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Algebra in Full Color & High Resolution with the New TI84C

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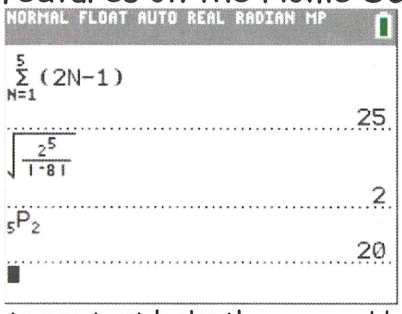
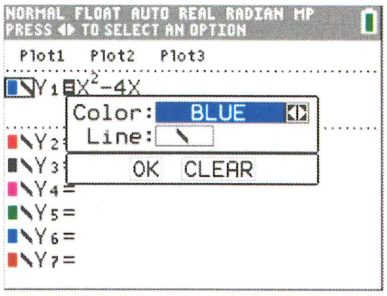
New features on the Home Screen



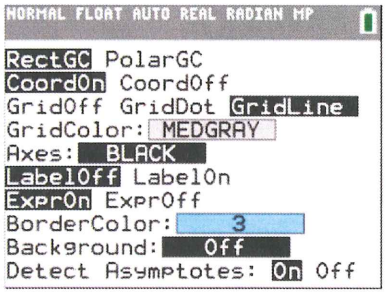
- Templates so text looks the way you'd write it!
- Mode settings at top of screen
- Separator lines between each execution

More GraphStyles

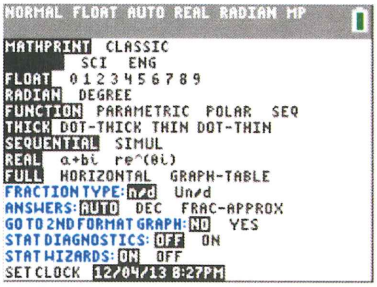


- Default setting is now a bold line

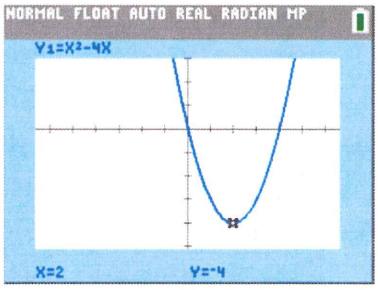
Many new Format Settings



Additions to MODE menu

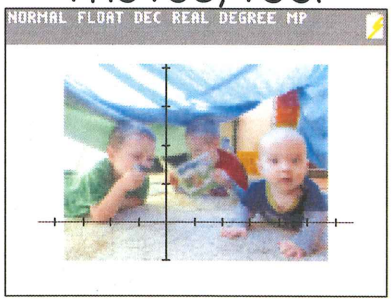


Graph Screen



- Gridlines easier to use
- Equation and trace values are off the graph
- Much higher resolution:
- graph screen now 265 by 165 pixels
  older 83 & 84 is 95 by 63 pixels
  see "ZOOM Decimal"

PHOTOS, TOO!



So photos are cool. But how does this improve my math class?

No More Batteries!

Plugs into any USB port such as your computer, wall adapter, or car adapter.

Battery strength indicator in top right of all screensln

USE ALGEBRA AND GEOMETRY TO ANALYZE PHOTOGRAPHS
USE PHOTOGRAPHS TO LEARN ALGEBRA AND GEOMETRY

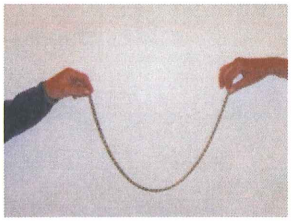
CCSS Mathematical Practice Standards
#4: Model with Mathematics
#5: Use Appropriate Tools Strategically
#7 Look For and Make Use of Structure.

How steep is a 7% grade? How close to 7% is the slope of the road in that warning sign?

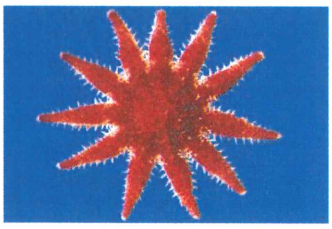
How steep is the wheelchair ramp up to Founder's Hall?

How close does the shape of a hanging chain resemble a parabola? Which form will you choose and why?

