Modeling Daylight Hours

by: Dwight Stead

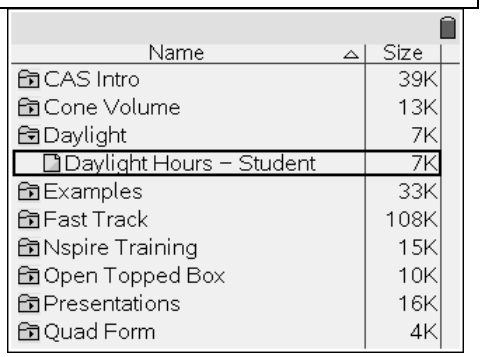
Grade level: Secondary
Subject: Mathematics
Time required: 75 minutes

Materials: Daylight Hours – Student.tns

In this activity you and a partner will create graphical and algebraic models of the data on the daylight hours for Windsor, ON and Whitehorse, YT. You will interpret the meaning of each of the parameters in the algebraic models. You will also determine how the models for the two cities differ and justify the reasons.

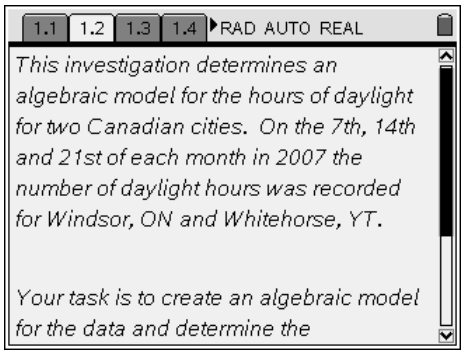
Turn on the Nspire unit.

From the **Home** screen choose **My Documents** and open the file: *Daylight Hours – Student.tns*



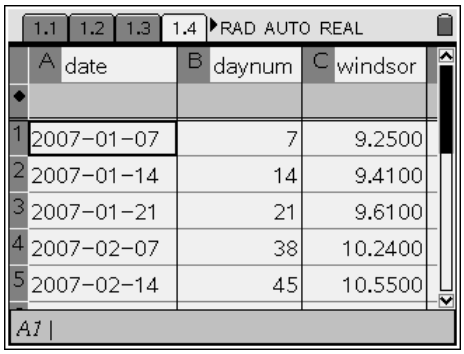
Go to page 1.2 and review the instructions for the activity.

Go to page 1.3. and review the description of the data that is provided for this activity.



Go to page 1.4. This spreadsheet contains the data collected on number of daylight hours for Windsor, ON at days throughout 2007.

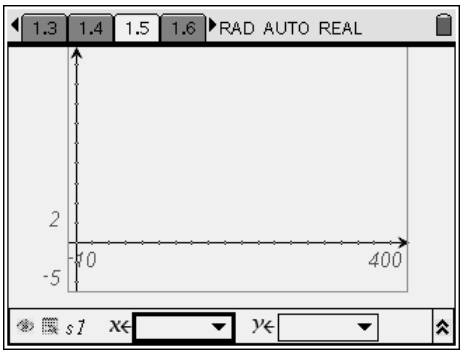
The data was collected from http://www.hia-iha.nrc-cnrc.gc.ca/sunrise_e.html



©2008 Texas Instruments Incorporated

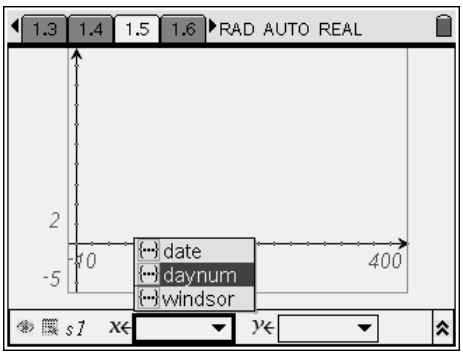
Go to page 1.5. You will make a scatter plot of day number and hours of daylight in Windsor.

Press menu **3 3** to change the screen to a scatter plot.



