**NCSSM** **Swing Lab**

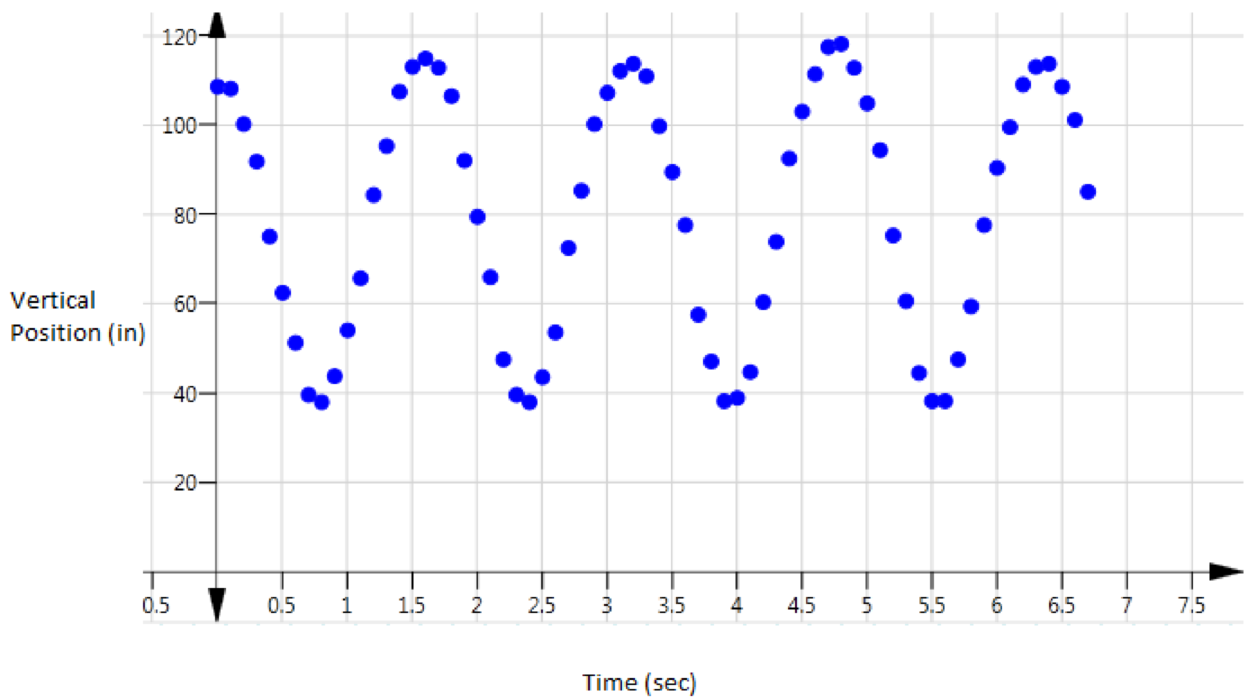
To complete the following activity, you will need access to the movie file of the swinger and the data points for the Swing Lab. This data is available in an Excel file or a TI Calculator program. A partial table of data is provided at the end of this handout.

**Pre-Activity:** Watch the video of the swinger. As you watch the video, think about breaking up her motion into her vertical position and horizontal position over time. For example, think about how high she swings or how far left or right she is from the "center" of her swing. The distance between the top of the two orange cones is approximately 72 inches. Think about how long it takes for the swinger to make one complete swing (from far left to far right back to far left again).

**Part I: Modeling the Vertical Position of the Swinger**

The goal for Part I of the lesson is for you to create a mathematical model that gives the swinger's vertical position as a function of time.

Let's consider the graph below. Along the horizontal axis we have time in seconds and along the vertical axis we have the vertical position of the swinger, i.e. her height off the ground measured in inches.




Using your knowledge of trigonometry, the graph and a data table of the points, create a model of the form $y(t)=P\cos(Q(t+R))+S$ or $y(t)=P\sin(Q(t+R))+S$ for the vertical position for the swinger as a function of time (t) in seconds.

