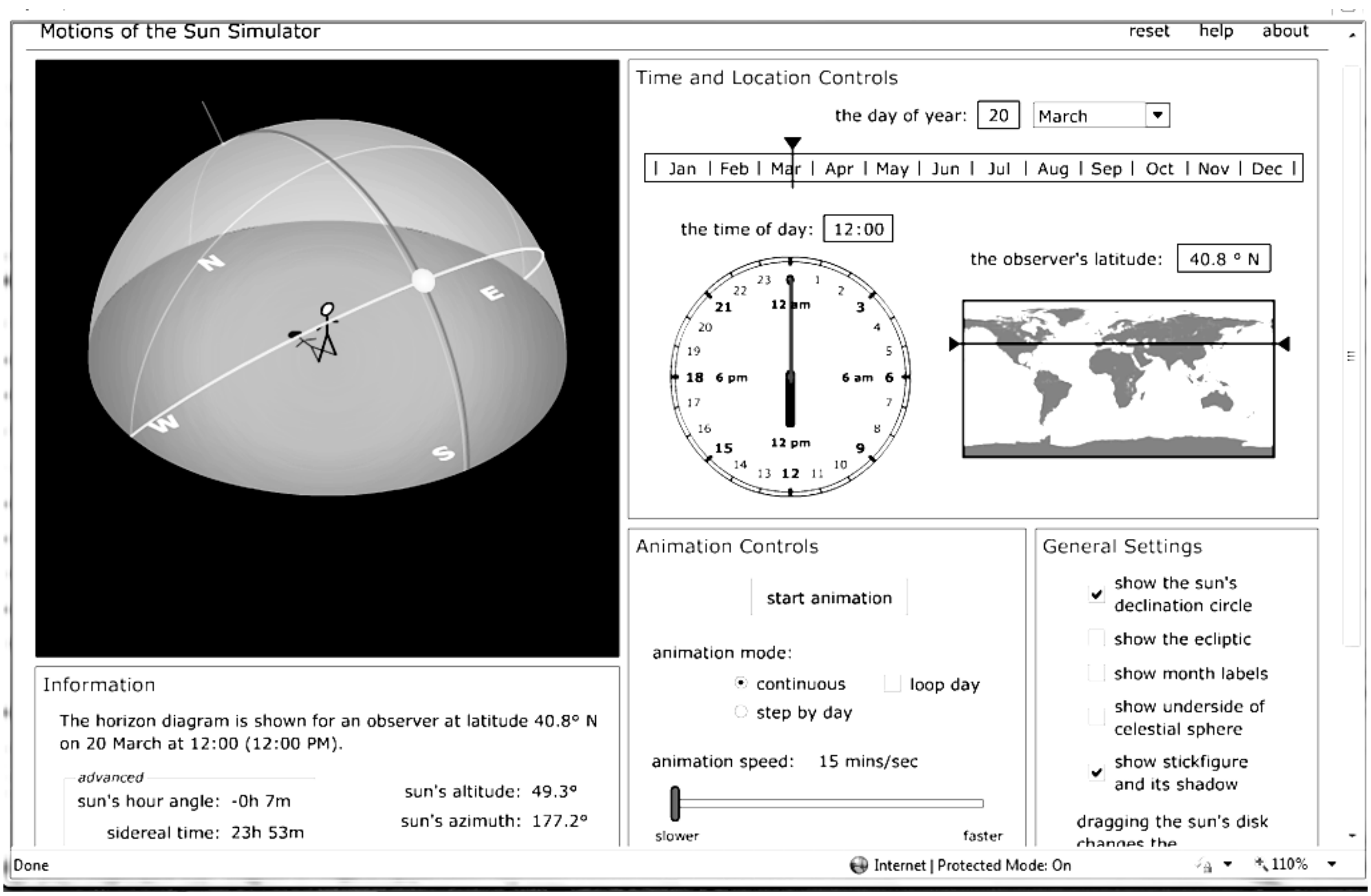
Procedures:

You will again use the simulation at
http://astro.unl.edu/naap/motion3/animations/sunmotions.html.
Go to the site.

