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Grade level(s)/Subject taught: Earth Science / Secondary Mathematics

Objectives: Students will use Interactive Physics and TI Interactive Software to:

- consider how gradient (slope) affects the velocity of an object rolling down an incline.
- make a table of values and a graph using the data generated by the model.
- calculate and compare the linear and quadratic regressions of the data generated by the model.
- consider the influence that a change in one variable has on another.
- make predictions and draw conclusions based on the data generated by the model.
- compare data generated by the model graphically, on a table of values, and in an equation.

Mathematical - Science Concepts or "key ideas" that modeling will be used to teach:

Students will:

- make a connection between gradient (Earth Science) and slope (math).
- use concepts of algebra to write and evaluate algebraic expressions, to look at the three views of a function, and to consider linear and quadratic relationships.
- use concepts of modeling and multiple representation to display the data, make predictions, and draw conclusions.
- use mathematical reasoning to analyze mathematical situations, make conjectures, gather evidence, and construct an argument.
- use technology to help manipulate parameters and apply the mathematics to real world situations.

Essential Questions: How does spacing of the contour lines on a topographical map affect the gradient? How does a change in gradient (slope) affect the velocity of an object rolling down an incline? What type of function can best model the relationship between slope and velocity?

Earth Science

In Earth Science, students have previously been taught the skills of using a topographic map to determine elevation from the contour lines, and measuring distance using the map scale. I will point out to the students that this is a map of a small island in the ocean (see attached map), so the first contour line would be 0 meters in elevation (sea level). The student's knowledge of these skills will be assessed with a bell work assignment that will have them measure the distance between points A and B, and the elevation at each point. Each student will have a copy of the map to work from, and I will walk around the room checking results. I will then use the overhead to go over the answers to make sure that everyone has the same values to begin with (there is an acceptable range of answers for the distance).

I will then introduce the concept of gradient by asking the students to find the formula for gradient in their Earth Science Reference Tables. The students work along with me as we calculate the gradient between points A and B, using the values that we found in the bell work assignment. I will emphasize that it is important to include the units in the equation, as well as the answer. The Interactive Physics program requires us to use the same units for the X and Y axis. This would not usually be the case with problems that the students would do in Regents Earth Science; the distance would usually be in either miles or kilometers, and the elevation would usually be in feet or meters. Since we will have to use the same units for elevation and distance, I will point out to the students that the units will not cancel out and need to be included in the answer (i.e. - m/m.).

After we complete the gradient calculations for A and B I will have the students calculate the gradient for A to C, B to C, and A to D. While the students are working I will circulate around the room checking results and helping anyone having difficulty. I will work out each problem on the overhead when I see that everyone has completed it.

I will relate gradient to slope and ask the students what they notice about the contour lines between A and B, and B and C. I will then have them compare the gradients to the distance between the contour lines, and point out that the closer the contour lines the steeper the gradient (more change over a small distance) and the further apart the contour lines the more gentle the gradient. I will then ask the students if their conclusions holds true for A to C and B to D. When the students have responded I will have them use the contour lines to predict which gradient is greater, D to E or E to C. The students will calculate the gradients to check their predictions.

Mathematics

The math lesson will begin with a warm-up activity in which students review the concept of slope. We will discuss the similarities between the term *gradient* used in Earth Science and the term *slope* used in math class. Then, I will teach students the basics that they need to run the Interactive Physics model and make the necessary changes to the parameters. I will also teach students how to make a table of values and a graph using the TI Interactive Software. After gathering and displaying the data students will also calculate linear and quadratic regressions and decide which one best fits the data generated by the model.

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.

The model makes the concepts come to life as it would be impossible to actually conduct this experiment in the real world. Furthermore, the software packages make the activity time efficient, making it easy to quickly run the experiment, gather the data, and display the results. As a result, more time can be spent on discussing the results and their implications. Students are able to make conjectures and within minutes test the validity of their arguments. The model provides a dynamic method allowing students to better understand the link between the science and mathematics concepts being studied.

