

# How Steep is Enough?

**Ratio  
Percent  
Slope  
Average  
Linear Equations  
Measurement**

Pike's Peak, Colorado has some very steep sections. There is a ranger check point about half way down the hill where each vehicle's brakes are checked for heat. If the brakes are too hot, the driver is asked to park the car for an hour so the brakes can cool before continuing the descent. If a driver elects to disregard the directive, the vehicle's license plate number is recorded. If there is an accident, the driver may not sue since that driver did not heed the advice given.

**Standards:** Problem Solving, Communication, Reasoning, Connections, Algebra, Statistics, and Geometry

**Materials:** fx-7400G, 1/72 and 1/30 scale toy cars of different shape, meter stick, long board, and a table

**Calculator Use:** RUN and GRAPH Menus, V-WINDOW

A 3% grade means a road rises 3 feet for every 100 feet it runs as shown in Figure 1.

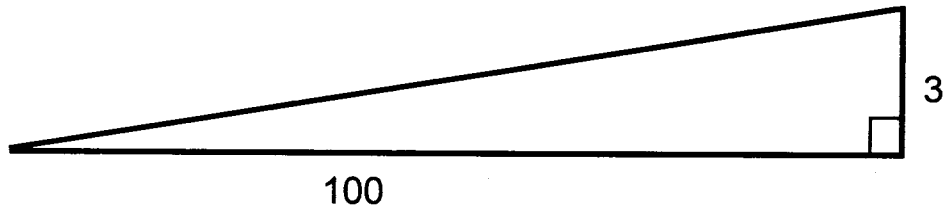


Figure 1

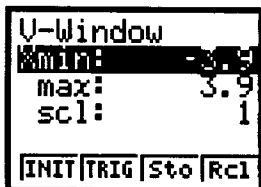
Perhaps you have seen "Runaway Ramps" on roads. They are there for safety when a vehicle loses braking power while descending a hill.

Highways have a recommended maximum grade. Why do you suppose that is? **A.**

Why would some roads exceed the maximum indicated grade? **B.**

## How to Set the Graph View Window

While in the GRAPH or STAT Menu:  
 Press SHIFT key.  
 F3 (V-WIN) reveals the screen below.



To change the graph window ranges:  
 Highlight Xmin or Xmax,  
 Press the desired min of max x for the x-axis.  
 Use your down arrow key to locate Ymin or Ymax.  
 scl is the distance between tick marks on the axis.

Pressing F1 (INIT) will reset the fx-7400G to the proper pixel settings for a rectangular screen. The screen is not square, so it is best not give the calculator the same X and Y values.

Place a meter stick perpendicular to a table top, one meter from the edge of the table. Place a board (longer than a meter) so it touches the meter stick and hangs over the edge of the table at the point a meter from the meter stick. See Figure 2.

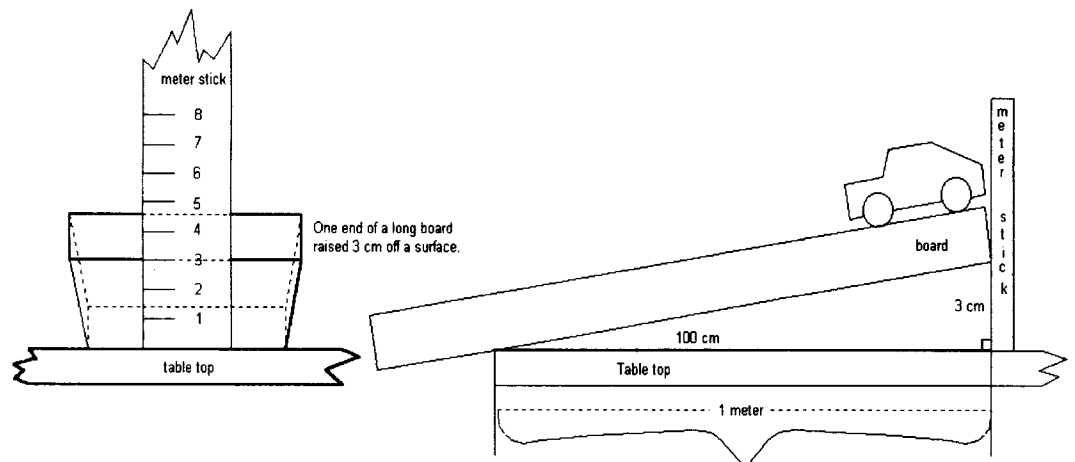
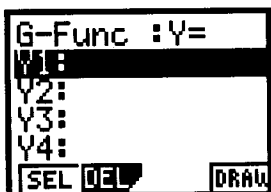


Figure 2

# How Steep is Enough?

## How to Graph Equations

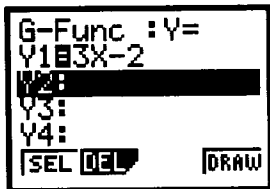
Enter the GRAPH Menu. The G-Func screen is shown below.



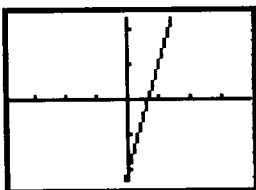
While Y1 is highlighted:

- Press 3
- X,T key
- key
- 2
- EXE (stores the equation)

Please remember that X is the X,T key directly below the red Alpha key. You cannot use your multiplication key for X. Your screen should be similar to the one below.



Press F4 (DRAW). The resulting graph is shown below.



Place one of the toy cars at the end of the board that is being raised, pointing the car along a path that is parallel to the edge, and approximately centered on the board. See Figure 2.

Slowly raise the board. Stop raising the board when the car starts to move. Record the height in Table 1.

Repeat the activity with different cars. Are the results always the same? Why or why not? **C.**

Complete each cell in the table.

What is the average in each column? **D.** \_\_\_\_\_

Car	Height in cm	% Grade	Rise Run	Slope
1935 Ford	7	7%	$\frac{7}{100}$	0.07

The "steepness" of a line is measured in a manner similar to what has been done here. The steepness is expressed as a ratio of rise over run which is called the *SLOPE*. The slope is used as lines are graphed.

In the Graph menu, enter the different slopes you computed and graph all those lines using 0 as the y-intercept. The above example would be  $Y = 0.07X + 0$  or  $Y = 0.07X$ . The appropriate equation is entered in Figure 3 below.

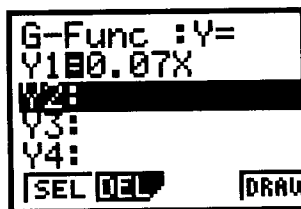


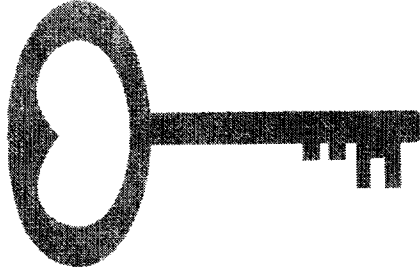
Figure 3

Adjust the view window so you are presenting an accurate picture of the slope. What can you conclude about the graphs? **E.**

When do you think the slope is steep enough to require run away ramps? **F.**

What slope prompts the Department of Transportation to build run away ramps on an Interstate Highway? **G.** \_\_\_\_\_

# Solution Key



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## How Steep is Enough

- A.** Answers will vary: safety, ability to travel at reasonable speeds
- B.** Answers will vary: terrain too steep, unable to build tunnels, scenic route
- C.** Answers will vary **D.** Answers will vary
- E.** Answers will vary: all straight, all pass through same point, bigger number gives steeper slope, like cut away side view of road
- F.** Answers will vary **G.** Answers will vary