Look at the controls on the right-hand side and set them as you did for Worksheet #1:

- 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.





1. Place the date indicator on January 1 and set the time for 12:00 p.m./noon (12:00 on the 24-hour clock). Put the cursor arrow a little beyond the end of December, click, and hold. Watch what happens to the altitude of the noon sun as the months go by. Watch it several times and describe how the altitude changes.

   When is the altitude highest? ____

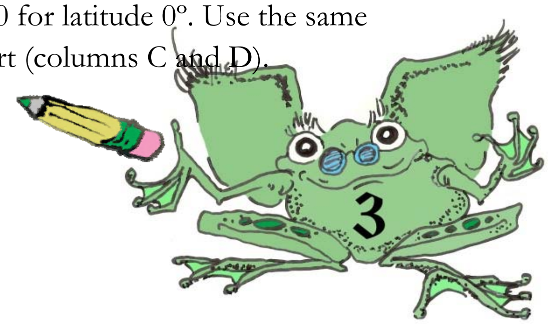
   When is the altitude lowest?____

2a. Set the time to 12:00 noon and the calendar date to March 20. Set the latitude to 0º or type in 0º in the observer's latitude window.

2b. What is the altitude of the noon sun? Read it from the information box under the animation diagram. Record the altitude in the data chart in column B.

   ____

2c. Determine the time of sunrise and the time of sunset on March 20 for latitude 0º. Use the same procedures you used for Worksheet #1. Put the times on the chart (columns C and D).



3a. Change the latitude to 10º north or type it in the window and record the new altitude. Add to the data chart.

3b. Find the sunrise and sunset times for 10º north. Add to the data chart.

4. Continue for each of the latitudes shown in the data table.

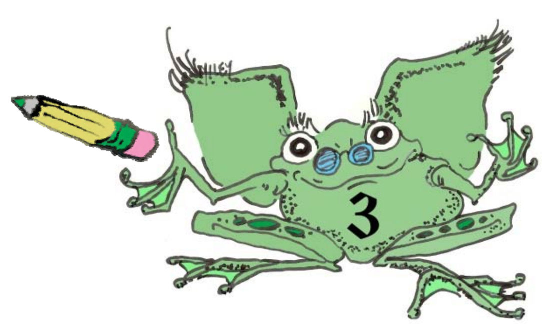
5. Carefully find the hours of daylight by subtracting the time of sunset from the time of sunrise (column D – column C).This can be tricky. Your teacher may give you some help.

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

6. Convert the hours and minutes of daylight to the nearest quarter hour. Put that 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

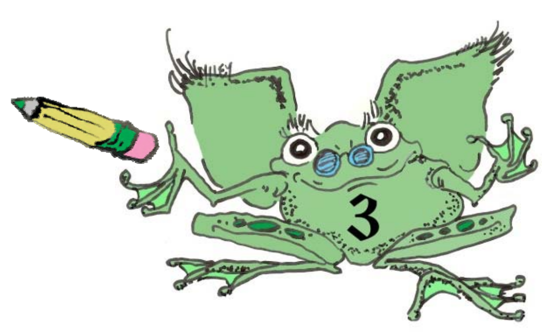
This will make it easier to graph the duration (length) of daylight.



Record your data here:

A Latitude (degrees north)	B Altitude at 12:00 noon on March 20 (degrees)	C Sunrise on March 20	D Sunset on March 20	E Hours and minutes of daylight	F Hours and minutes converted to nearest quarter hour
0					
10					
20					
30					
40					
50					
60					
70					
80					
90					

Graph your data:



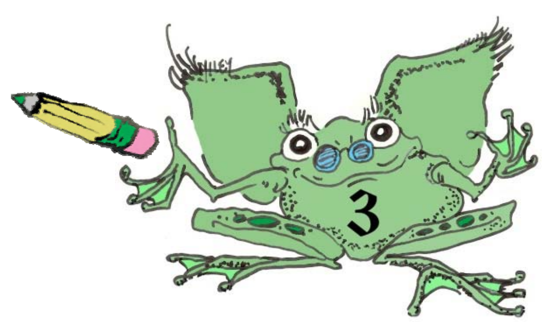
Make two (2) graphs of the data highlighted in gray:

Graph (1): Latitude and height of the sun

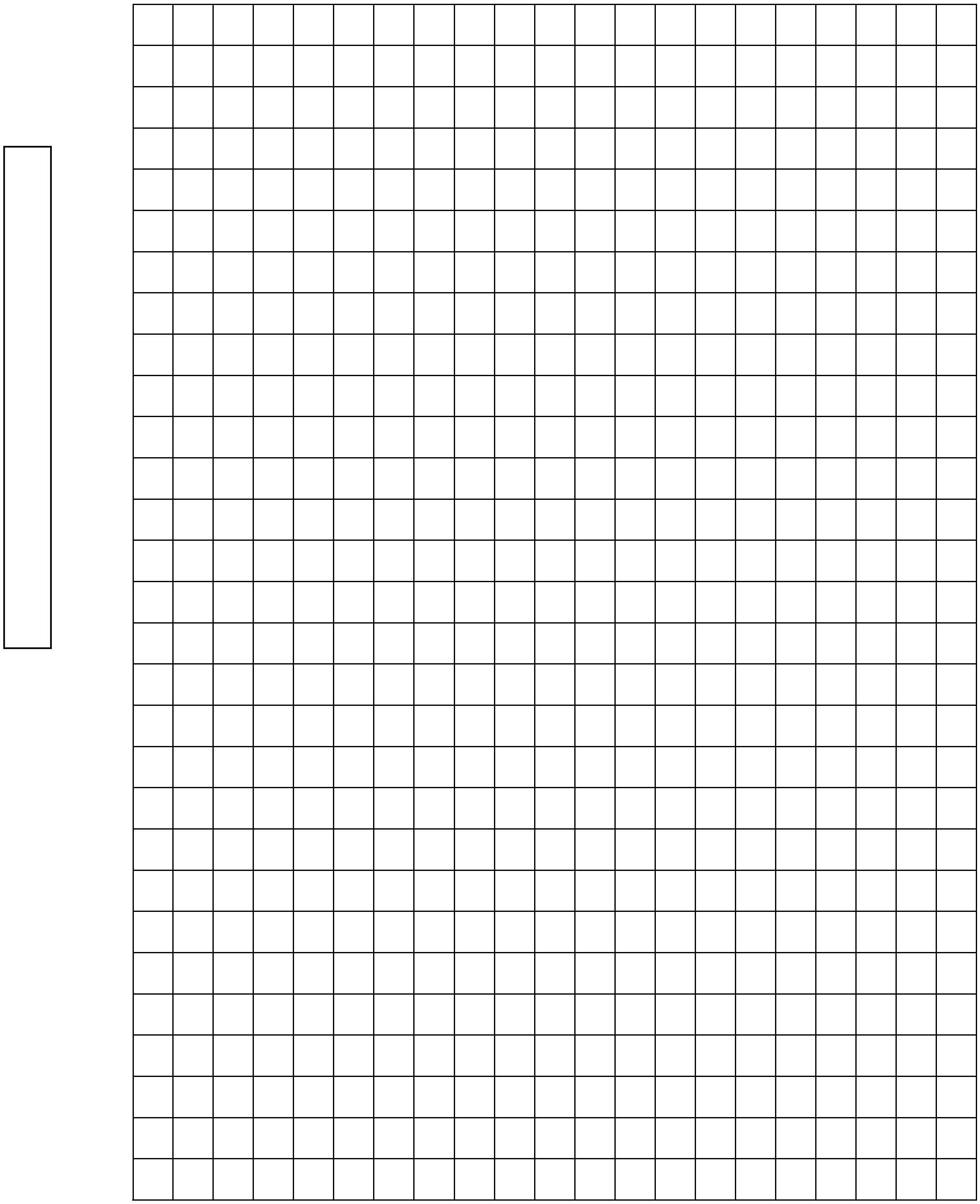
- Label the *x*-axis with "Latitude (degrees north)" — column A.
- Label the *y*-axis with "Altitude at 12:00 noon (degrees)" — column B.
- Connect the data points.

