Exploring the Sine Curve

In this Skill Sheet we will explore the effect of changing parameters in the general form of the sine curve, as given by:

$$y = a\sin n(x - c) + d$$

where a = the amplitude, n = the frequency, c = the phase shift and d = the offset from the x-axis. We will put scrollbars on the spreadsheet to control the values of these parameters and observe the effect of changing them by making a graph of the sine curve.

1. Begin by setting up the spreadsheet as follows (but don't worry about the numerical values).

	A	B	C	D	E	F
1						
2		x-val	y-val		amplitude	3.3
3		0	-2.2016		frequency	13.6
4		0.031416	-2.5921		phase shift	2
5		0.062832	-2.39072		offset	0.7
6		0.094248	-1.63366			

2. For ease of use, you need to name the cells F2 (amp), F3 (freq), F4 (shift) and F5 (offset). To do this for the cell F2, follow these steps:

    a. Click on F2

    b. Move the cursor to the Name Box and replace F2 with the name *amp*.
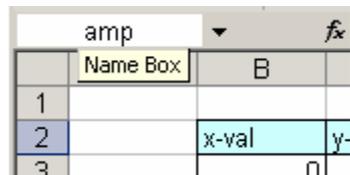
    c. Press <Enter> to establish the name.

    d. Repeat steps a – c for cells F3, F4 and F5.

    Naming cells doesn't take long, but it does make the formulae that you enter later much easier to understand.

3. We can now add the scrollbars to control these parameters. To do this, choose **View:Toolbars:Forms** which will place the following on your screen. The scrollbar tool is selected below:

Scroll Bar

    Drag over cells H2: L2 to make the scrollbar appear. Right click this scrollbar, choose **Format Control** and select the **Control** tab. The only thing that we need to set up is the Cell Link, which should be set to G2:

Cell link: G2

Note that the scrollbar is automatically set to range between 0 and 100, giving a percentage figure. Thus if we want a value to range between a *min* and a *max*, having a *range = max – min,* then the formula to use is:

Cell Formula = min + range*scrollbar/100

4. For the amplitude, which we will give a range between 1 and 5, the formula is:

    (F2) = 1 + 4*G2/100

    Use the scrollbar to establish that you really have entered the formula correctly.

5. You can add the scrollbars for the Frequency, Phase Shift and Offset individually, but there is a quick method, which is worth knowing. Hold down the <Ctrl> key and drag a copy of the scrollbar down to H3:L3. Right click the new scrollbar and make the Cell Link refer to cell G3. Do the same to create scrollbars for Phase Shift and Offset.

    The formulae that w suggest for these parameters are:

    (F3) = G3/20 (which gives the frequency a range from 0 to 5)

    (F4) = G4*PI()/50 (which gives the phase shift a range from 0 to 2π)

    (F5) = -5 + G5/10 (which gives the offset a range from -5 to +5)

6. The next step is to create the data for the graph. We suggest that the x-values go in increments of PI()/20. Set:

    (B3) 0

    (B4) = B3 + PI()/20

    Use the Fill Handle to drag the above formula down to B43, where you should see that it has reached a value of 2π, or 6.28…

    Set:

    (C3) = amp*SIN(freq*(B3 – shift)) + offset

    and double click the Fill Handle to complete the data for plotting.

7. And now for the graph itself. Here's a technique for selecting data that you need to become proficient with.

   Click in B2 and press <Ctrl> + <right arrow> to select the top row of the data. Then press <Ctrl> + <down arrow>. This selects the data for plotting.

   Click on the **Chart Wizard** button, and create an X-Y Scatter chart in the space below the scrollbars. You may need to adjust the y-axis using **Format: Axis** as follows:
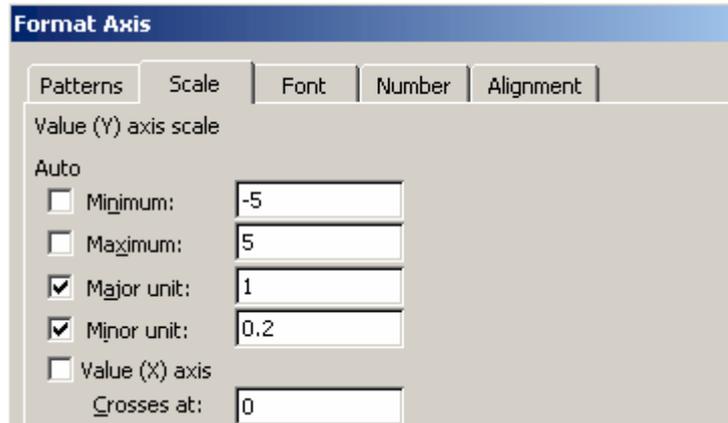
The graph is now complete, and you should be in a position to check out the effect of changing the parameter values.

Questions

1. What phase shift is needed to make the graph have the appearance of a cosine function?

2. What parameter settings are needed to make the graph pass through the even numbers on the x-axis?

3. What happens when the amplitude is equal to the offset?

4. The x-values go as far as 2π. What is the relationship between the frequency and the shape of the curve?

5. What changes to formulae are needed to make the offset range from -2 to 3?