Standard form: $y=ax^2+bx+c$
Vertex form: $y=a(x-h)^2+k$
Factored form: $y=a(x-r_1)(x-r_2)$



Why wait until calculus to learn about (and teach) polar graphing? Using only elementary geometry, model these seastars with your 84c.



Use images provided by TI or images you find yourself. It's easy to insert any image as the background for a TI84C graph screen. Just drag the image file into the Device Explorer window of TI-Connect software. (see attached page for details)

USE COLOR AND QUICKPLOT TO ANALYZE QUADRATIC FUNCTIONS

What can you say about *a, b, c,* and *the discriminant,* b^2-4ac, for each of the following graphs of: $y=ax^2+bx+c$?

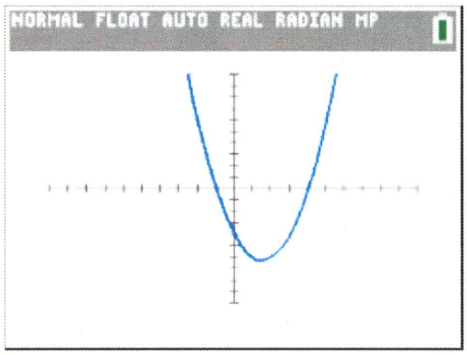


Figure 1

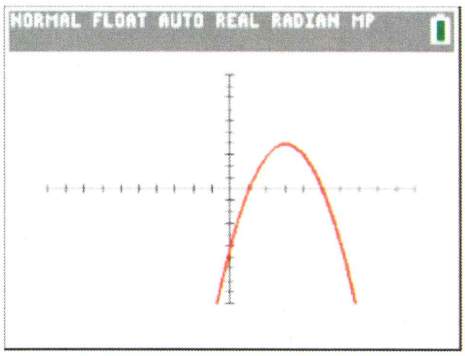


figure 2

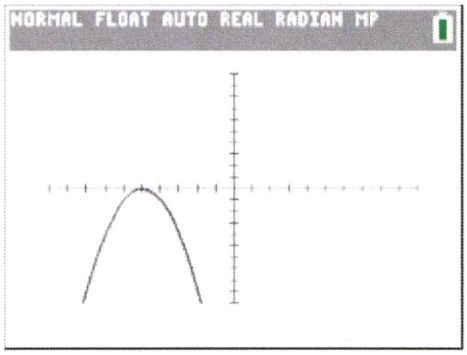


Figure 3

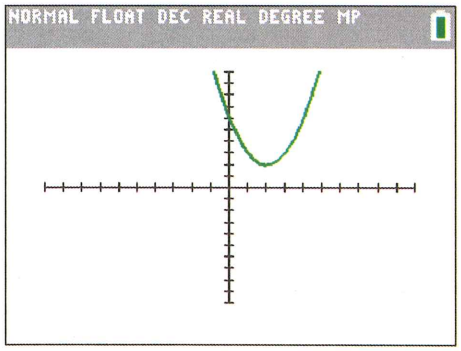


figure 4

When asked how *a, c,* and b^2-4ac impact the graph, of a parabola, most teachers are able to present this clearly, but b is less obvious. The beauty of GC technology is we can look at several transformations simultaneously. The 84C makes it even easier to see because each transformation is in a sharp, easily distinguished color.

- Reset your 84C to default settings.
- Graph $y1=x^2-4x$ in the Standard Window. Review how (and why) we might prefer viewing this in the ZoomDec window.
- Add $y2=x^2-2x$, $y3=x^2$, $y4=x^2+2x$, and $y5=x^2+4x$.
- Observe how changing b causes a translation of the graph that appears to be a parabolic path.
- Verify that it is, in fact, a parabola. Use QuickPlot to grab the coordinates of the vertices of each graph. Then find an equation (perhaps using QuadRegression) that fits all the vertices.

How Steep Is A 7% Grade?