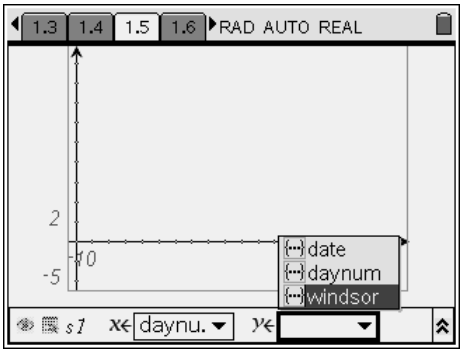
Press enter and choose **daynum** from the list using the **NavPad** and press enter**.**

This selects the *independent* variable.



Press tab enter and choose **windsor** from the list using the **NavPad** and press enter**.**

This selects the *dependent* variable.



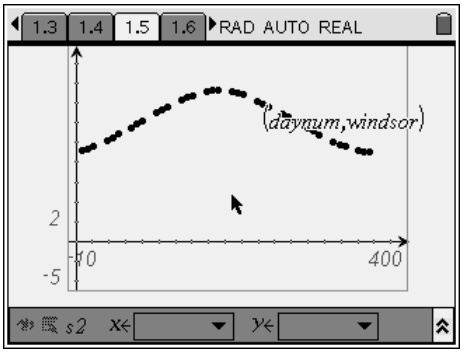
A scatter plot of day number and hours of daylight appears.

What type of relation is this?

_____

What would you expect *period* of the relation to be? Give reasons.

_____

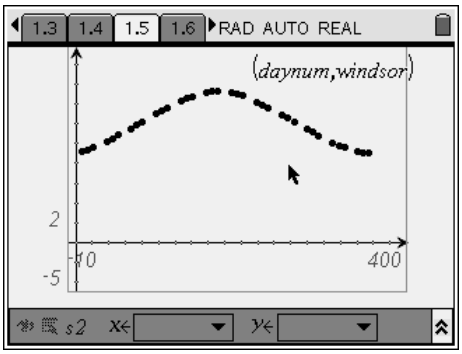


©2008 Texas Instruments Incorporated

To change to the graph window press the (esc) key.

You can move the label to the top right corner by grasping the label *(daynum,Windsor)* and holding the on the **NavPad** until the hand closes.

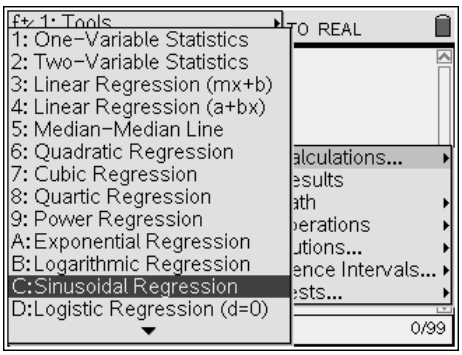
Using the **NavPad** move the label to the top right corner. Pressing (esc) drops the label.



Next you will perform a *sinusoidal regression* to create an algebraic model.

Go to page 1.6. This blank calculator page will be used for the regression.

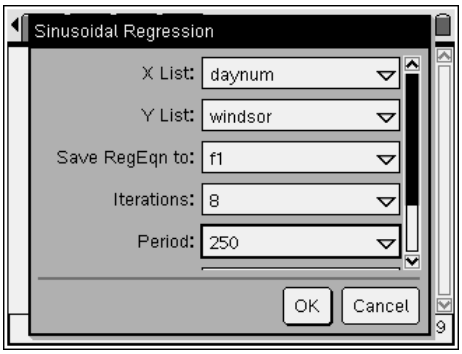
Press (menu) **7 1 C** to open dialogue box for the sinusoidal regression.



Pressing on ▼ on the **NavPad** opens the list of choices for the *X List*. Use ▼ to choose **daynum** and press (enter)

Press (tab) to move to the next field and repeat the steps to select the values you see on the right.

