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Discovering Sinusoidal Relationship

Wilson Burgos
The College at Brockport

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Name: Wilson Burgos

Grade level(s)/Subject taught: Secondary Mathematics

Objectives: Students will use Interactive Physics to:

- discover a sinusoidal relationship between variables in a real world problem.
- discover that changes in the initial velocity have an effect on the graph's period.
- discover that changes in the location of a fixed point along the radius of the circle have an effect on the graph's amplitude.
- compare data generated by the model graphically, on a table of values, and in an equation.
- make conjectures, predictions, and draw conclusions based on the data generated by the model.

Mathematical Concept or “key idea” that Interactive Physics will be used to teach:

Students use:

- concepts of trigonometry such as the period and amplitude of a sine curve.
- concepts of algebra to look at the three views of a function.
- concepts of modeling and multiple representation to display the data, make conjectures, make predictions, and draw conclusions.
- mathematical reasoning to analyze mathematical situations, make conjectures, gather evidence, and construct an argument.
- technology to apply the mathematics to real world situations.

Essential Questions: What type of function best represents the behavior being modeled? What changes do you observe as you as you make changes to the initial parameters in the model? How are these parameters (variables) represented on a graph, a table of values, and an equation?

Think about this: A bead is placed somewhere on the spoke of a bicycle wheel. What does the path of the bead look like as the bicycle is ridden at constant speed?

Students often think that the answer to this question is some type of looping motion because they think of a stationary bike rather than a moving bicycle. Class will begin with a warm-up activity in which we will discuss this question and review previously learned characteristics of graphs, tables, and equations. Then, I will teach students the basics they need to run the Interactive Physics model I have created.

The work time will proceed with students working in pairs in the computer lab to complete the problem below. As students work, I will monitor their progress by listening to their discussions, asking questions, and addressing misconceptions. At the end of class, students will present their findings to the rest of the class and explain how they came to their conclusion.

This activity would take several class periods if students had to perform all the calculations, make their tables, and graphs by hand for the numerous sets of data. Interactive Physics allows us to manipulate the initial parameters and analyze several “what if” scenarios without focusing on computation or graphing skills. Students are able to make conjectures and within minutes test the validity of their arguments.

Problem:

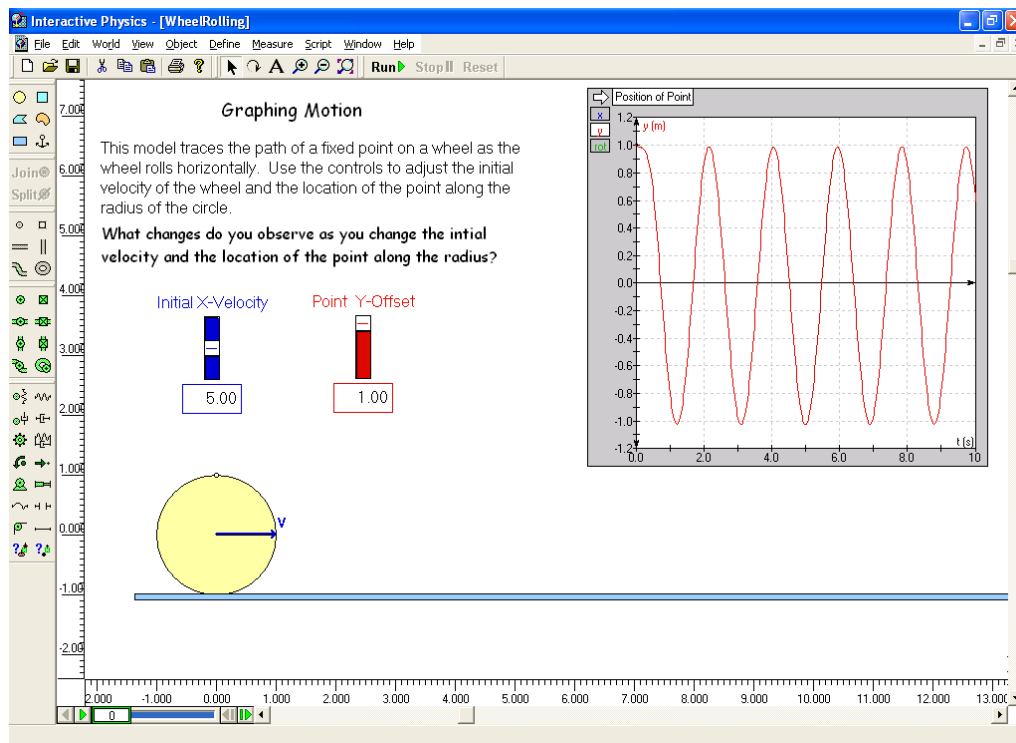
Part 1: Changing the parameters of the model

This model traces the path of a fixed point on a wheel as the wheel rolls horizontally. Use the controls to adjust the initial velocity of the wheel and the location of the point along the radius of the circle. First, leave the initial velocity constant as you change the location of the point. Then, leave the location of the point constant as you make changes to the initial velocity. What changes do you observe as you change the initial velocity and the location of the point along the radius?

Part 2: Three views of a function

When you run the program, the graph is automatically generated in the workspace. After running the program generate a table of values by exporting the data to an Excel worksheet. Using the TI Data Editor send the data to your graphing calculator and make a stat plot. Use your calculator to calculate the regression equation. How are the initial velocity and the location of the point represented on the graph, the table of values, and the equation?

Screenshot of Expected Student Work:



Rubric:

Category	1	2	3
Use of Interactive Physics Software	Did not use IP software to simulate the problem.	IP software was used to run the model but the data generated was not used effectively.	IP Software was used effectively to run the model and generate data.
Use of model to make conjectures	Conclusions are not consistent with the model and the evidence provided is irrelevant.	Conclusions may be inconsistent with the data generated by the model due to minor errors.	Able to describe the relationship between the changes made to the initial parameters and the data generated.
Accuracy of Results	Many flaws in calculations, data are not organized, or shows no understanding of the task.	Conclusions are inaccurate; data could be better organized, or shows partial understanding of the task.	Calculations are accurate, well organized, and demonstrates full understanding of the task.
Three views of a function	Does not show any understanding of the relationship between the model, its graph, the table of values, and the equation.	Partial understanding of the relationship between the model, its graph, the table of values, and the equation.	Fully understands the relationship between the model, its graph, the table of values, and the equation.