Student Activity

Name _____

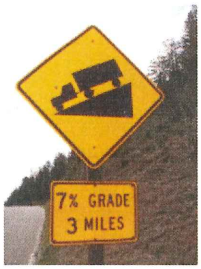
Class _____

Objectives

- See how slope is applied in the real world
- Connect gradient (as percentage) with slope (as rise/run)
- Graph Linear Functions
- Transform y=x with rotations and shifts
- Connect transformations with m and b in y=mx+b
- Use Background Image (with 84C)

Materials

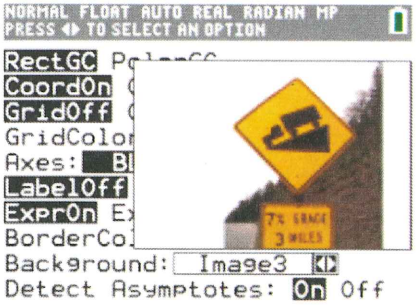
- TI-84 Plus, or
- TI-84 Plus C
- Metric ruler



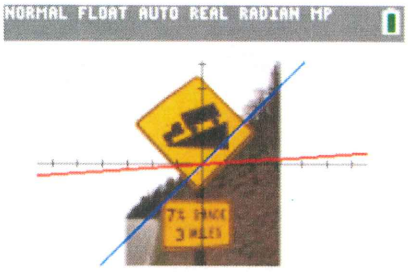
1. What does the warning sign in the figure above mean? How steep is a 7% grade?

2. The truck pictured on the warning sign sits on a "road" that is the hypotenuse of a right triangle. Do you think the slope of the hypotenuse is actually 7%? If not, then estimate the slope.

3. Set up your TI-84PlusC. If not already done, load the background image onto your calculator. Go to the FORMAT menu and scroll through the background images until the image is located (as seen at right). Note: It might be stored as any image from Image0 to Image9.



4. Go to the Y= menu and enter Y1=X. Go to the ZOOM menu and select 4:ZDecimal. You should have the graph seen at the right. The line Y=X has a slope of 100%. Enter an equation in Y2 that has a slope of 7%. If entered correctly, your screen will match the image at right. (If using a TI-84plus, you should have the 2 lines, but not the image.).



5. 100% is steeper than the "slope" pictured in the sign. 7% is not steep enough. Use trial and error to graph a line that appears parallel to the "road" in the sign. How steep is this "road"?

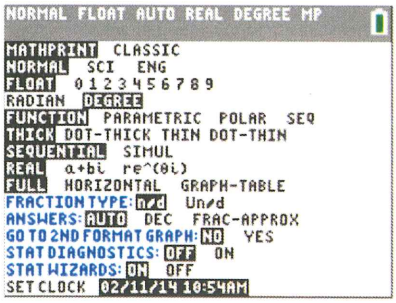
6. Compare the result from part 5 above with the actual highway sign in the photograph at the beginning of this activity. Use a metric ruler to measure the legs of the right triangle in millimeters. Make the comparison easier by converting this ratio (rise/run) to a percent.

7. Your line from part 5 appears parallel to the road (hypotenuse) under the truck. (see figure at right) It would be easier to confirm if the line is parallel if you raise it so it coincides with the road. How must you modify the equation to raise the line? If necessary, adjust the slope so the line "fits" the road better. What is your new equation?

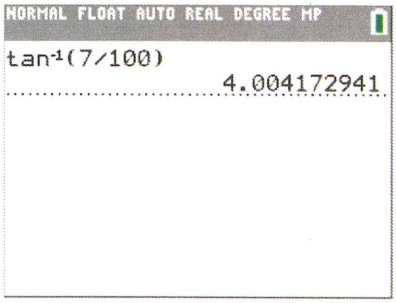
8. Compared with the slope of the "road" in the warning sign, a 7% grade does not appear very steep. How steep is 7% in degrees? (We're looking at the angle whose vertex is at the origin, and one ray is the positive x-axis, and the other ray is the line with the 7% slope)
   Estimate the slopes (in degrees) of both of the "roads".

   7% GRADE = $\frac{7}{100}$ slope = _____ degrees

   "Road" in Sign = _____ slope = _____degrees



Trigonometry is the study of ratios of the sides of right triangles. The angle of elevation of these 2 lines can be found by calculating the inverse of the tangent of the slopes. Be sure your calculator is in Degree MODE. Press [MODE]. Then arrow down and right to highlight DEGREE. Press [ENTER] to select DEGREE. Then press [2nd] [QUIT] to return to the HOME screen. Calculate the degrees of the 7% slope by pressing [2nd] [TAN⁻¹] [.] [0] [7] [)] [ENTER]. Repeat these steps to calculate the angle of elevation of the "road" in the warning sign. (The figures at right show the MODE menu with DEGREE selected and the HOME screen with the inverse tangent of 7%.