When all the values have been selected press (enter) to perform the regression and place the regression function into **f1(x)**.



The results of the regression are displayed. Record the indicated values below:

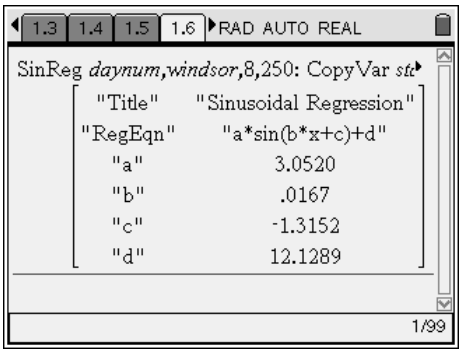
a = _____

b = _____

c = _____

d = _____

y=a·sin(b·x + c) + d

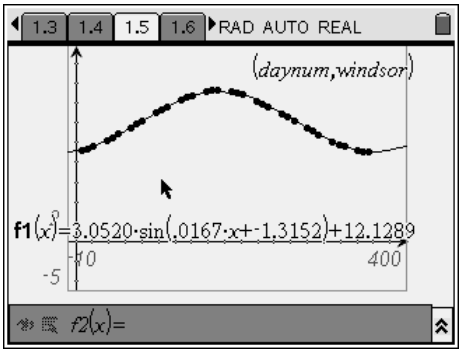


Go back to page 1.5. You will graph your algebraic model on the scatter plot and interpret the significance of the parameters **a**, **b, c** and **d**.

First you must change back to a function graph. Press (menu) 3 1

Press the up arrow to see the algebraic model in the window at the bottom of the screen. To make it graph this function press (enter)

To move the cursor to the graph window press (esc). Grasp the algebraic model label and move it the lower right part of the screen.

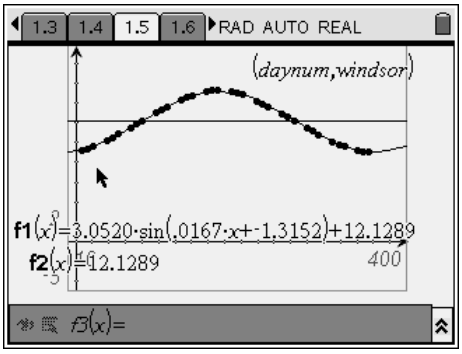


To interpret the impact of the **d** parameter we will graph a horizontal line with the same value.

Press (tab) to move to the function window and enter the value of **d** next to **f2(x)** and press (enter)

Move the label for **f2(x)** to the lower right part of the screen.

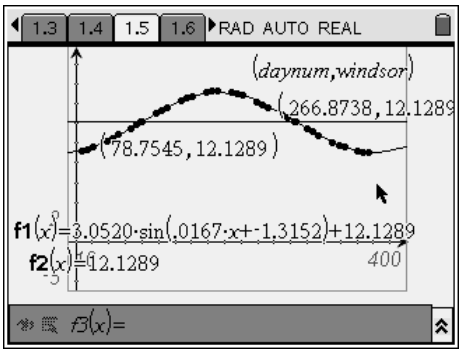
What is the impact of the **d** parameter?



Next you will determine where the two functions displayed intersect and interpret the significance of the points.

Press (menu) **6 3** to select the intersection points mode. Using the **NavPad** move the cursor to one of the two function graphs. It should flash once the cursor is on it. Press the (enter) button and move to the second function and repeat the process.

The coordinates of two points of intersection will be displayed. Press (esc) to exit intersection mode. Grasp and move the coordinates so they can be seen easily.



©2008 Texas Instruments Incorporated

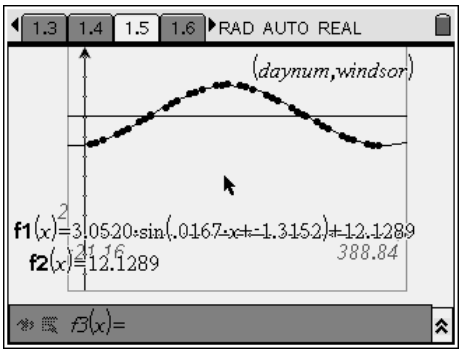
The x coordinates of the intersection points tell you the day number when the daylight hours was the value of **d**.

