**Activity 6.5.2 Daylight Hours**

Over the course of the year, the amount of daylight changes each day. To determine the number of daylight hours each day, the time of sunrise was subtracted from the time of sunset.

Here is a year’s worth of daylight hours for Boston, Massachusetts, latitude 42 degrees north.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Date | Day of the year | Hours of Daylight |  | Date | Day of the Year | Hours of Daylight |
| 1/2  2/3  3/7  4/8  5/2  6/3 | 2  10  18  26  34  42  50  58  66  74  82  90  98  106  114  122  130  138  146  154  162  170  178 | 9.2  9.3  9.6  9.8  10.1  10.4  10.8  11.1  11.5  11.9  12.3  12.7  13.0  13.4  13.8  14.1  14.4  14.8  14.9  15.1  15.2  15.3  15.2 |  | 7/5  8/6  9/7  10/1  11/2  12/4  12/28 | 186  194  202  210  218  226  234  242  250  258  266  274  282  290  298  306  314  322  330  338  346  354  362 | 15.2  15.0  14.8  14.5  14.3  13.9  13.6  13.3  12.9  12.5  12.1  11.8  11.4  11.0  10.7  10.3  10.0  9.6  9.5  9.3  9.2  9.1  9.2 |
|  |  |  |  |  |  |  |

1. Plot the data using a spread sheet, your calculator stats menu, or by hand on graph paper.

Assume that the number of daylight hours will be the same next year. Plot a two-year cycle by repeating the data for another year.

1. Find a sinusoidal equation that models the hours of day light as a function of the day of the year. (a sinusoidal model is either y = a sin(b(x)) + d or y= a cos(b(x)) + d).
2. Your model will not contain every data point, but it will give a good approximation of the data. Deciding what your constants will involve intelligent estimation. Explain what thought process you had in making the choices you made to arrive at a model for the length of day as a function of day of the year.
3. Explain how you verified that your equation is a reasonable model for the data.

1. Here is the length of day data for Fairbanks, Alaska. Graph this data on the same coordinate axis as the Boston Data.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Day of the year | Hours of Daylight |  | Day of the Year | Hours of Daylight |
| 0  10  20  30  40  50  60  70  80  90  100  110  120  130  140  150  160  170 | 3.7  3.9  4.2  5.7  8.2  8.6  9.1  10.7  12.2  13.7  15.3  15.7  16.2  18.6  20.2  20.5  20.6  20.7 |  | 180  190  200  210  220  230  240  250  260  270  280  290  300  310  320  330  340  350  360 | 20.7  20.6  20.3  18.8  18.4  15.9  15.5  15.0  13.4  11.0  10.5  8.9  8.4  8.0  5.6  4.0  3.8  3.7  3.7 |

1. Explain in full sentences what is the same, and what is different between the amounts of daylight in the two cities. For both cities, comment on the amplitude, period, phase shift, and average number of daylight hours (i.e. the midline).
2. Explain how to find a model for the Fairbanks data by modifying your model for the Boston data. What is the equation for the Fairbanks, Alaska length of day function?
3. Tromso, Norway, latitude 69 degrees north, is 200 miles north of the Arctic Circle. People do not even see the sun between November 20 and Jan 20. They do, however, enjoy 24 hours of daylight during the summer. Draw a sketch of what the length of day function for Tromso might look like. Put a scale on each axis. (You are not expected to find the data for the length of day in Tromso, just draw a very rough sketch of what seems reasonable.)
4. Does the sketch for Tromso show a sine wave? Why or why not?

In the southern hemisphere, the annual daylight pattern is reversed. The longest days are December and January, and the shortest days in June and July.

1. Sketch a graph of the length of day function for Wellington, New Zealand or Puerto Montt, Chile – cities that have latitude of about 42 degrees south – the same distance south of the equator that Boston is north of the equator. (Again, you are not expected to find actual data, just make a rough sketch based on the Boston length of day function.)
2. Explain how to modify the equation you have for Boston to obtain a formula for New Zealand or Chile; write the formula for New Zealand or Chile.

Now return to the Boston length of day data or the equation. We will be looking at how fast the daylight hours increase or decrease at different times of the year.

1. a. Look at the Boston data, and sketch, again, a graph of the daylight hours for Boston as a function of day of the year.
2. Between what 2 days of the year are the hours of day light increasing most rapidly?

c. Find the slope between the two points in 12a. This is the average rate of change of daylight hours per day at that time. (Show your work)

d. Find how many minutes per day we are gaining daylight around the first day of spring.

e. Find how many minutes per week we are gaining daylight around the first day of spring.

f. Indicate the place on your graph where the daylight hours increase most rapidly.

g. Tell where the average change in daylight hours per day DECREASES most rapidly. How many minutes per day of daylight are being lost? Indicate the place on your graph where daylight is lost most rapidly.

h. Tell where there is the least change in daylight hours. What is the average rate of change in daylight hours at these 2 times of the year? Indicate the place on your graph where daylight is not changing (or changes the least).

1. Look at the Fairbanks, Alaska data and graph. Examine the region where the greatest increase of daylight hours occurs.
2. What season or time of year is this?
3. Between what 2 or 3 days does Fairbanks, Alaska see the most rapid increase in daylight hours?
4. Tell the average rate of change in daylight hours per day and convert to the number of minutes of daylight per day are being gained in Fairbanks at that time. (show work)
5. How many extra hours of daylight would Fairbanks have in a week?
6. How does the graph for Fairbanks, Alaska compare with the graph for Boston when the daylight is increasing most rapidly?

If you are interested in more information about the hours of daylight, investigate these websites and videos:

1. To find the number of hours of daylight for any major city in the world, go to the United States Naval Observatory website and to obtain the data. A search with “daylight US Navy” brings you to their website: <http://aa.usno.navy.mil/data/docs/Dur_OneYear.php> .
2. A You Tube video explaining why daylight increases and decreases throughout the year can be found at <https://www.youtube.com/watch?v=rcquRMaVSKU> , or search:“What Causes the Seasons” by Treetest63.
3. A very detailed explanation of the rotation earth is given by the video <https://www.youtube.com/watch?v=82p-DYgGFjI> “Earth’s Motion Around the Sun, not as simple as I thought”, by Aryan Navabi, as part of the Cassiopeia Project at <http://www.cassiopeiaproject.com> .