9. Calculate the slopes (in degrees) of both of the "roads":

   7% GRADE = $^{7}/_{100}$ slope = about 4 degrees

   Steepness of "Road" in Sign = _____ slope = degrees

   Four degrees may not seem very steep. But ask a truck driver if that's a steep hill, or even better, try riding your bicycle up a hill that's rated 7% for 3 miles. It's steeper than it seems!

10 Here's another way to think about the steepness of the hill. The sign says the hill is 3 miles long. What's the total change in elevation?

Activity Overview

Make a real-world connection between the gradient on a highway sign with the slope of a line. Use transformations of y=x to determine the slope of the "road" (hypotenuse of a triangle) on a highway sign. If using a TI-84plusC, this is done with background images on the graph screen.

Materials

- TI-84 Plus or TI-84 Plus C Graphing Calculator
- Photo of highway warning sign saved as Background Image (for TI-84plusC)
- Metric Ruler

Middle school students may or may not be familiar with the slope-intercept form ($y = mx + b$) of linear equations. This activity has students "build" a linear equation which (ideally) will have them discover the effect of *m* and *b* on the graph of a line.

Before starting this activity, if using the TI-84plusC, load the background image of the highway warning sign onto each handheld unit. (See Getting Started with TI-Connect and Let's Talk in the Appendix for instructions on loading Background Images). It does not matter which image number is used for storing. The provided image is stored as image3, but this can be changed using TI-Connect software. If the student calculators are TI-84plus (non color), then refer to the first figure in the Student Activity when asking the following questions.

1. How steep is a 7% grade? (note: most people will answer this by saying the steepness, or slope, is 7%). Steer the discussion to help students understand that by converting the percent to a fraction, then the slope definition of rise/run, or 7/100 will be more obvious.

2. The truck pictured on the warning sign sits on the hypotenuse of a right triangle. Do you think the slope of the hypotenuse is actually 7%? If not, then estimate the slope.

3-5 If using a TI-84plusC, estimating can be done visually by graphing linear equations until the graph appears to be parallel to the hypotenuse of the triangle on the warning sign.

If using a TI-84plus, estimating can be done directly with the photograph at the beginning of the student activity.

6. Have students confirm their estimates by actually measuring the legs of the right triangle in the warning sign in the photograph at the start of their worksheet. Use millimeters, then convert the resulting ratio (rise/run) to a percent.

7. Their line might appear parallel, but it's difficult to confirm. It would be easier to tell if the line could be shifted vertically so it actually coincides with the "road" in the warning sign. Ask students how to change the equation so it can be raised upwards. Have them use trial and error to determine the amount of the shift.

   There may be slight variations in their equations. This is expected due to the thickness of the lines and the resolution of the screen. The graph of the equation seen in the screenshot in the student activity has the equation $y = .41x + 1.2$

8-9 While most middle school students have not yet studied trigonometry, this is a good opportunity to look ahead and discuss how trigonometry, the study of ratios of sides of right triangles, can help us convert slope (as percents or fractions) into an angle of elevation measured in degrees. The TI-84plus and TI-84plusC have built in Trig functions. The tangent function calculates the ratio of the side opposite the angle of elevation to the side adjacent to the angle (rise/run). So, since we have the rise/run, we use the inverse tangent to find the measure of the angle of elevation.
Part 8 of the student activity asks the student to estimate the number of degrees of each slope. Part 9 has the students calculate each angle measure using the Inverse Tangent function on their TI-84.

10 Lead students to interpret this mathematical answer for the driver on the highway. About every 100 feet the driver moves along the road, the elevation drops 7 feet. To be more precise, the 100 feet is a horizontal change. Using the Pythagorean Theorem: $7^2 + 100^2 = 10049$. $\sqrt{10049} \approx 100.25$ feet, so for every 100.25 feet of travel, the elevation drops 7 feet. For estimating distances and elevation changes, 100 feet is close enough.

The sign says the hill is 3 miles long. 3 miles is 15840 feet. $15840ft \times \frac{7ft}{100ft} = 1109ft.$

So, the hill drops about 1100 feet in elevation from top to bottom.

Extension

Find photographs on the Internet and/or take your own photographs that include straight lines and load onto the TI-84plusC as background images. Even better, have students take photographs. When loaded as background images, use transformations of linear functions to find equations in $y = mx + b$ form. Student motivation is increased when the images have meaning to them. Assign tasks such as finding out how steep the roof of their house or school might be (carpenters call this pitch), or how steep is a wheelchair ramp. Encourage creativity!!