What is significance of these two dates?

To interpret the impact of **a,** we will trace the curve until we find the maximum and minimum values.

But first we will get rid of the coordinates of the intersection points.

To hide an object on the screen, move the cursor over the coordinates and press ctrl menu. Select **Hide/Show** from the menu that appears. Repeat the process for the other intersection point.

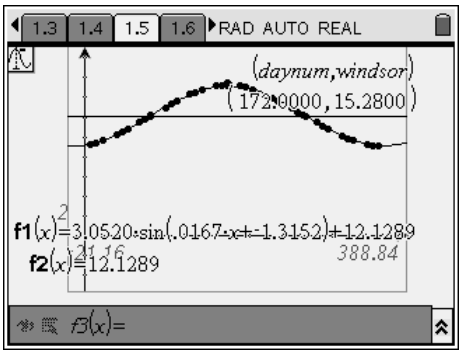


Press menu **5 1** to select graph trace mode. Pressing ◀ or ▶ on the **NavPad** moves along a curve. Pressing ▲ or ▼ on the **NavPad** moves from one curve to another.

It takes some practice and care to trace along a curve. When a maximum appears a small box with **M** is placed on the screen. Similarly **m** will appear when a minimum is reached.

Once you have found the maximum and minimum values, calculate the difference each is from the value of **d**.

What is the significance of the parameter **a**?



What day numbers correspond to the maximum and minimum values?

What is the significance of these two dates?

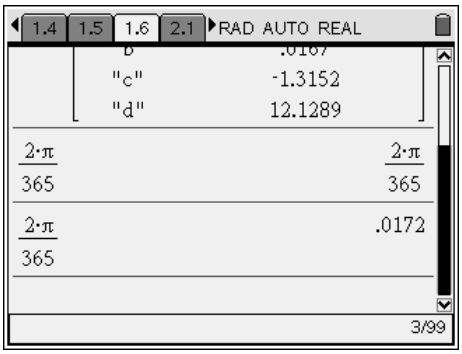
©2008 Texas Instruments Incorporated

The impact of **b** can be determined by performing a calculation.

Go to page 1.6. Divide 2(π) by the period of the function.

To get a decimal value press (ctrl) and then (enter)

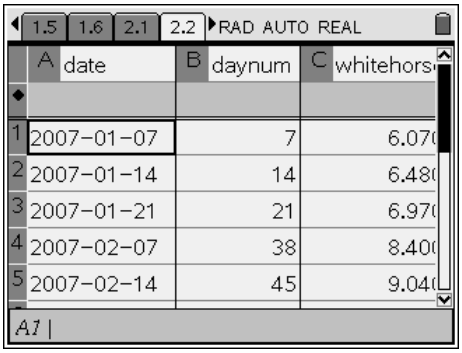
Why is the value of **b** always $\frac{2\pi}{period}$?



Now that you have investigated the relationship between day number and daylight hours for Windsor you will repeat the process for Whitehorse, YT.

Starting at page 2.1 you will perform the steps on pages 2 to 6 and record your findings below:

What type of relation is this?



What would you expect *period* of the relation to be? Give reasons.

Algebraic model for Whitehorse, YT

a = _____

b = _____

c = _____

d = _____

y=a·sin(b·x + c) + d

Reflection:

Examine the three two algebraic models you have recorded. How do the values of **a**, **b**, **c** and **d** compare fro the two cities?

What is the relationship between a city's latitude and the amplitude of the algebraic model?

Summary:

Make a summary of the role of each of the following parameters:

The value of **a** provides ...

The value of **b** provides ...

The value of **d** provides ...

©2008 Texas Instruments Incorporated