Instantaneous Rate

Description: Students learn about instantaneous rates and derivatives by investigating the rate of change of a door's angle as it closes. They look at the graph of the angle as a function of time, calculate the average rate of change between two points on the graph, make the time difference between the points smaller and smaller, and discover that the average rate (the slope of the secant) approaches a limiting value: the derivative.

Technology Strength: By adjusting a slider to make the separation between two points (times) incredibly small, students can approximate the instantaneous rate of change at a point or the slope of the tangent at that point and make a connection between these two concepts.

Objectives: Make a connection between the instantaneous rate of change at a point and the slope of the tangent to the graph at that point; see the instantaneous rate as a limit of the slope between two points

Prerequisites: Familiarity with finding slope given two points on a graph

Suggested Grade Level: 11 to 12

Sketchpad Level: Beginning

Suggested Duration: 30 minutes

Suggested Classroom Setting: Whole Class, Student Pairs. This activity, designed for use by student pairs, can be easily modified for whole-class use.

Preparation: Review the Activity Notes. Preview the student sketch. Work through the steps on the worksheet and make a copy of the worksheet for each student.

Materials: None

Student Worksheet(s): Instantaneous Rate

Student Sketch: Instantaneous Rate.gsp

Presentation Sketch: None

Vocabulary: Increasing, decreasing, rate of change, average rate of change, instantaneous rate of change, derivative, tangent, limit

Sketchpad Version: GSP5

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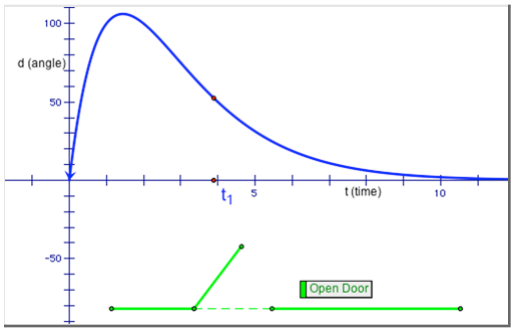
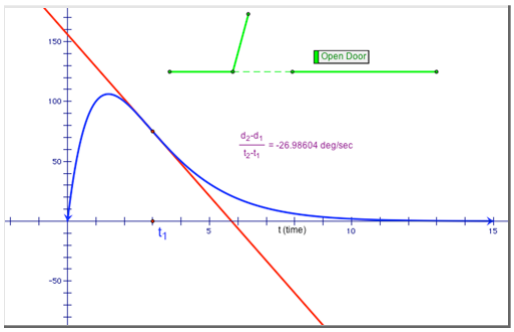
Using the Sketch:

In this sketch, students investigate the rate of change of a door's angle by first dragging a point along the time axis and observing how the angle of the door changes. They then look at the door's position at two different times and use the calculator to compute the average rate of change between the two points. They adjust a slider that controls the separation between the two times and observe the connection between this average rate and the slope of a given secant line through these two points.



Students investigate further by pressing a series of action buttons that enable the separation to become incredibly small and by tabulating the values of the average rate. Students discover in their table that as the separation between the two points gets smaller and smaller, the average rate and secant slope approach a limiting value. Students approximate this instantaneous rate and make a connection between this rate and the slope of the tangent line to the graph at that point.



Sketch Tips:

Sketch Tips show skills needed in this activity, and the step at which the skill is first used.

Sketch Tip	**Tip Sheet or Tip Video**
Step 5: Calculate an expression using **Number | Calculate**	Using the Calculator
Step 5: Click a value in the sketch to enter it into the Calculator	Using the Calculator
Step 8: Add a row to a table by double-clicking with the **Arrow** tool	Working with Tables

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