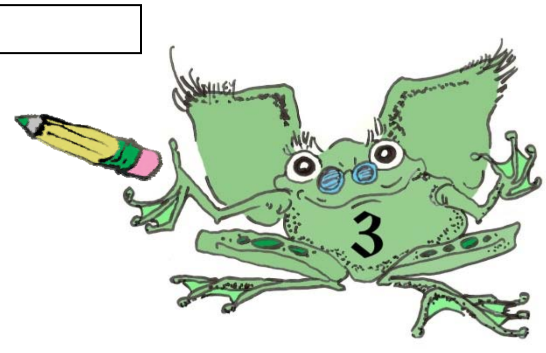
Graph (2): Latitude and length of day

- Label the *x*-axis with "Latitude (degrees north)" — column A.
- Label the *y*-axis with "Hours of Daylight" — column F.
- Connect the data points

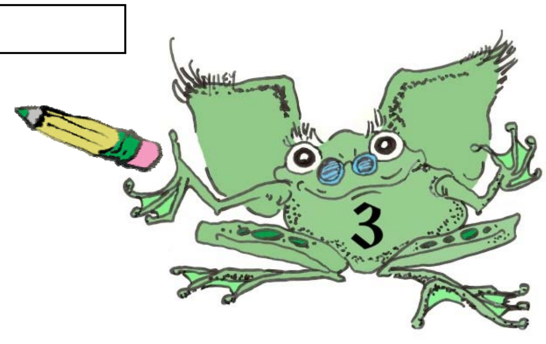


Graph (1): Latitude and height of the sun





Graph (2): Latitude and length of day



Discussion Questions:

1a. Compare the data for the different latitudes north of the equator: both altitude of the sun at noon on March 20 and the duration of daylight:

Which latitude has the highest sun altitude? ______________________________

Which latitude has the lowest sun altitude? ______________________________

Which latitude has the most hours of daylight? ______________________________

Which latitude has the fewest hours of daylight? ______________________________

1b. Make a generalization about latitude and <u>sun altitude</u> on March 20 by completing this sentence:

On March 20, as the latitude north of the equator increases, the altitude of the sun

____.

1c. Make a generalization about the latitude and the <u>duration of daylight</u> on March 20 by completing this sentence:

On March 20, as the latitude north of the equator increases, the duration (number of hours) of

daylight ________________________________.

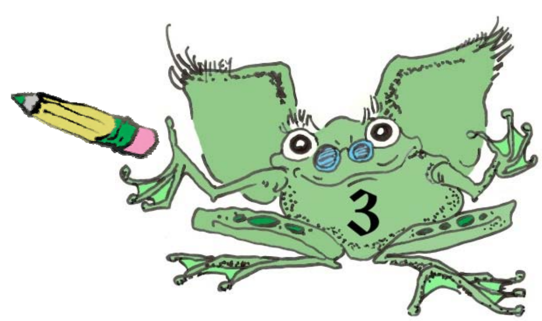
2. From March 20 to June 21, the duration of daylight increases so that all latitudes north of the equator have more than 12 hours of sunlight. Make a prediction by completing this sentence:

On June 21, as the latitude north of the equator increases, the duration (number of hours) of

daylight ________________________________.

3. Use your graph to predict the altitude of the sun at 12:00 noon and the duration of daylight on March 20 at latitude 45° north.

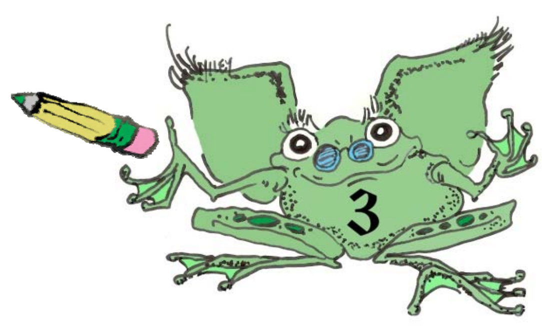
Altitude of the sun: ______________ Duration of daylight: ______________



4. How does the angle of the Earth and its revolution around the sun cause different latitudes to have

different sun altitudes at 12:00 noon on March 20?

the amount of daylight that each receives?



5. Compare the changes in the sun's altitude at 12:00 noon on March 20 at latitudes north of the equator by calculating the unit rate of change (slope). Use the information from the graph to calculate the unit rate of change (slope). If your data points all lie on a line, determine the unit rate of change (slope) of the line. If your data points do not produce a line, determine the slope of the best-fit line that you drew. *(If you use the best-fit line, the ordered pairs to determine slope must be from the best-fit line, not from your data chart.)*

Unit Rate of Change

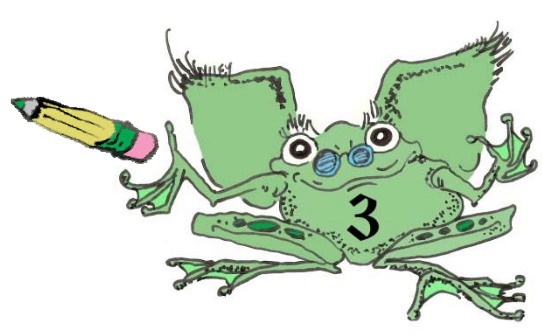
$$\frac{\Delta \text{ Altitude of the sun (degrees above the horizon)}}{\Delta \text{ Latitude (degrees north)}} = \frac{\Delta y}{\Delta x} = \frac{(y_2 - y_1)}{(x_2 - x_1)}$$

Ordered Pair used for calculation (x_1, y_1) (x_2, y_2)	Δ Altitude of the sun (degrees above the horizon) Δy	Δ Latitude (degrees north) Δx	**Unit Rate of Change (slope)** $\Delta y/\Delta x$

6. Put the unit rate of change (slope) into words by completing the sentence below:

As you travel north from the equator on March 20, for each north latitude degree traveled, the sun's altitude above the horizon ______________________________ *by* ____________ *degrees.*

7a. What would the graph of north latitude degrees and the sun's altitude look like on June 21?



7b. How would the slope or slopes of the June 21 graph compare to the March 20 graph?

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8. What is the *y*-intercept for the March 20 latitude – sun altitude graph?
Use the equation for a line to calculate the *y*-intercept. Use the line or best-fit line you used in #5. The equation for a line is

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

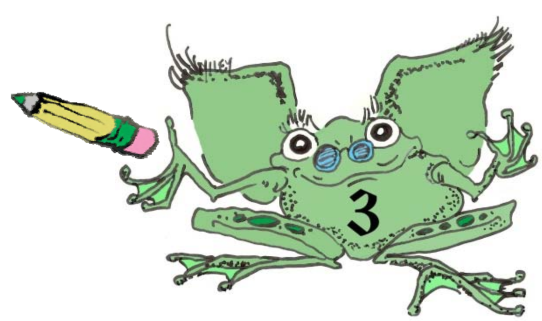
Y-Intercept
$m =$ Ordered pair (x, y) = (___ , ___) $y = mx + b$ Solve for *b*:

9. Based on the unit rate of change that you calculated above and the *y*-intercept, write an equation for the line on the March 20 latitude – sun altitude 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

10. Use the formula above to calculate the height of the sun at 45º north latitude. Show your work.
$x = 45°$ north

$y =$ _______________ Degrees above the horizon



11. Would the formula above work in the Northern Hemisphere on other days of the year? Explain.

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12. Would the formula above work in the Southern Hemisphere on March 20 if the units for x were changed to degrees south? Explain.

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