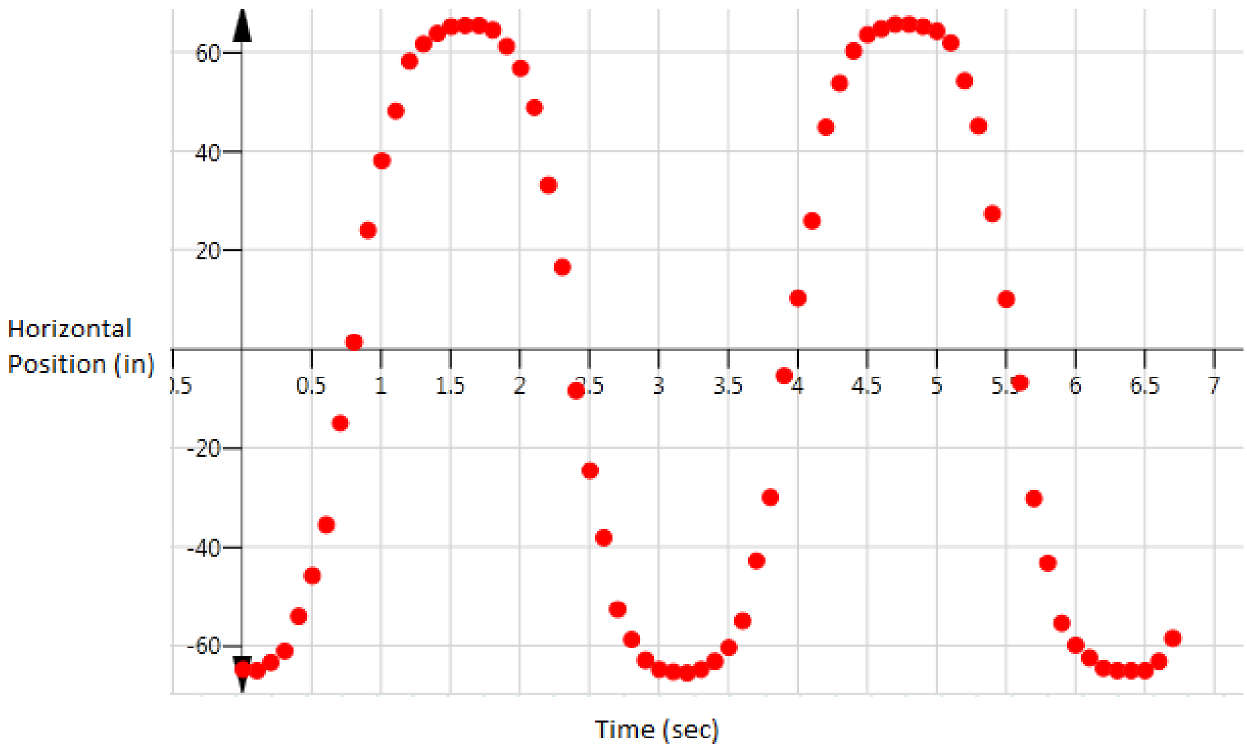
Carefully explain how you arrive at each of the values for the constants P, Q, R and S.

Using technology, create a graph of the given data along with a graph of your model. Discuss the accuracy of your model. Include information about the physical problem as you discuss the accuracy of your model.

**Part II: Modeling the Horizontal Position of the Swinger**

The goal for Part II of the lesson is for you to create a mathematical model that gives the swinger's horizontal position as a function of time.

Let's consider the graph below. Along the horizontal axis we have time in seconds and along the vertical axis we have the horizontal position of the swinger. If we assume that the horizontal position of the swinger is zero when the swing is at rest, then the variable on the vertical axis is her horizontal position from that center point. Her horizontal position is positive when she is to the right of that center point and negative when she is to the left of that center point.




Using your knowledge of trigonometry, the graph and a data table of the points, create a model of the form $y(t)=P\cos(Q(t+R))+S$ or $y(t)=P\sin(Q(t+R))+S$ for the horizontal position for the swinger as a function of time (t) in seconds.

Carefully explain how you arrive at each of the values for the constants P, Q, R and S.

Using technology, create a graph of the given data along with a graph of your model. Discuss the accuracy of your model. Include information about the physical problem as you discuss the accuracy of your model.

Compare the periods of the models you found in Parts I and II. Explain why the periods of the trigonometric models make sense in the context of the problem.

**Part III: Modeling the Motion of the Swinger Parametrically**

The goal for Part III of the lesson is for you to create a parametric model that gives the swinger's motion over time. You will use the work you did in Parts I and II.

Using a TI Calculator or some other parametric equation graphing tool, enter the horizontal position model into the x(t) function and the vertical position into the y(t). Carefully choose an appropriate window for the graph of the swinger's motion and create a graph of the swinger's motion.

Discuss the accuracy of your parametric model.

**Swing Lab Data Table**

A partial table that includes the time (in seconds) and the horizontal and vertical positions (in inches) of the swinger is given below.

| Time (sec) | Horizontal Position (in) | Vertical Position (in) |
|---|---|---|
| 0.0 | -65.0 | 108.8 |
| 0.2 | -63.6 | 100.4 |
| 0.4 | -54.3 | 75.0 |
| 0.6 | -35.7 | 51.1 |
| 0.8 | 1.3 | 37.7 |
| 1.0 | 38.1 | 53.9 |
| 1.2 | 58.3 | 84.4 |
| 1.4 | 63.9 | 107.6 |
| 1.6 | 65.6 | 115.1 |
| 1.8 | 64.6 | 106.7 |
| 2.0 | 56.9 | 79.5 |
| 2.2 | 33.2 | 47.4 |
| 2.4 | -8.5 | 37.7 |
| 2.6 | -38.3 | 53.5 |
| 2.8 | -59 | 85.4 |
| 3.0 | -65.0 | 107.4 |
| 3.2 | -65.8 | 114 |
| 3.4 | -63.4 | 99.9 |
| 3.6 | -55.2 | 77.6 |
| 3.8 | -30.1 | 46.9 |
| 4.0 | 10.2 | 38.7 |
| 4.2 | 44.9 | 60.3 |
| 4.4 | 60.4 | 92.6 |
| 4.6 | 64.9 | 111.6 |
| 4.8 | 65.8 | 118.4 |
| 5.0 | 64.4 | 105.1 |
| 5.2 | 54.3 | 75.3 |
| 5.4 | 27.4 | 44.3 |
| 5.6 | -6.9 | 38 |
| 5.8 | -43.5 | 59.3 |
| 6.0 | -60.1 | 90.5 |
| 6.2 | -64.8 | 109.3 |
| 6.4 | -65.3 | 114 |
| 6.6 | -63.4 | 101.3 |