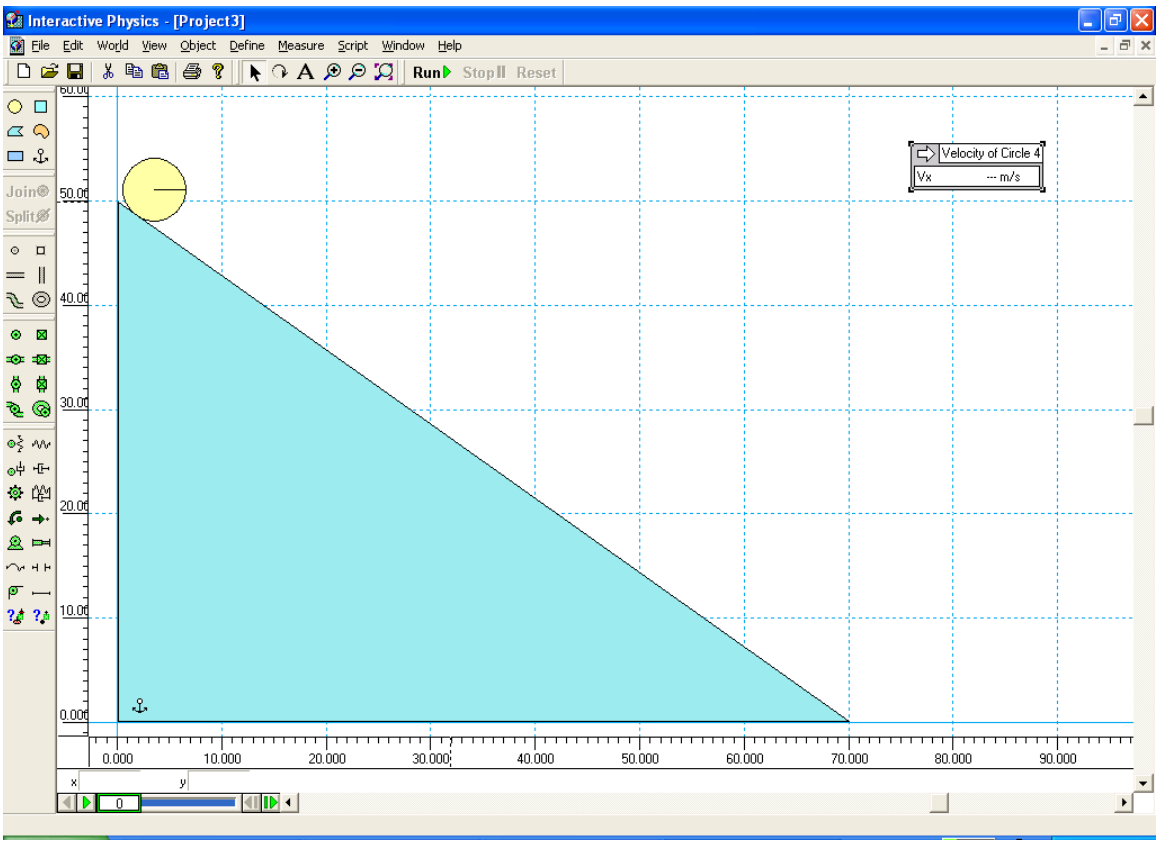
Problem:

1. Using Interactive Physics students will change the horizontal and vertical lengths of an incline to model different distances and elevations. Using the model, students will roll an object down the incline. The model is setup to calculate the velocity of the object and automatically pause after 4 seconds.

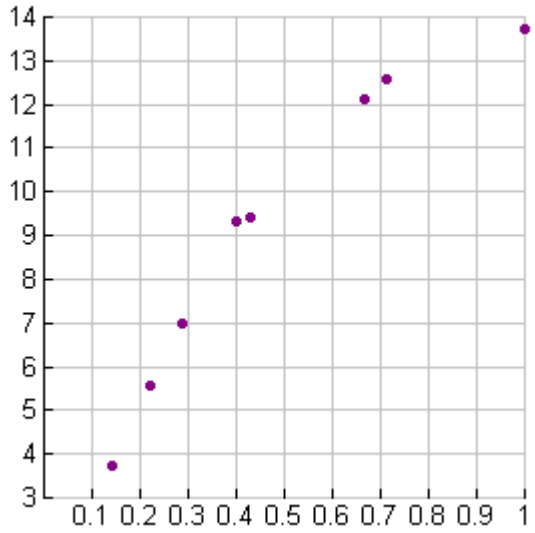
2. Using Texas Instrument's Interactive Software, students will construct a table of values with four columns: distance, elevation, slope, and velocity. They will construct a scatter plot of the data and calculate linear and quadratic regressions.

3. Students will use the graph and table of values to determine the relationship between slope and velocity. They will discuss which of the regressions best models this relationship and present their findings to others.

Screenshots of expected student work:



Distance	Elevation	Slope	Velocity
70	10	.14	3.742
70	30	.43	9.42
70	50	.71	12.592
70	70	1.00	13.729
30	20	.67	12.139
50	20	.40	9.328
70	20	.29	6.995
90	20	.22	5.572



Earth Science Rubric:

Category	Strong	Capable	Developing
Conceptual Understanding	Demonstrates in depth understanding of concept.	Demonstrates a general understanding of the concept.	Demonstrates limited or no understanding of the concept.
Interprets Results	Uses inferences/interpretations to answer the question posed and verify the solution.	Uses limited inferences/interpretations to answer the question posed and verify the solution.	Is unable to interpret results or obtain the correct solution.
Communication	Communicates the process effectively and clearly.	Communicates a partial explanation of the process or needs prodding to answer questions.	Communicates a limited explanation of the process or is unable to communicate the process.

Mathematics 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 TI Interactive Software	Did not use the Ti Interactive software to generate a table and graph.	Software was used but the data was not displayed effectively.	Software was used effectively to generate a table and a graph.
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 resulting measurements.
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.
Application of mathematics and science concepts and understanding of their relatedness.	Does not show any understanding of the relationship between the model and the math or science concept being studied.	Partial understanding of the concepts and the implications of the activity.	Fully understands the concepts, is able to make generalizations, and can apply the results of the activity.

Map used in Earth Science class: