Getting Started with TI-Nspire™ Technology in Connecting Science and Mathematics

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Conversion – Direct or Inverse Variation?

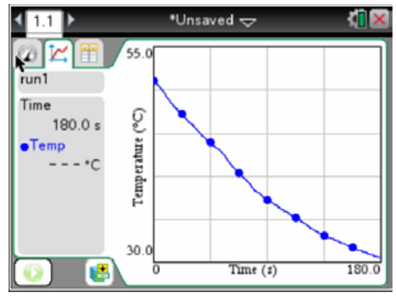
Student Activity

Name ______________

Class ______________

In this activity you will examine the relationship between ounces and grams. By mathematically modeling the relationship with a linear equation, you will relate each of the parameters in the equation to a physical quantity.

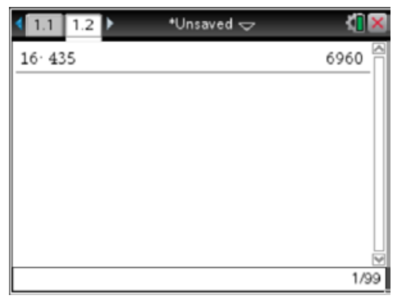
In the second part of the activity, you will collect and analyze temperature data and draw conclusions about cooling objects.



Open a New Document and Add a Notes Page

1. Title the page “Conversion”.
2. Find five boxes (or box labels) with weight identified in both grams and ounces. Organize them from smallest to largest.

Add a Calculator Page

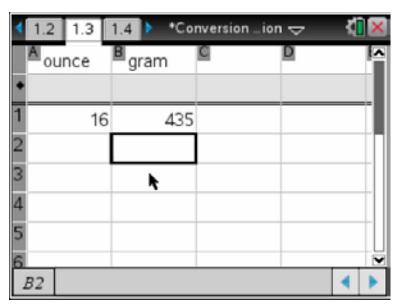


3. Compare the grams to ounces on the box labels. Do the grams and ounces appear to be directly related or inversely related?

4. Calculate the product of ounces and grams for each box label. Does a consistent pattern occur when the two are multiplied together?

5. Calculate the quotient of grams divided by ounces for each box label. Does a consistent patter appear?

Add a Lists & Spreadsheet Page



6. Enter the data from the box labels into the spreadsheet.
   - Label Column A **ounce**, and enter the label values in ounces.
   - Label Column B **gram**, and enter the label values in grams.
   - Label Column C **prod** for product. In the diamond cell ♦, type **=ounces*grams** and press enter.
   - Label Column D **quo** for quotient. In the diamond cell ♦, type **= grams/ounces** and press enter.

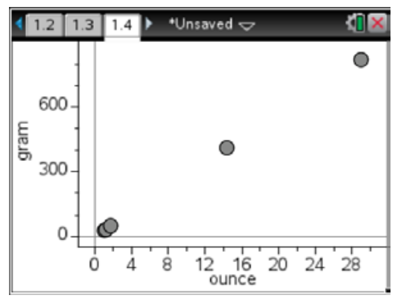
Analysis

7. Do you see any consistent trend in the data that is produced?

8. Do you believe the product or the quotient is most constant?

9. Does this mean that the grams and ounces are directly or inversely related?

Add a Data & Statistics Page



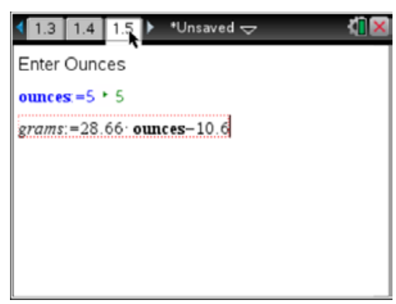
10. Place ounces on the *x*-axis and grams on the *y*-axis.
11. Determine the best fit line for this set of data by selecting **Menu > Analyze > Regression > Show Linear (mx+b)**.
12. What equation do you get when you perform the linear regression?

13. In the graph, *x* represents __________________ and *y* represents __________________.

14. How does the slope of the line compare to the values in the spreadsheet on page 1.3?

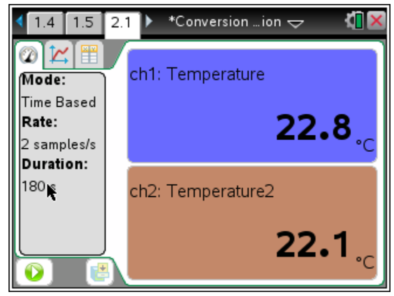
15. What are the units for the slope?

Add a Notes Page



16. Type "**Enter Ounces**".
    - Insert a Math Box by selecting **Menu > Insert > Math Box**.
    - Type **ounces:=5** and press enter.
17. Insert a second Math Box, and enter the equation that you received from the prior page.
    - Change *y* to grams and *x* to ounces: **Grams:= m*ounces + b**.
    - Enter the values of *m* and *b* from the equation you generated on the prior page.
18. Change the value of the ounces, and observe the result of grams.
19. Create a "grams to ounces" calculator. The variable **grams** is already used, so use the variable **grams2** for grams and **ounces2** for ounces.

Add a New Problem to Compare Fahrenheit to Celsius



20. Select [doc▾] **> Insert > Problem**. The tab at the top of the screen should indicate that this is page 2.1.
21. Connect two Vernier® EasyTemp™ sensors to the TI-Nspire™ Lab Cradle. Slide the handheld onto the TI-Nspire Lab Cradle.
22. Wait for a moment for the Vernier DataQuest™ application to launch. If it does not launch, select **Add Vernier DataQuest**.
    - To set up the Vernier DataQuest app, think of variables that are being measured and how they are being measured.
23. Two temperature readings should appear in the **Meter View**.
    - Change the units on temperature probe 2 to Fahrenheit by selecting **Menu > Experiment > Set Up Sensors > Change Units**.
    - Selecting **Menu > Experiment > Collection Setup**. Set the **Mode** to Time graph for 5 samples per second for 30 seconds.
    - Place both temperature probes in hot water and allow them to equilibrate to the water.
    - Click on the Start button, and move both probes to ice water.
24. What happened to both temperature readings?

25. Do you believe the temperatures are directly or inversely related? Explain your answer.

Add a Data & Statistics Page

26. Add **run1.tempemperature** (Celsius) to the *x*-axis and **run1.temperature2** (Fahrenheit) to the *y*-axis.
27. Determine the equation that best fits your data. Select **Menu > Analyze > Regression > Show Linear (mx+b).** What does this equation represent?

28. Create an equation for converting from Fahrenheit to Celsius.

Add a Notes Page

29. Create a Celsius to Fahrenheit converter and a Fahrenheit to Celsius converter.

Conversion – Direct or Inverse Variation?
Student Activity

Name ______________

Class ______________

Wrap Up

1. List three things that you learned by completing this activity.

2. What do you see as the greatest strength for your classes in this activity?

3. How could this activity help you to introduce your students to TI-Nspire™ Technology?

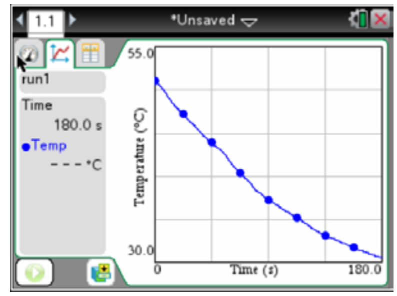
Conversion – Direct or Inverse Variation?

TEACHER NOTES

TI PROFESSIONAL DEVELOPMENT

Math and Science Objectives

- Students will first predict and then examine the relationship between ounces and grams.
- Students will mathematically model the relationship with the linear equation in the form $y = mx+b$
- Students will relate each of the parameters in the equation to a physical quantity.
- Students will draw conclusions about cooling objects and make predictions about how changes in the data collection will affect the results.
- Students will use appropriate tools strategically (NGSS).



TI-Nspire™ Technology Skills:

- Collect temperature data with the Vernier® DataQuest™ app

Tech and Troubleshooting Tips:

1. The temperature sensor can be heated using hot water or a hair dryer. If students use the hot water, they should wipe the sensor immediately after removing it from the water so that evaporation is not a factor in the cooling. The hair dryer simply requires heating the sensor and collecting data once the dryer is turned off.
2. As the temperature sensor cools, check to see that fans or air conditioners are not blowing directly on the sensor.

Lesson Files:

Student Activity

- *Conversion_Direct_or_ Inverse_Variation_Student.pdf*
- Conversion_Direct_or_ Inverse_Variation_Student.pdf

Vocabulary

- ounces
- grams
- conversion factor

About the Lesson

- Making predictions prior to the exploration is an important step in helping students to connect real world phenomena to mathematics.
- As a result, students will:
  - Organize the boxes in order from smallest ounces to largest ounces.
  - Analyze the relationship simply as products and quotients, as a list of numbers, and as a graph.
  - Develop a conceptual understanding of the relationships between different measures.
  - Make a real-world connection about linear functions and their use as a conversion equation.

Materials and Materials Notes

- TI-Nspire™ handheld or TI-Nspire™ computer software
- TI-Nspire™ Lab Cradle and two Vernier® EasyTemp™ probes
- Five box labels with ounces and grams given.
- Cup of hot water with a temperature probe.

Discussion Points and Possible Answers

Tech Tip: Using the TI-Nspire™ Lab Cradle with the standard temperature sensor requires a USB cable to connect to the teacher computer. If you do not have the adapter, you might want to collect data with the student handheld and transfer it to the computer using TI-Nspire™ Navigator™ System or Teacher Software.

Teacher Tip: Making predictions is very important to helping students to connect the physical world to the mathematical world. Ask students to make a prediction prior to analyzing the data and then to sketch it. You might then want to ask them to compare their predictions to those of other students in the class as you walk around and look at the sketches. Once the data is collected, come back to those predictions and discuss any errors.

Open a New Document and Add a Notes Page

1. Title the page “Conversion”.
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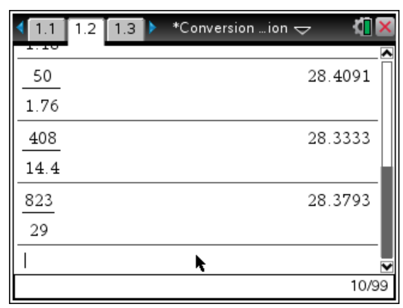
Add a Calculator Page



3. Compare the grams to ounces on the box labels. Do the grams and ounces appear to be directly related or inversely related?

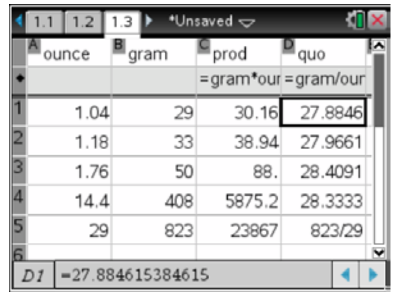
   Answer: Grams and ounces appear to be directly related.

4. Calculate the product of ounces and grams for each box label. Does a consistent pattern occur when the two are multiplied together?

   Sample Answer: As the grams and ounces increase, their product increases.

5. Calculate the quotient of grams divided by ounces for each box label. Does a consistent patter appear?

   Sample Answer: Each quotient is approximately 28.



Add a Lists & Spreadsheet Page

6. Enter the data from the box labels into the spreadsheet.
   - Label Column A **ounce**, and enter the label values in ounces.
   - Label Column B **gram**, and enter the label values in grams.
   - Label Column C **prod** for product. In the diamond cell ♦, type **=ounces*grams** and press enter.

     Label Column D **quo** for quotient. In the diamond cell ♦, type **= grams/ounces** and press enter.

> **Tech Tip:** Column labels must be typed into the cells at the top of each column (labeled A-D, respectively).

Analysis

7. Do you see any consistent trend in the data that is produced?

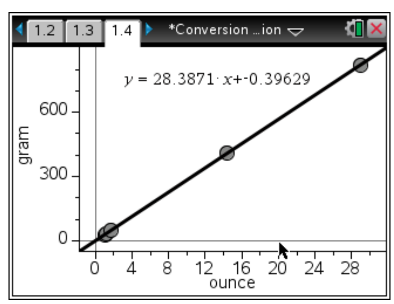
   Sample Answer: As the grams and ounces increase, their product increases. Each quotient is approximately 28.

8. Do you believe the product or the quotient is most constant?

   Answer: The quotient is most constant.

9. Does this mean that the grams and ounces are directly or inversely related?

   Answer: When one quantity increases, the other quantity also increases (and vice versa). Therefore, grams and ounces are directly related



Add a Data & Statistics Page

10. Place ounces on the x-axis and grams on the y-axis.
11. Determine the best fit line for this set of data by selecting **Menu > Analyze > Regression > Show Linear (mx+b)**.
12. What equation do you get when you perform the linear regression?

    Sample Answer: $y = 28.3871x - 0.39629$

13. In the graph, x represents ____ounces_____ and y represents____grams_____ .

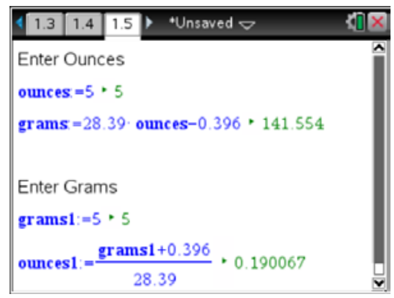
14. How does the slope of the line compare to the values in the spreadsheet on page 1.3?

    Sample Answer: The slope of the line is approximately the same as the quotient of grams divided by ounces (in Column D).

15. What are the units for the slope?

    Answer: The units for slope are grams/ounce.

Add a Notes Page



16. Type "**Enter Ounces**".
    - Insert a Math Box by selecting **Menu > Insert > Math Box**.
    - Type **ounces:=5** and press [enter].

    Tech Tip: A Math Box can also be inserted by pressing [ctrl] [M].

17. Insert a second Math Box, and enter the equation that you received from the prior page.
    - Change *y* to grams and *x* to ounces: **Grams:= m*ounces + b**.
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19. Create a "grams to ounces" calculator. The variable **grams** is already used, so use the variable **grams2** for grams and **ounces2** for ounces.

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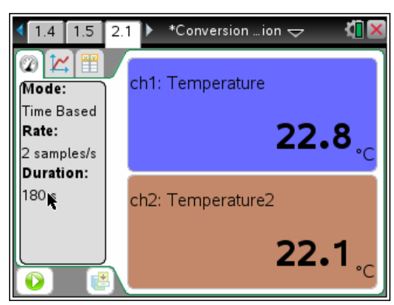
22. Wait for a moment for the Vernier DataQuest™ application to launch. If it does not launch, select **Add Vernier DataQuest**.
    - To set up the Vernier DataQuest app, think of variables that are being measured and how they are being measured.

    Tech Tip: Some settings can be changed using the Context menu. To access the context menu, click in the region whose settings you want to change, and press [ctrl] [menu].



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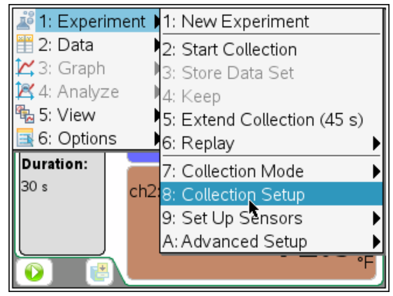
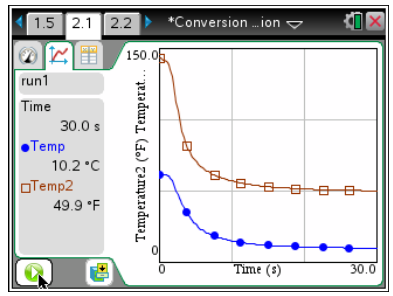


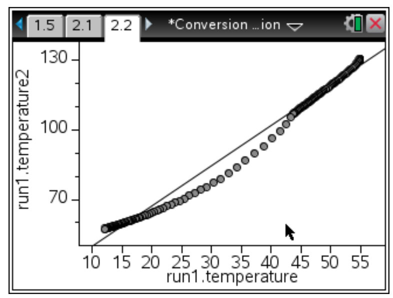
24. What happens to both temperature readings?

    <u>**Sample Answer:**</u> Both temperatures begin to increase.



25. Do you believe the temperatures are directly or inversely related? Explain your answer.

    <u>**Sample Answer:**</u> The plot is directly proportional which means as the Celsius temperature increases, so does the Fahrenheit.



Add a Data & Statistics Page

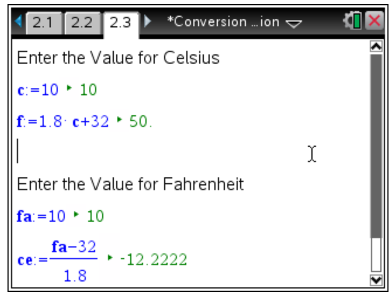
26. Add **run1.tempemperature** (Celsius) to the *x*-axis and **run1.temperature2** (Fahrenheit) to the *y*-axis.
27. Determine the equation that best fits your data. Select **Menu > Analyze > Regression > Show Linear (mx+b).** What does this equation represent?

    <u>**Sample Answer:**</u> The equation should be around $y = 1.8x + 32$ The equation represents the relationship between Celsius and Fahrenheit.

28. Create an equation for converting from Fahrenheit to Celsius.

    <u>**Sample Answer:**</u> C = (F – 32)/1.8

Add a Notes Page



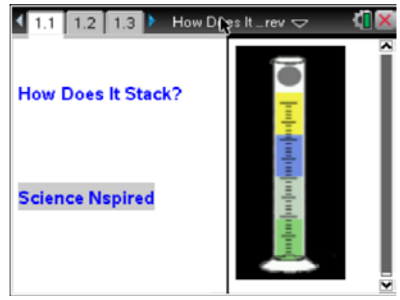
29. Create a Celsius to Fahrenheit converter and a Fahrenheit to Celsius converter.

Tech Tip: Students will need to enter their expressions in Math Boxes. For the first converter, recommend that students represent Celsius with a C and Fahrenheit with an F. The variables must be different for the second converter. If they are the same, they will conflict with one another.

How Does It Stack?
Student Activity

Name ________________
Class ________________

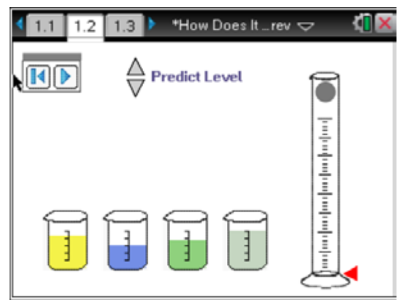
Open the TI-Nspire™ document *How_Does_It_Stack.tns.*
Have you ever wondered why ice floats in water? Do you know why a mixture of oil and vinegar eventually separates? Have you wondered why a rock sinks in water, while polystyrene foam floats? In this activity, you'll use a simulation to explore these questions.



The TI-Nspire document contains a virtual density column. Your task is to calculate the density of each of the four solutions. Then, based on the results, predict the order in which the layers will settle. Finally, you will predict where a solid object will float when dropped into the column.

Move to pages 1.2–1.3.

Press ctrl ▶ and ctrl ◀ to navigate through the lesson.



1. Hover the cursor over a beaker to reveal the mass and volume of a solution.
   a. IMPORTANT: If you click on the beaker, the liquid will be "poured" into the cylinder, forcing you to reset.
   b. When you reset, the masses and volumes of the liquids in the beaker change.
   c. You can reset the page using the reset button on the screen or the delete button on the handheld.

Container 1	Container 2	Container 3	Container 4
Mass: _____________	Mass: _____________	Mass: _____________	Mass: _____________
Volume: ___________	Volume: ___________	Volume: ___________	Volume: ___________

2. Use the calculator page 1.3 or Scratchpad to calculate the density of each solution.

   What is the formula for calculating density? ________________________________

Container 1	Container 2	Container 3	Container 4
Density: __________	Density: __________	Density: __________	Density: __________

3. Once you have determined the densities, return to page 1.2 and click on the solution containers in the order in which they will settle in a graduated cylinder.
   If you select an incorrect order, you will receive a Goat. Reset the page and try again.

4. Hover the cursor over the solid ball to reveal mass and volume.

   Mass: _______________________ Volume: _______________________

5. Use the calculator page 1.3 to calculate the density of the solid ball.

   Density of Solid Ball: _______________________

6. Use the arrows beside "Predict Level" to move the red arrow next to the graduated cylinder to show where you predict the ball will float in the column.
7. Click the play button to watch the ball fall through the density column. If you correctly predicted the location of the ball, you will receive a Gold Star. If you did not predict the correct location of the ball, you will receive a Goat. Press the Reset button and try again until you receive the Gold Star.

Move to pages 2.1–2.5. Answer the following questions below or on your handheld.

Q1. When poured into the graduated cylinder, the most dense liquid will _________.

- A. float on top
- B. be the middle layer
- C. be the bottom layer
- D. chemically react

Q2. As the solid becomes more dense, it is most likely to ___________.

- A. sink
- B. float
- C. rise to the top
- D. be suspended midway in the liquids

Q3. Density is __________.

- A. how heavy an object is
- B. the size of an object
- C. $D = \frac{V}{m}$
- D. how closely packed the matter is

Q4. The density of glycerin is 1.26 g/mL. If the mass of glycerin increases from 125 g to 250. g, the volume __________.

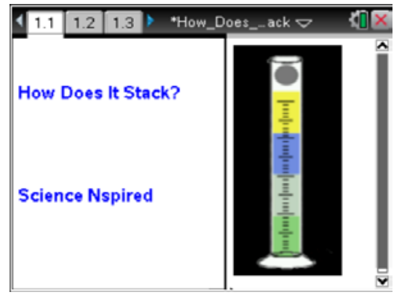
- A. doubles
- B. decreases by one half
- C. is unchanged
- D. decreases by one fourth

Q5. The density of glycerin is 1.26 g/mL. If the mass of glycerin increases from 125 g to 250. g, the density __________.

- A. doubles
- B. decreases by one half
- C. is unchanged
- D. decreases by one fourth

Science Objectives

- Students will calculate the density of liquids.
- Students will order the liquids in a graduated cylinder
- Students will predict at what level a solid object will float in the liquids.



Vocabulary

- density
- float
- liquid
- mass
- sink
- solid
- volume

TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Answer multiple choice questions

About the Lesson

- This lesson allows students to visually see the relationship between density of solutions and the relative position of an object in the solutions based on its density.
- As a result, students will:
  - Understand how solutions will separate based on their densities.
  - Predict where a solid object will stop within the given solutions based on the known densities.

Tech Tips:

Make sure that students understand how to reset the animation by clicking .

Lesson Materials:

Student Activity

- How_Does_It_Stack_Student.doc
- How_Does_It_Stack_Student.pdf

TI-Nspire document

- How_Does_It_Stack.tns

Using TI-Nspire™ Navigator™

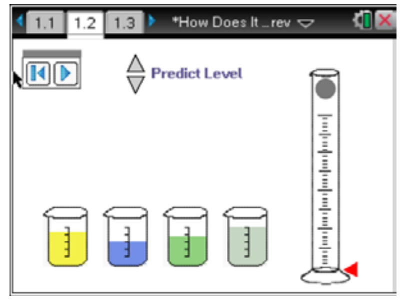
- Send out the TI-Nspire document.
- Monitor student progress using Screen Shots.
- Use Live Presenter to spotlight student answers.

Activity Materials

- *How_Does_It_Stack.tns* document
- TI-Nspire™ Technology

Discussion Points and Possible Answers

Move to pages 1.2–1.3.



1. Students will hover over each beaker to obtain mass and volume data.
   a. IMPORTANT: If students click on the beaker the liquid will be "poured" into the cylinder and they will have to reset the page to remove the liquid from the cylinder.
   b. Make sure the students understand that when reset is pressed, the masses and volumes of ALL the liquids in the beakers change. They basically have to start over again.

c. The page can be reset using the reset button on the screen or the delete button on the handheld.

> **Tech Tip:** Students can press to use Scratchpad instead of moving between pages 1.2 and 1.3 to perform calculations.

2. Students will use the calculator page 1.3 to calculate the density of each solution. Guide students to use dimensional analysis if they cannot remember the formula for density. The units of g/mL are units of mass divided by weight, so the formula is: $\text{density} = \dfrac{\text{mass}}{\text{volume}}$.
3. Next the student will back to page 1.2 and click on the solutions in the order they would be poured into the graduated cylinder—most dense first and least dense last.
   If the student is not successful, he/she will get a "Goat" and will have to reset the page to start over.
4. The student will then hover over the solid ball to get its mass and volume.
5. Students return to page 1.3 or use Scratchpad to calculate the solid ball's density.
6. Students then predict on page 1.2 where the solid will settle in the column. Be sure students understand which buttons are "predict" and which are "reset/play."
7. Students click the play button to test their predictions. If the prediction is incorrect, the student will have to reset the simulation and try again until they get a gold star.

> **Tech Tip:** If students have to reset because they incorrectly predicted where the ball will fall, they will start over again with new liquids.

TI-Nspire Navigator Opportunities

Use Screen Capture to monitor for "goats" and "gold stars" as students progress through the simulation.

Move to pages 2.1–2.5.

Have students answer the questions on either the handheld, the activity sheet, or both.

Q1. When poured into a graduated cylinder, the most dense liquid will ________.

Answer: C. be the bottom layer

Q2. As the solid becomes denser, it is more likely to ________.

Answer: A. sink

Q3. Density is _____________.

Answer: D. how closely packed the matter is

Q4. The density of glycerin is 1.26 g/mL. If the mass of glycerin in the graduated cylinder is increased from 125 g to 250. g, the **volume** of the glycerin ________.

Answer: A. doubles

Q5. The density of glycerin is 1.26 g/mL. If the mass of glycerin in the graduated cylinder is increased from 125 g to 250. g, the **density** of the glycerin ________.

Answer: C. is unchanged

TI-Nspire Navigator Opportunities

TI-Nspire Navigator can be used to make screen shots to follow student progress. A visual check can be made to see which students are successful and which are struggling.

Wrap Up

When students are finished with the activity, collect the TI-Nspire document using the TI-Nspire Navigator System. Save grades to Portfolio. Discuss activity questions using Slide Show.

Assessment

- Formative assessment will consist of questions embedded in the TI-Nspire document. The questions will be graded when the document is retrieved by TI-Nspire Navigator. The TI-Nspire Navigator Slide Show can be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test, inquiry project, performance assessment, or an application/elaborate activity.

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Introduction to Data Collection

TI PROFESSIONAL DEVELOPMENT

Activity Overview

In this activity, you will see how easy and efficient it is to collect and analyze data using TI-Nspire™ technology and the built-in Vernier® DataQuest™ application.

Materials

- *Vernier® EasyLink™ adapter*
- *Stainless Steel Temperature probe*

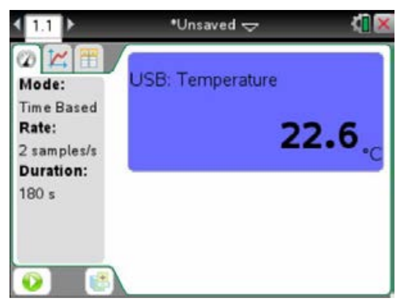
Step 1:

Turn on the TI-Nspire™ CX handheld, and create a new document by selecting **New Document**.

- If asked to save the current document, select "Yes" or "No."

A new document will appear. Though you have the opportunity to add one of the seven built-in TI-Nspire applications, do not select an application at this time.

Step 2:



Obtain a TI Stainless Steel Temperature probe and the Vernier EasyLink adapter.

Plug the TI Stainless Steel Temperature probe into the EasyLink adapter, and then connect the Vernier EasyLink adapter to the mini-USB port on top of the handheld.

This should launch the Vernier DataQuest application on Page 1.1.

Step 3:

Discuss the following questions with your partner:

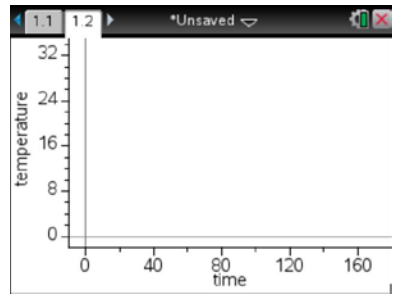
- What is the temperature? What are the units?
- How often does the temperature reading update?
- What are the default settings for the mode, rate, and duration?
- What happens as [tab] is pressed?
- What do you think each of the following icons represent? 

Step 4:

Let the temperature return to room temperature. Note your measure of the temperature of the room and compare it with others around you.

- Are the values the same?
- If not, how could one account for the differences?

Step 5:



Now we want to heat the temperature probe. Discuss with your partner how you might go about this, and share your plan with others in the room.

Predict what a plot of temperature vs. time would look like if you implemented your plan.

Step 6:

The best way to perform most temperature change experiments is to start the temperature change event and then start the data collection.

Start heating the probe. To start collecting the data, press [tab] until the Play button in the lower left of the screen is highlighted. Then press [enter]. Alternately, you can hover the cursor over the Play button and use the click button ( ) on the Touchpad.

Note: The [enter] and buttons perform slightly different commands. The click ( ) is like a left-click on a computer mouse and will activate the part of the screen that the cursor or pointer ( ) is over.

Step 7:

During the data collection, a scaled graph will appear and the Play button will change to a Stop button. After a brief period of time, end the experiment by clicking the Stop button.

When the experiment ends, the File Cabinet appears .

Introduction to Data Collection

TI PROFESSIONAL DEVELOPMENT

Step 8:

Examine your results and compare with your prediction. Discuss the following questions:

- Did you need the full time for the experiment, or did you end it early?
- We are interested in the rate at which the temperature increased. How would you describe this rate? At the start? Toward the end?
- What material did you use to warm the probe? Do you think that the material used to heat the probe matters? Why?
- Check with others in the room, and see their results. How do they compare with your results? What material did they use to warm the probe? Would that account for the differences?

Step 9:

To look at the table of data from the experiment, press tab until the Table option is highlighted and then press enter. Alternately, use the Touchpad to position the pointer over the Table icon and press .

Explore your rate of warming by looking at the change in temperature over equal increments of time.

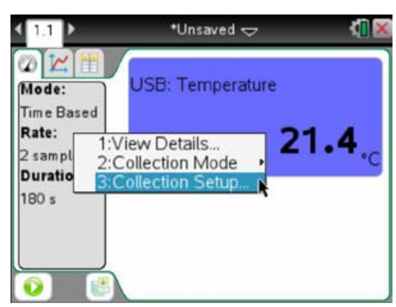
- How could you quantify this change in rate of warming?
- How does this compare with your earlier analysis?

Step 10:

To save the results from the first experiment, place this "run" in the File Cabinet . Press tab until the File Cabinet is highlighted and press enter.

- What changes do you notice on the screen?

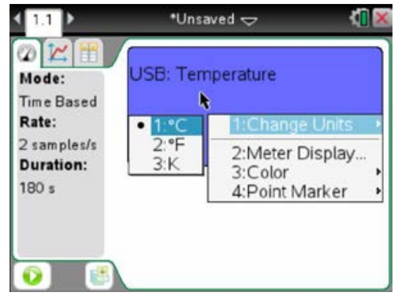
Step 11:



Now design an experiment that will cool the temperature probe.

Consider changing some of the options by right-clicking (ctrl menu) an area of interest (Mode, or the Gauge reading). For example, the default settings of three minutes and the units can be changed.

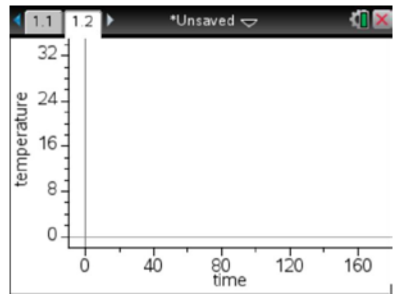
Note that these options are also under the menu. Based on what you learned in the heating experiment, adjust the settings as needed for your cooling experiment.



Step 12:

As you prepare for the cooling experiment, consider the following questions:

- What will you use to cool the probe?
- How long will it take to cool?
- What units will you use?
- What will the plot of temperature vs. time look like this time?



Step 13:

Collect the data using your design for cooling. Once the cooling begins, start the data collection as soon as possible. Highlight the play button, and press enter to start.

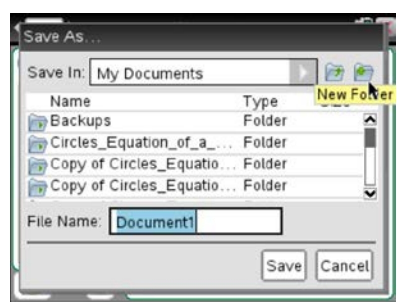
Step 14:

Explore your rate of cooling as before, and look at the table of data. Discuss the following questions:

- Were the rates of cooling or heating the same in both experiments? Explain.
- To compare the heating and cooling experiments, what variables should you control?

Step 15:

We might use this data again, so the experiment should be saved. To save the experiment, press ctrl S, name the document, and select a folder to place it in. If necessary, create a new folder.



Cool It
Student Activity

Name ________________
Class ________________

How do drinks cool?

When you have a drink which is very hot, you have probably noticed that it quickly cools off to a temperature that you consider tolerable. Your drink then remains in a drinkable temperature range for quite a while until it eventually cools off too much as it approaches room temperature. When you think about how this drink cools, you are thinking about math and science. In this activity, you will explore how the temperature changes as a function of time. Because watching an entire cup of hot chocolate or coffee cool will take a long time, we will conduct our experiment by heating a temperature sensor and watching it cool. Begin by making a prediction of how the temperature will change as a function of time and sketching a graph of the prediction to the right. Begin your prediction graph at the instant the sensor is pulled from the water cup. Be sure to label your axes.

Write a sentence to explain why you think the graph will look like your prediction.

____

Objectives:

- Understand how objects cool by recording temperature as a function of time for a sensor as it cools.
- Model the cooling data with the appropriate mathematical function.

Materials:

- Vernier EasyTemp® USB temperature sensor or Vernier Go! ® Temp USB temperature sensor with interface (Vernier EasyLink® USB sensor interface or TI-Nspire Lab Cradle)
- Cup of hot water with a temperature of 45º–55ºC or a hair drier to heat the temperature sensor.

Cool It
Student Activity

Name ______________
Class ______________

Data Collection:

1. Open a new document on the TI-Nspire™ handheld. Connect the temperature sensor directly or with the interface. You will use the default settings.
2. Place the temperature sensor in the cup of hot water and watch for the readings to become steady indicating that the sensor has reached the temperature of the water.
3. Remove the sensor from the cup of hot water, wipe it off so that evaporation is not a factor and let it sit on the edge of the table without touching anything to cool. Begin the data collection immediately by pressing the green arrow in the lower left corner of the screen (▷).
4. Once the data is collected, send the data file to each group member's handheld.

Analysis:

1. Compare your data with your prediction. If they are different, explain why you think data does not match your prediction exactly and sketch the graph of the collected data on the same set of axes, labeling each relationship.
2. Why is the room temperature important in this activity?
3. Click on the graph to select a data point. Move the tracing cursor to find the starting temperature and then use your graph or other methods to determine the temperature of the room in ºC. The room temperature should be lower than your lowest temperature recorded. Record them below

Starting Temperature (ºC)	
Room Temperature (ºC)	
Difference in Temperatures (ºC)	

4. You may recognize that the data appears to be exponential. You will model this data with an equation in the form $y = a \bullet b^x + c$. Use what you know about transformations and the data points in the table above to find values for *a* and *c.* Note that *a* is not the starting temperature. Explain why *a* is different value in the table. Record the values for *a* and *c* in the table to the right.

a	
c	

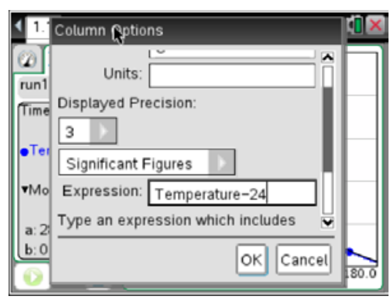
5. You will guess a value for *b*. Does the graph show exponential growth or decay? Based upon this, what are the possible values for *b*?

6. Select **MENU** > **Analyze** > **Model**. Type in the model $y = a \bullet b^x + c$ (be sure to enter the multiplication sign between *a* and *b*) and then enter the values for *a* and *c* along with your estimate for *b*. The spin increment will allow you to adjust the values in the increments you choose by the value entered. To obtain a good fit, you will need to adjust the value of *b* possibly *a* or *c*. Adjust the values using the up and down arrows in the details box to the left of the graph. You can also click the value of *b* and enter a specific value of your choice. Once the model fits the data, record the equation.

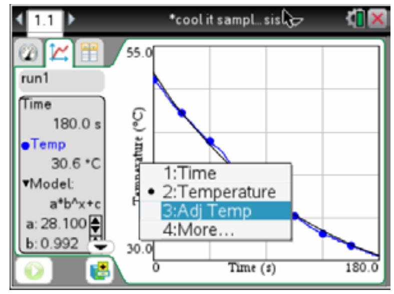
7. What is the physical representation of each parameter *a, b* and *c*?

8. An exponential regression can also be used to find the equation but the exponential regression is in the form $y = a \bullet b^x$ with no vertical shift value of *c* from above. How could the data be transformed so that the regression model can be used on the curve?

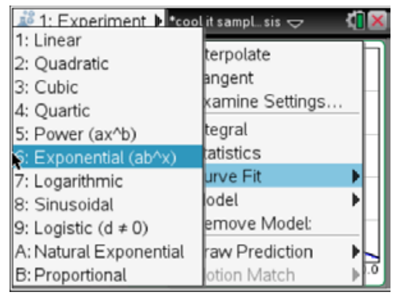
9. Since the temperature levels off at room temperature rather than zero, the exponential curve is shifted upward by room temperature. Subtracting room temperature from all of the temperature values will allow the data to be analyzed with an exponential regression. Select **Menu > Data > New Calculated Column**. Name the new column *Adj Temp*. The Expression must be typed in precisely with Temperature – Room Temperature value.



10. To see the graph of the Adjusted Temp as a function of time, click on the *Temperature* label along the dependent axis of the graph and change it to *Adj Temp*. Or you may select it from the Graph Menu.



11. Select **Menu > Analyze > Curve Fit > Exponential**. Record the value of the exponential regression.



12. Compare the exponential regression value with the value of the model you developed. Write an equation for the original data set using the exponential regression.

13. How would the graph change if the experiment were performed outside on a very cold day?

14. How would the graph change if the hot water had a higher initial temperature?

15. Write a short paragraph to summarize what you learned in this activity.

Cool It

TEACHER NOTES

TI PROFESSIONAL DEVELOPMENT

Math and Science Objectives

- Students will first predict and then examine the relationship for temperature as a function of time for an object that is cooling.
- Students will model mathematically the relationship with the exponential equation in the form $y = a \bullet b^x + c$.
- Students will relate each of the parameters in the equation to a physical quantity.
- Students will draw conclusions about cooling objects and make predictions about how changes in the data collection will affect the results.
- Students will use appropriate tools strategically. (CCSS Mathematical Practice)

Vocabulary

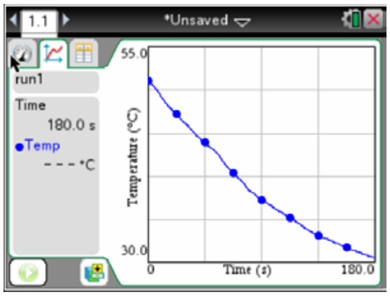
- temperature
- initial temperature
- exponential equation

About the Lesson

- Making predictions prior to data collection is an important step in helping students to connect real world phenomena to mathematics.
- Students will heat a temperature probe either in hot water or with a hair drier and then watch it cool. They will find the mathematical equation for the data by creating their own model first and then by transforming the data so that they can run an exponential regression.
- As a result, students will:
  - Develop a conceptual understanding of how objects cool.
  - Make a real-world connection about exponential functions and transformations.

Materials and Materials Notes

- TI-Nspire handheld or TI-Nspire computer software
- Vernier EasyTemp® USB temperature sensor or Vernier Go! ® Temp USB temperature sensor with interface (Vernier EasyLink® USB sensor interface or TI-Nspire Lab Cradle)



TI-Nspire™ Technology Skills:

- Collect temperature data with the Vernier DataQuest™ app

Tech and Troubleshooting Tips:

1. The temperature sensor can be heated using hot water or a hair drier. If students use the hot water, they should wipe the sensor immediately after removing it from the water so that evaporation is not a factor in the cooling. The hair drier simply requires heating the sensor and collecting data once the drier is turned off.
2. As the temperature sensor cools, check to see that fans or air conditioners are not blowing directly on the sensor.

Lesson Files:

Student Activity

Cool_It_Student.pdf

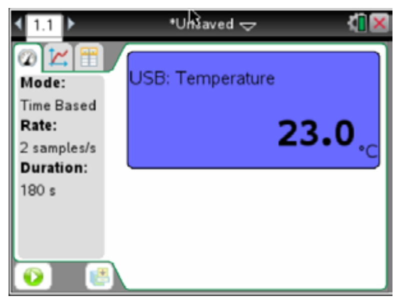
Cool_It_Student.doc

- Cup of hot water with a temperature of 45º–55ºC or a hair drier to heat the temperature sensor.
- Using EasyTemp with a computer requires the use the mini-standard USB adaptor to plug the temperature sensor into a computer with TI-Nspire™ Teacher Software or TI-Nspire™ Student Software. Using the TI-Nspire™ Lab Cradle with the standard temperature sensor requires a USB cable to connect to the teacher computer.
- If you do not have the adapter, you may want to collect data with the student handheld and transfer to the computer using TI-Nspire Navigator™ System or Teacher Software.

Discussion Points and Possible Answers

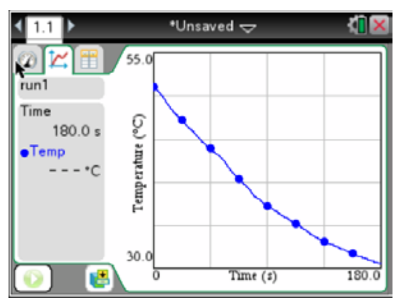
> **Teacher Tip:** Making predictions is very important to helping students to connect the physical world to the mathematical world. Ask the students to make a prediction prior to collecting data and sketch it. You may then want to ask them to compare their predictions to those of other students in the class as you walk around and look at the sketches. Once the data is collected, come back to those predictions and discuss any errors. In this activity, students often show the temperature curve leveling off at a temperature of zero rather than room temperature.

Data Collection



- To collect data with a temperature sensor, first turn on the TI-Nspire and choose **New Document**. Then, plug in the EasyTemp sensor and the Vernier DataQuest app will automatically launch. The handheld shows a meter which will change as the temperature varies. You are using the default setting which collects data for 180 seconds.

> To begin the data collection, click the green **Start Collection** arrow in the lower left corner of the screen.



- Once collection begins, the handheld will show the graph of temperature as a function of time.
- A sample graph is shown to the right

Analysis

1. Compare your data with your prediction. If they are different, explain why you think the data does not match your prediction exactly, and sketch the graph of the collected data on the same set of axes, labeling each relationship.

   <u>Sample answer</u>: Some graphs will match the prediction and some will not. The most common error is that students don't realize that the temperature levels off at room temperature, which is higher than zero.

2. Why is the room temperature important in this activity?

   <u>Sample answer</u>: The graph is asymptotic to the room temperature.

3. Click on the graph to select a data point. Move the tracing cursor to find the starting temperature and then use your graph or other methods to determine the temperature of the room in ºC. The room temperature should be lower than your lowest temperature recorded. Record them below.

   <u>Sample answers</u>:

Starting Temperature (ºC)	51.1
Room Temperature (ºC)	23.0
Difference in Temperatures (ºC)	28.1

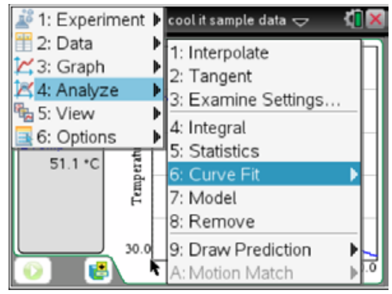
4. You may recognize that the data appears to be exponential. You will model this data with an equation in the form $y = a \bullet b^x + c$. Use what you know about transformations and the data points in the table above to find values for *a* and *c.* Note that *a* is not the starting temperature. Explain why *a* is different value in the table. Record the values for *a* and *c* in the table to the right.

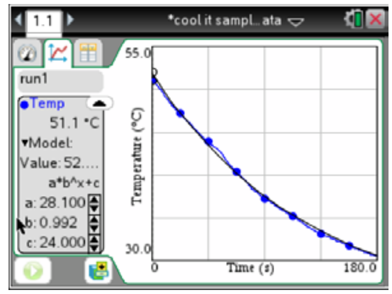
a	28.1
c	24.0

   <u>Sample answer</u>: The value of *a* is the difference between the starting temperature and the final temperature.

5. You will guess a value for *b*. Does the graph show exponential growth or decay? Based upon this, what are the possible values for *b*?

   <u>Sample answer</u>: The graph shows an exponential decay so the value of *b* must be between 0 and 1.





6. Select **MENU** > **Analyze** > **Model**. Type in the model $y = a \bullet b^x + c$ (be sure to enter the multiplication sign between *a* and *b*) and then enter the values for *a* and *c* along with your estimate for *b*. The spin increment will allow you to adjust the values in the increments you choose by the value entered. To obtain a good fit, you will need to adjust the value of *b* possibly *a* or *c*. Adjust the values using the up and down arrows in the details box to the left of the graph. You can also click the value of *b* and enter a specific value of your choice. Once the model fits the data, record the equation.

   Equation for Sample Data: $y = 28.1 \bullet (0.992)^x + 24.0$

Tech Tip: Students often become confused when they choose *Model* because a default equation appears. They should just type their model over the given one. If they have errors, they can go to the Analyze menu and remove the model and then re-enter it. One common error is to omit the multiplication sign between *a* and *b*.

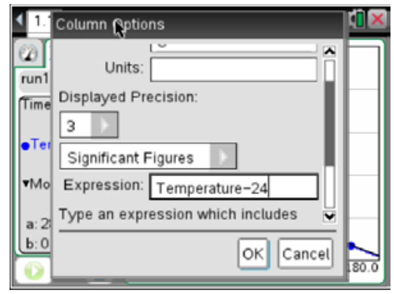
7. What is the physical representation of each parameter *a, b* and *c*?

   Sample answer: The parameter *a* represents the difference between the starting temperature and room temperature. The parameter *b* represents the percentage of temperature that the probe retains each second. The parameter *c* represents the temperature of the room.

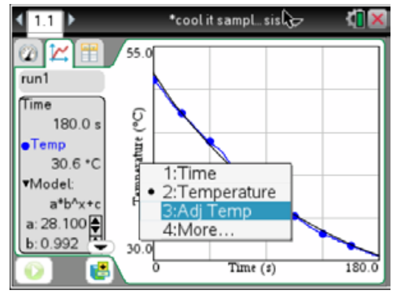
8. An exponential regression can also be used to find the equation but the exponential regression is in the form $y = a \bullet b^x$ with no vertical shift value of *c* from above. How could the data be transformed so that the regression model can be used on the curve?

   Sample answer: If the room temperature is subtracted from all of the temperature values, the graph will be shifted down so that it has a horizontal asymptote of zero and we can run the exponential regression.

9. Since the temperature levels off at room temperature rather than zero, the exponential curve is shifted upward by room temperature. Subtracting room temperature from all of the temperature values will allow the data to be analyzed with an exponential regression. Select **Menu > Data > New Calculated Column**. Name the new column *Adj Temp*. The Expression must be typed in precisely with Temperature – Room Temperature value.



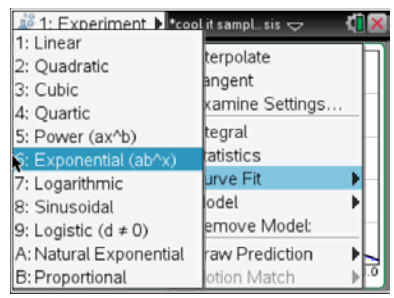
Tech Tip: Arrow down on the right side to access the Expression.



10. To see the graph of the Adjusted Temp as a function of time, click on the *Temperature* label along the dependent axis of the graph and change it to *Adj Temp*. Or you may select it from the Graph Menu.

11. **Menu > Analyze > Curve Fit > Exponential**. Record the value of the exponential regression.

   <u>Sample Data Solution:</u> $a = 50.0$ and $b = 0.997$, so $y = 50(0.997)^x$.



12. Compare the exponential regression value with the value of the model you developed. Write an equation for the original data set using the exponential regression.

   <u>Solution for Sample Data:</u> The equation $y = 50(0.997)^x + 24$ is obtained by adding the room temperature to the exponential regression.

13. How would the graph change if the experiment were performed outside on a very cold day?

   <u>Sample answer:</u> The final temperature would be lower so the horizontal asymptote will be lower and the graph may be a little steeper since the difference between the initial and final temperatures will be greater. The value for *a* would be larger.

14. How would the graph change if the hot water had a higher initial temperature?

    Sample answer: The initial temperature and the value of *a* would be greater.

15. Write a short paragraph to summarize what you learned in this activity.

Match Me

Student Activity

Name ______________

Class ______________

Activity Overview

In this activity you will match your motion to a given graph of position-versus-time. You will apply the mathematical concepts of slope and y-intercept to a real-world situation.

Materials

- TI-Nspire™ handheld or computer software
- Calculator-Based Ranger 2™ data collection device with USB CBR 2-to-calculator cable

  Note: If the CBR 2 is used with a computer, a mini-standard USB adaptor to plug the CBR 2 into the computer is needed.

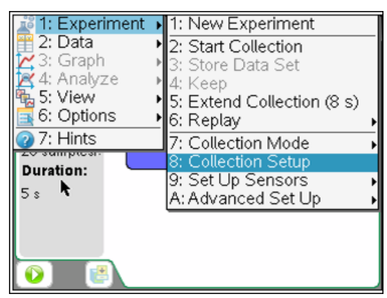
Part 1—Step-by-step setup

To utilize the built-in, easy-to-use **Motion Match** feature, first turn on the TI-Nspire handheld and choose **New Document**. Then, plug in the CBR 2 and the Vernier DataQuest™ app for TI-Nspire will automatically launch.

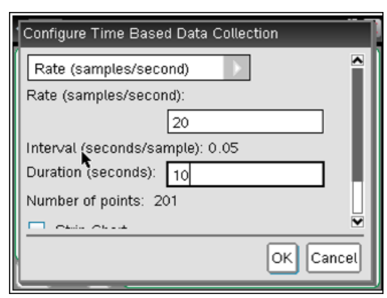
Hold the CBR 2 so that it points toward a smooth surface like the wall or door. Move forward and backward to observe the reading changes on the meter.

1. How far are you from the wall? _________

Record all the digits that are given, as well as the units.

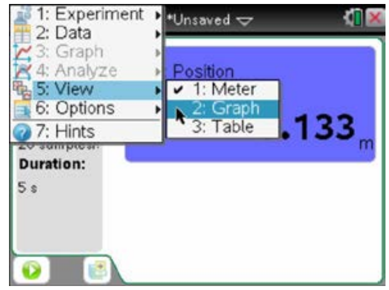


You will set up an experiment for 10 seconds. Press **Menu > Experiment > Collection Setup.** Change the duration to 10 seconds.

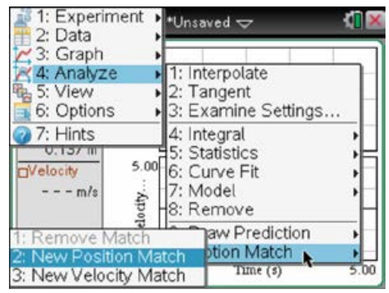


Match Me
Student Activity

Name _______________
Class _______________



Now, set up the graph. Select **Menu > View**. There are three views. The first view displayed was **Meter**. Choose the **Graph** view for additional menu options.



Press **Menu > Analyze > Motion Match > New Position Match**.

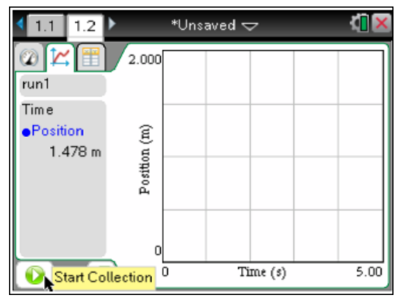
2. What physical quantity is the dependent variable?

   ____

   A. velocity in meters/second

   B. position in meters

   C. time in seconds



3. What variable is plotted on the *x*-axis?

   ____

Draw your Position Match on the graph to the right.

4. What is the domain? Include units. _________

5. What is the range? Include units. __________

6. Record your observations about the graph by answering the following questions:

   a. What is the *y*-intercept?

   b. What does the *y*-intercept represent physically?

   c. At approximately what distance from the wall should the motion detector be located to match the initial position in the motion graph?

   d. The slope is the rate of change of position with respect to time. Between what times does the graph depict the slowest motion?

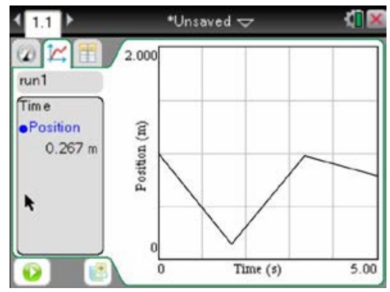
Match Me
Student Activity

Name ______________
Class ______________

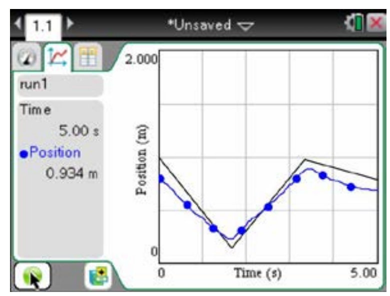
7. Press the **Start Collection** arrow in the lower-left corner of the screen. Point the CBR 2 at a wall and move back and forth until your graph matches the Position Match graph as closely as possible. If you are not pleased with your first attempt, press **Start Collection** again to repeat. You may want to review the information that you wrote about the graph to assist you. When you are satisfied with your match, sketch the graph you created on top of the given graph.

8. Describe the parts of your graph that were difficult to match and how you made adjustments, based on your graph of your walk, to make a better match in your next attempt.

Now, look at the graph shown at the right.



9. Describe how you would need to walk in order to match that graph with your motion. Be sure to include information about the *y*-intercept, position at various times, velocity, and direction. For what times does the graph depict the slowest motion and the fastest motion?



10. Describe the graph with the round dots that was created when **Start Collection** was pressed. Contrast the graph of position-versus-time that should have been created with what actually happened. Write at least two complete sentences. Example: *From 2 seconds to 3.5 seconds, the person moved too slowly to reach the original position – one meter from the wall.*

Part 2—Extend and Explore

Press **Menu > Analyze > Motion Match > New Position Match**. Press **Start Collection** and walk to match the graph. A trial can be saved by pressing the Store Data Set icon next to **Start**.

11. Discuss your new match with a classmate.

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Math and Science Objectives

- Students will examine graphs of position-versus-time and match them with their motion to demonstrate their understanding of the graph.
- Students will explain how velocity and starting position relate to slope and *y*-intercept.
- Students will use appropriate tools strategically. (CCSS Mathematical Practice)

Vocabulary

- speed
- velocity
- initial position

About the Lesson

- In this lesson, students will examine a graph of position-versus-time and collect data by moving in front of a Calculator Based Ranger 2™ data collection device to match their motion to the given graph.
- As a result, students will:
    - Develop a conceptual understanding of how their motion affects the slope and position values on the graph.
    - Make a real-world connection between position, time, and velocity.

Materials and Materials Notes

- CBR 2 with USB CBR 2-to-calculator cable.
- Using the CBR 2 with a computer requires the use the mini-standard USB adaptor to plug the CBR 2 into a computer with TI-Nspire™ Teacher or Student Software. This adapter will convert the CBR 2 USB cable to a standard USB connection so that it can be connected to the computer.
- Alternately, use the legacy CBR™ with the TI-Nspire Lab Cradle. You will need the MDC-BTD cord to connect a motion detector to the TI-Nspire Lab Cradle. With the TI-Nspire Lab Cradle, you can connect multiple motion detectors to extend your exploration.

TI-Nspire™ Technology Skills:

- Collect motion data with the Vernier DataQuest™ app for TI-Nspire.

Tech and Troubleshooting Tips:

1. Flip the motion detector open. Set the switch to normal.
2. Check that the four AA batteries in the motion detector are good.
3. Unplug and plug the CBR 2 back in.
4. When using an older CBR or motion detector with the TI-Nspire™ Lab Cradle, you may need to launch the Vernier DataQuest™ app. Then press **Menu > Experiment > Advanced Setup > Configure Sensor > TI-Nspire Lab Cradle: dig1 > Motion Detector**.

Lesson Files:
Student Activity
Match_Me_Student.pdf
Match_Me_Student.doc

Discussion Points and Possible Answers

Part 1—Step-by-step setup

To utilize the built-in, easy-to-use **Motion Match** feature, first turn on the TI-Nspire™ handheld and choose **New Document**. Then, plug in the CBR 2 and the Vernier DataQuest™ app will automatically launch.

Hold the CBR 2 so that it points toward a smooth surface like a wall or door. Move forward and backward to observe the reading changes on the meter.

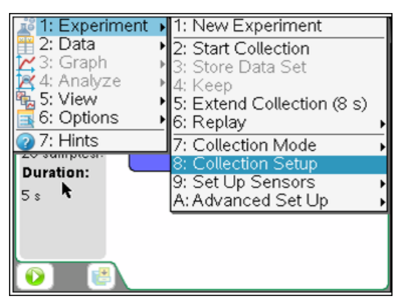
Tech Tip: The Vernier DataQuest app is user-friendly. It should launch when the CBR 2 is connected. To begin the data collection, click the green **Start Collection** arrow in the lower-left corner of the screen.

1. How far are you from the wall? Record all the digits that are given, as well as the units.

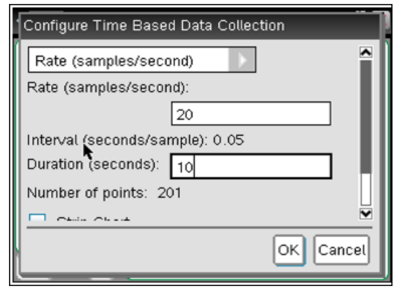
   Sample answer: Answers will vary. The meter in the above screen shows 0.289 m from the wall or closest object.

Teacher Tip: When the CBR 2 is first connected, it begins clicking and displays a measurement. Have the students move the CBR 2 by pointing it at different objects. Ask them what the motion detector is doing. It should be measuring the distance from the CBR 2 to the object directly in front of it. Be aware that it reads the distance to the closest item in its path, so students should keep an open area between the wall and the target object or person.

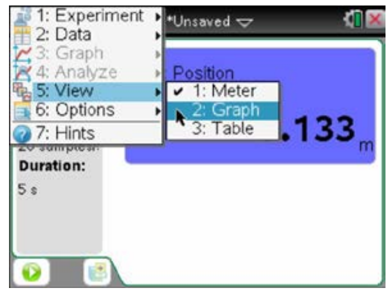
You will set up an experiment for 10 seconds. Press **Menu > Experiment > Collection Setup.**



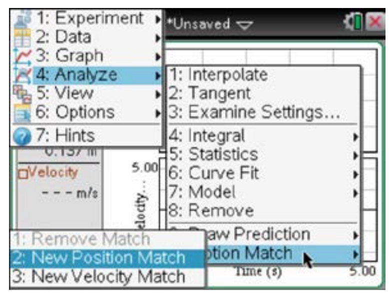
Change the duration to 10 seconds.



Now, set up the graph. Select **Menu > View**. There are three views. The first view displayed was **Meter**. Choose the **Graph** view for additional menu options.



Select **Menu > Analyze > Motion Match > New Position Match**.



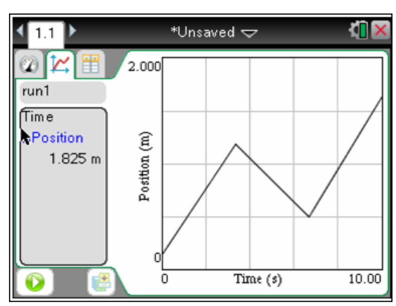
2. What physical quantity is the dependent variable?
   A. velocity in meters/second
   B. position in meters
   C. time in seconds

   Answer: B. position in meters

3. What variable is plotted on the *x*-axis?

   Sample answer: The time in seconds, the independent variable, is plotted on the *x*-axis.

Draw your Position Match on the graph to the right.



Answer: Student graphs will vary because the Vernier DataQuest app randomly generates new graphs.

4. What is the domain? Include units.

   Sample answer: The domain is from 0 to 10 seconds.

5. What is the range? Include units.

   Sample answer: The range is from 0 to 2 meters (This answer could vary).

6. Record your observations about the graph by answering the following questions.

   a. What is the *y*-intercept?

      Sample answer: Numerical values may vary but the answer should be in meters.

   b. What does the *y*-intercept represent physically?

      Sample answer: The *y*-intercept represents the starting position of the target object or person, sometimes referred to as the initial position. It indicates how near the target should be to the wall before beginning to move.

   c. At approximately what distance from the wall should the motion detector be located to match the initial position in the motion graph?

      Sample answer: Answers will vary depending on the motion graph generated, but the answer should be in meters.

   d. The slope is the rate of change of position with respect to time. Between what times does the graph depict the slowest motion?

      Sample answer: Answers will vary depending on the motion graph generated. The slope of each line segment is the velocity and provides information on how fast the target object or person is moving and in what direction. Some students may say that velocity is speed. This is a great opportunity to explain the difference between speed and velocity. Speed indicates how fast the target is moving, but it does not include direction. Since speed has magnitude only, it is referred to as a scalar quantity. Speed is always positive. Velocity is called a vector quantity and is defined as the change in position divided by the change in time. It includes both the magnitude and direction. Velocity can be positive or negative for a person moving back and forth along a line. Velocity is positive when the target moves away from the motion detector, increasing the distance, and negative when the target moves toward the motion detector, decreasing the distance between the detector and itself.

Teacher Tip: It is important for students to make a prediction before simply pressing the **Start** button. Making predictions and testing those predictions supports higher level thinking.

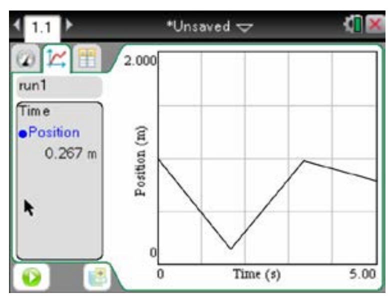
7. Press the **Start Collection** arrow in the lower-left corner of the screen. Point the CBR 2 at a wall and move back and forth until your graph matches the Position Match graph as closely as possible. If you are not pleased with your first attempt, press **Start Collection** again to repeat. You may want to review the information that you wrote about the graph to assist you. When you are satisfied with your match, sketch the graph you created on top of the given graph.

Tech Tip: If the students are not satisfied with their results, they can repeat the data collection by clicking the **Start Collection** arrow again. This will overwrite the previous trial.

8. Describe the parts of your graph that were difficult to match and how you made adjustments, based on your graph of your walk, to make a better match in your next attempt.

Sample answer: Answers will vary.

Now, look at the graph shown at the right.

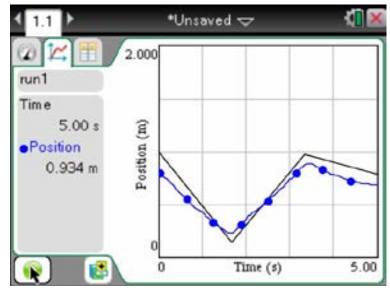


9. Describe how you would need to walk in order to match that graph with your motion. Be sure to include information about the *y*-intercept, position at various times, velocity, and direction. For what times does the graph depict the slowest motion and the fastest motion?

Sample answer: The walker begins one meter from the wall and moves toward the wall at a constant velocity for about 1.7 seconds. The walker gets about 0.2 meters from the wall and then begins walking away from the wall at about the same rate for another 1.7

seconds, arriving back at 1.0 meters from the wall. The walker then begins to slowly move toward the wall until a total time of 5 seconds has elapsed. The slopes of the first two sections appear to indicate the same speed, but the first of these velocities is negative, while the second is positive. The walker moved slowest during the time period from 3.4 to 5 seconds.

10. Describe the graph with the round dots at the right that was created when **Start Collection** was pressed. Contrast the graph of position-versus-time that should have been created with what actually happened. Write at least two complete sentences. Example: *From 2 seconds to approximately 3.5 seconds, the person moved too slowly to reach the original position – one meter from the wall.*



Sample answer: Answers will vary but may include the following information: The walker began a little too close to the wall, so the *y*-intercept value is smaller than it should be. The walker was moving too slowly in the second section of the graph between 1.7 and 3.4 seconds. The walker was moving at about the right velocity for the third section of the graph, but the final position was a little closer to the wall than it should have been.

> **Teacher Tip:** If time permits, you should have each student match a graph without coaching. You may want to have them save the document and send it in via TI-Nspire™ Navigator™ system as an individual evaluation. When students can match the graphs on their own, you are more assured that they understand the meaning of the *y*-intercept and slope as they relate to motion graphs.

Part 2—Extend and Explore

Press **Menu > Analyze > Motion Match > New Position Match**. Press **Start Collection** and walk to match the graph. A trial can be saved by pressing the Store Data Set  icon next to **Start**.

11. Discuss your new match with a classmate.

Sample answer: Answers will vary depending upon the graph generated.

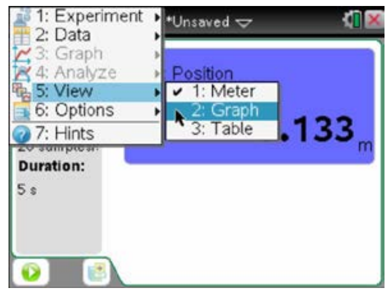
Teacher Extension

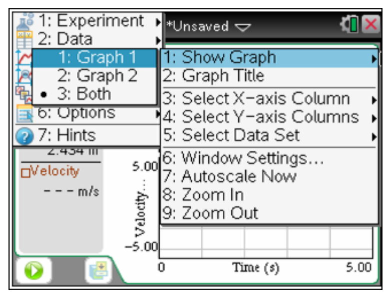
You can create your own matches for students if you want to be sure that they can match a graph with specific criteria. Follow these steps.

1. Open a new TI-Nspire document and then connect the CBR 2 data collection device.

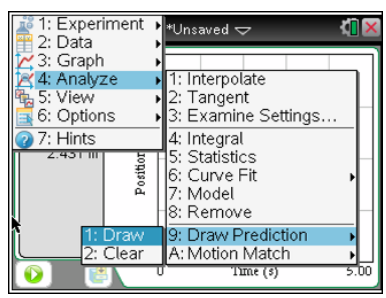
2. You will set up an experiment for 10 seconds. Press **Menu > Experiment > Collection Setup**. Change the duration to 10 seconds.

3. Now, set up the graph. Select **Menu > View**. Choose the **Graph** view. Then select **Menu > Graph > Show Graph > Graph 1**.

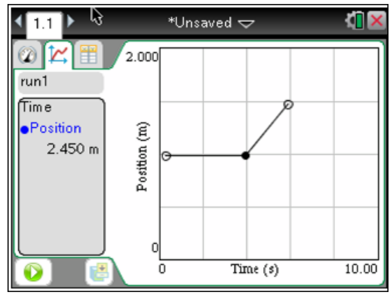




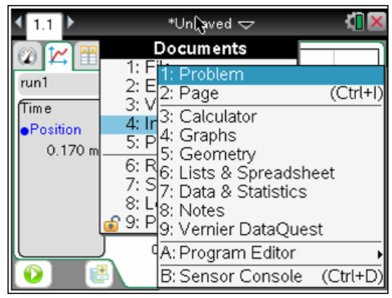
4. To draw your own graph to be matched, select **Menu > Analyze > Draw Prediction > Draw**.



5. A pencil appears on the grid. Move the pencil to a point just off the vertical axis on the left side of the grid, and click to set the initial position. Use the pencil to draw the path that you want students to match. Click at each point to set the end point of a segment. Use the esc key to exit the Draw mode when you have completed the match.



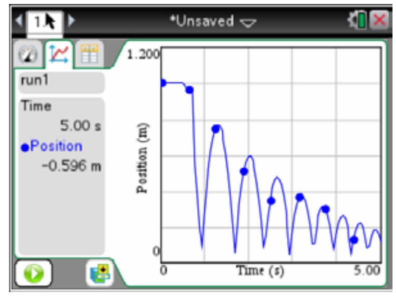
6. To create a TI-Nspire document with multiple matches, insert a new problem for each match. To insert a new problem, press doc▾ and select **Insert > Problem**. Follow the directions for creating a graph to be matched. If you want to create a velocity match rather than a position match, choose to view **Graph 2** rather than **Graph 1** (**Menu > Graph > Show Graph > Graph 2**.)



How Does It Bounce?
Student Activity

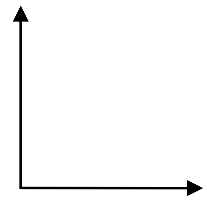
Name ________________
Class ________________

How do balls bounce and rebound?



When you drop a basketball, it does not rebound to the same height from which you dropped it. But how high does it bounce? The rebound height of a basketball can be used to determine whether the ball is inflated to the correct pressure. You will sometimes see basketball referees drop the ball from a certain height to see if it rebounds correctly prior to officiating a game. In this activity, you will explore how the height of a ball varies as a function of bounce number.

Before you begin, predict the graph of height as a function of bounce number. Sketch your prediction to the right. Be sure to label the axes.



Write a sentence to explain why you think the graph will look like your prediction.

Objectives:

- Understand how balls bounce by collecting position data for a bouncing ball and recording the height as a function of bounce number.
- Model the data with the appropriate mathematical function.

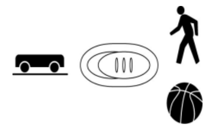
Materials:

- TI-Nspire™ handheld or computer software
- Calculator-Based Ranger 2™ data collection device (CBR 2™)
- Ball (Basketballs, racquetballs or kick balls work well. Avoid tennis balls or other fuzzy balls.)

How Does It Bounce?
Student Activity

Name ________________
Class ________________

Data Collection:



1. Open a new document on the TI-Nspire™ handheld. Set the switch on the CBR 2 to *normal* and connect it to the handheld with the USB square-end long cable.

2. Find a good location to drop the ball. It should bounce straight up and down without going off to the side. Practice a few times before setting up the CBR 2.

3. You cannot place the motion detector on the floor and bounce the ball on it, but you can reverse the positions so that the data will appear as though it was collected with the floor as the zero height. Set the CBR 2 to a fixed height approximately 1.5 meters above the ground. Select **Menu > Experiment > Set Up Sensors > Zero**. Then select **Menu > Experiment > Set Up Sensors > Reverse**.

4. To show only the position versus time graph, click the **Graph View** tab ( ). Select **Menu > Graph > Show Graph > Graph 1**.

5. Hold the ball at least 15 cm below the CBR 2 and start data collection ( ) just before dropping the ball. You want the CBR 2 to record the initial height of the ball as well as the bounce heights.

6. The position versus time graph should contain a series of at least five parabolas. If it does not, try again. Show your graph to your teacher before proceeding to the next section of the activity. Once your graph is approved, send the document to your other group members.

Data:

Click on the graph to select a data point. Move the tracing cursor to find the starting height. Record it in the data table as the Maximum Height for Bounce Number 0. Then move the cursor to each successive maximum height and record the height in the table below.

Analysis:

1. Enter the Bounce Number and Bounce Height (round to 2 decimal places) data into the table below.

2. Divide each bounce height by the previous bounce height for each set in your data table. For example, divide the height of bounce 1 by the height of bounce 0. Write the ratio as a decimal value in the right column of the table.

Bounce Number	Bounce Height (m)	Ratio of Bounce Heights
0		
1		
2		
3		
4		
5		

3. Examine the data in the table. Is the relationship linear? How can you tell from the differences in the Maximum Height values?

4. Is the data quadratic? How can you tell from the differences in heights?

5. What do you notice about the ratios shown in the right column of the table?

6. Find the average of these values.

7. How could you use the average value and the initial height to find the height of bounce 1 using mathematics?

8. How would you then be able to predict the height of bounce 2?

9. Write the estimation of height 2, H_2 as a function of the initial height, $H_{o.}$ Now do the same for H_5, the height of the 5th bounce.

How Does It Bounce?

Student Activity

Name ________________
Class ________________

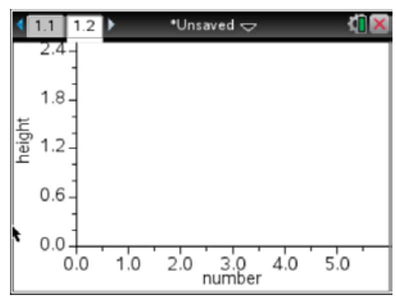
10. This type of function is an exponential function. It has the form, $y = a * b^x$ where b is the percentage of the return written as a decimal. What is the value of ***a***? Hint: think about the height for bounce zero. Explain your reasoning.

11. Write the equation for height as a function of bounce number for this set of data.

12. To check your model, create a graph of maximum height as a function of bounce number on the handheld. First, you must enter the data into the Lists and Spreadsheets application by adding a new page to your document. Name the first column Number and the second column Height. Enter the values from your data table above into the columns on the handheld.

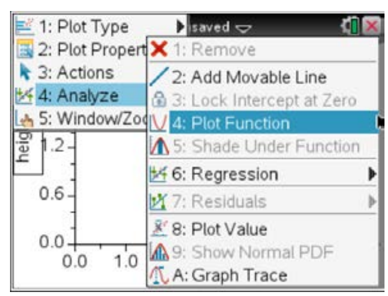
13. Add another new page and choose Data & Statistics. Click on the horizontal axis, and select **Number** for your independent variable. Click on the vertical axis, and select **Height** for your dependent variable.

14. Sketch the graph to the right.



15. How does it compare with the prediction that you made prior to the data collection?

16. Check to see how the equation you found matches with your data. From the menu on the Data and Statistics page, choose Analyze and then Plot Function. Enter the equation for the maximum height as a function of the bounce number. You must use x for the bounce number in the equation.



17. Does the function that you entered match the data? If not, make adjustments. Record the equation that matches your data and any needed adjustments.

18. An exponential equation has the form $y = a \cdot b^x$. Explain what ***a*** and ***b*** represent in this equation.

How Does It Bounce?
Student Activity

Name ________________
Class ________________

19. Use your model to predict the height of the next bounce. Show your work.

20. Why do you think the ball does not bounce as high as the previous bounce?

21. In science, you learn about kinetic and potential energy. How do the concepts of energy relate to this bouncing ball? Is mechanical energy conserved?

22. Summarize what you learned in this activity.

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How Does It Bounce?
TI PROFESSIONAL DEVELOPMENT

Math and Science Objectives

- Students will first predict and then examine the relationship for maximum bounce height as a function of bounce number for a ball bouncing under a motion detector.
- Students will model mathematically the relationship with the exponential equation in the form $y = ax^b$.
- Students will relate each of the parameters in the equation to a physical quantity.
- Students will draw conclusions about bouncing balls and the loss of energy in the bounce.
- Students will use appropriate tools strategically. (CCSS Mathematical Practice)

Vocabulary

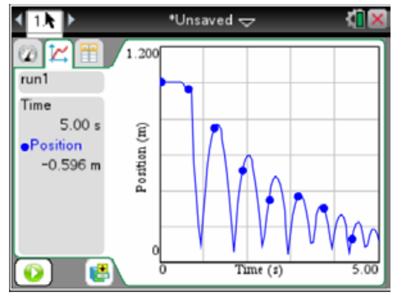
- position
- initial value
- exponential equation

About the Lesson

- Making predictions prior to data collection is an important step in helping students to connect real-world phenomena to mathematics.
- Students will drop a ball under a motion detector to collect position as a function of time. They will find the maximum height for each bounce and record it in a data table.
- Students will develop the mathematical equation for the data by creating their own model of an exponential function.
- As a result, students will:
  - Develop a conceptual understanding of exponential functions
  - Make a real-world connection about exponential functions and transformations.

Materials and Materials Notes

- TI-Nspire™ handheld or computer software
- Calculator-Based Ranger 2™ data collection device (CBR 2)
- Ball (Basketballs, racquetballs or kick balls work well. Avoid tennis balls or other fuzzy balls.)



TI-Nspire™ Technology Skills:

- Collect position vs. time data with the Vernier DataQuest™ application for TI-Nspire.

Tech Tips:

1. The CBR 2™ needs to be set to zero position with the floor and reversed. Once this setting is made, students must keep the CBR 2 at that same distance from the floor.
2. Have students look for a good location prior to setting up the CBR 2. Find a spot where the ball will bounce without moving horizontally.
3. Some students have the misconception that the graph represents a picture of the motion rather than the function of position versus time. Allowing the ball to move side to side contributes to this misconception.

Lesson Files:
Student Activity

- How_Does_It_Bounce_Student.pdf
- How_Does_It_Bounce_Student.Student.doc

- Using the CBR 2 USB cable with a computer requires the use of the mini-standard USB adaptor to plug the motion detector into a computer with TI-Nspire™ Teacher or Student Software. The TI-Nspire Lab Cradle also can be used with the Vernier Go!® Motion USB motion detector, which connects directly to the computer.
- If you do not have the adapter, you may want to collect data with the student handheld and transfer it to the computer using the TI-Nspire™ CX Navigator™ System.

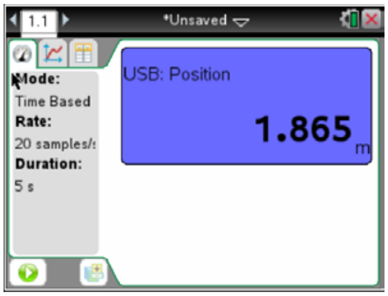
Discussion Points and Possible Answers

Teacher Tip: Making predictions is very important in helping students connect the physical world to the mathematical world. Ask students to make a prediction and sketch it prior to collecting data. You then may want to ask them to compare their predictions to those of other students in the class as you walk around and look at the sketches. Once the data is collected, come back to those predictions and discuss any errors. In this activity, students should show height decreasing with bounce number, but may not know how. Many may make a linear graph as a prediction. Stress that a prediction is just that. It should never be corrected for points, but instead be used as a place for students to correct their own thinking and conceptual understanding.

Data Collection

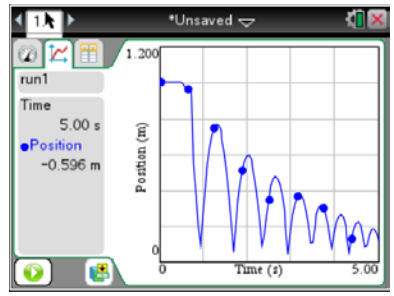
Teacher Tip: Before collecting data, students should find a good spot that allows the ball to bounce straight up and down. Suggestions are: table, tile or wood floor, concrete or carpet that is not plush.

To collect data with a CBR 2, first turn on the TI-Nspire and choose **New Document**. Plug in the CBR 2 sensor and the Vernier DataQuest™ application will launch automatically. The handheld shows a meter which will change as the position varies. You are using the default setting which collects data for 5 seconds.



Teacher Tip: Be sure the CBR 2 switch is set to *normal* as shown in the student handout. You may want to remind students to zero and reverse the data collection. Some also may need assistance in changing the view to show only the position graph.

Once collection begins, the handheld will show the graph of position as a function of time. A sample graph is shown to the right.



Teacher and Technology Tips:

You may want to remind students to show you their graphs prior to proceeding. The graphs need to look like the one shown to the right, with at least 5 parabolic sections.

Some students may have trouble collecting the data. If so, you could have another group send them a data file, or you use the TI-Nspire CX Navigator System to find one good set of data, collect it, and send it out the entire class.

Each student should have a set of data to analyze on his or her handheld.

Analysis:

1. Enter the Bounce Number and Bounce Height (round to 2 decimal places) data into the table below.

2. Divide each bounce height by the previous bounce height for each set in your data table. For example, divide the height of bounce 1 by the height of bounce 0. Write the ratio as a decimal value in the right column of the table.

Sample data:

Bounce Number	Bounce Height (m)	Ratio of Bounce Heights
0	0.97	
1	0.77	0.79
2	0.60	0.78
3	0.48	0.80
4	0.39	0.81
5	0.31	0.80

3. Examine the data in the table. Is the relationship linear? How can you tell from the differences in the Maximum Height values?

   Sample answer: The data is not linear. Linear data would have a constant difference between the bounce heights. The difference in this table is decreasing.

4. Is the data quadratic? How can you tell from the differences in heights?

   Sample answer: The data is not quadratic. If the data set were quadratic, the second difference would be a constant and it is not in this case.

5. What do you notice about the ratios in right column of the table?

   Sample answer: The ratios in the sample data are all close to 0.80.

6. Find the average of these values.

   Sample answer: For the sample data, the average is 0.80.

7. How could you use the average value and the initial height to find the height of bounce 1 using mathematics?

   Sample answer: Multiply 0.80 by the initial height to estimate the height of the first bounce.

8. How would you then be able to predict the height of bounce 2?

   Sample answer: Multiply 0.80 by the first height to estimate the height of the second bounce.

9. Write the estimation of height 2, H_2 as a function of the initial height, $H_{o.}$ Now do the same for H_5, the height of the 5^{th} bounce.

   Sample answer: $H_2 = H_0 \times (0.8)^2$; $H_5 = H_0 \times (0.8)^5$

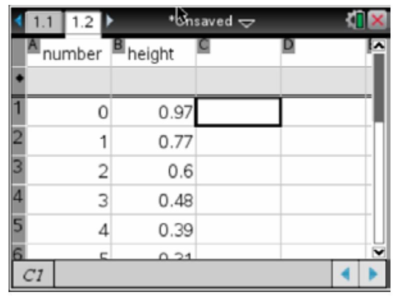
10. This type of function is an exponential function. It has the form $y = a \times b^n$,y=a∗,b-x. where *b* is the percentage of the return written as a decimal. What is the value of *a*? Hint: think about the height for bounce zero. Explain your reasoning.

    Sample answer: The value for *a* is the starting height before the ball was dropped.

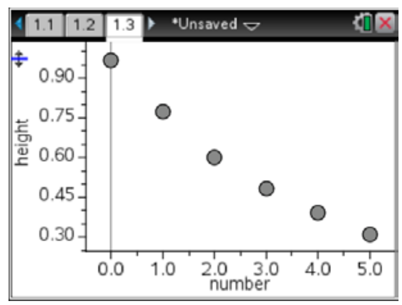
11. Write an equation for height as a function of bounce number, *n*, for this set of data.

    Sample answer: $H_n = 0.97 \times (0.8)^n$,

12. To check your model, create a graph of maximum height as a function of bounce number on the handheld. First, you must enter the data into the Lists & Spreadsheet application by adding a new page to your document. Name the first column *Number* and the second column *Height*. Enter the values from your data table above into the columns on the handheld.



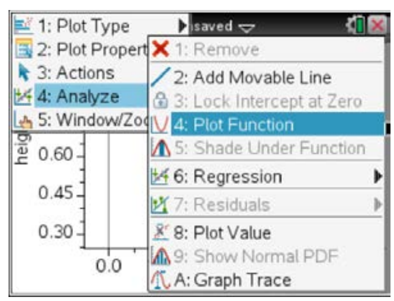
13. Add another new page and choose Data & Statistics. Click on the horizontal axis, and select **Number** for your independent variable. Click on the vertical axis, and select **Height** for your dependent variable.



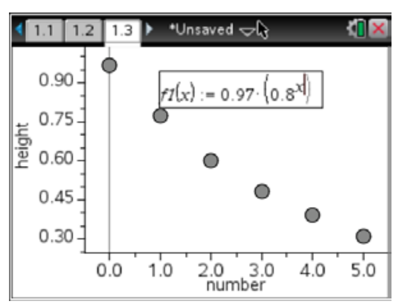
14. Sketch the graph to the right.

15. How does it compare with the prediction that you made prior to the data collection?

    Sample answer: Answers will vary.



16. Check to see how the equation you found matches the data. Select **Menu > Analyze > Plot Function**. Enter the equation for the maximum height as a function of the bounce number. You must use *x* for the bounce number in the equation.



Teacher Tip: Some students may need to make some slight adjustments, but the equation should fit the data well.

17. Does the function that you entered match the data? If not, make adjustments. Record the equation that matches your data and any needed adjustments.

Sample answer: Answers will vary.

18. An exponential equation has the form $y = a \times b^n$. Explain what *a* and *b* represent in this equation.

Sample answer: The value of *a* represents the initial height of the ball from the floor. The value of *b* represents the percentage of the height retained each bounce.

19. Use your model to predict the height of the next bounce. Show your work.

Sample answer: $H_n = 0.97 \times (0.8)^n$; $H_6 = 0.97 \times (0.8)^6$; $H_6 = 0.97 \times (0.8)^6 = 0.97 \times 0.26 = 0.25$; 0.25 m

20. Why do you think the ball does not bounce as high as the previous bounce?

Sample answer: Energy is lost each time the ball bounces.

21. In science, you learn about kinetic and potential energy. How do the concepts of energy relate to this bouncing ball? Is mechanical energy conserved?

Sample answer: Mechanical energy is the sum of kinetic and potential energies. The ball begins with potential energy only. As the ball falls, the potential energy is converted to kinetic energy. When the ball strikes the ground, its potential energy with respect to the ground is zero because all of the energy is now kinetic. When the ball makes contact with the ground, the kinetic energy is converted to heat energy and therefore mechanical energy, but not total energy, is lost.

22. Summarize what you learned in this activity.

Sample answer: Answers will vary.

Why Bigger Is Not Necessarily Better

TI PROFESSIONAL DEVELOPMENT

Name ________________

Class ________________

Open the TI-Nspire™ document *Why_Bigger_is_Not_Necessarily_Better_Simulation.tns.*

In this activity, you will investigate one consequence of an increase in volume of an object, which will be used to represent a single cell.

Move to page 1.2.

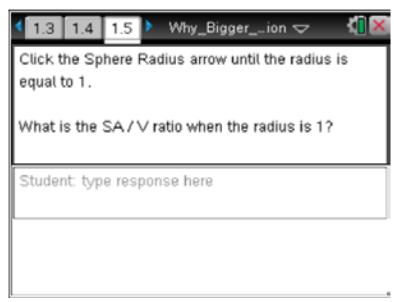
Press ctrl ▶ and ctrl ◀ to navigate through the lesson.

Did you know that the biggest cell on the planet is an ostrich egg? In contrast, most cells are FAR smaller. For example, red blood cells are only 7 or 8 MILLIONTHS of a meter in diameter, and the biggest bacterial cells are about 1/10th the size of red blood cells! Why are most cells so small? In Biology, whether you're considering tiny structures like cells, or huge animals like elephants and whales, surface area plays a key role in function and survival.

As you perform this experiment and graph the data you collect, think about how the surface area and volume of a cell affect how rapidly it can exchange materials with its environment. Also, think about the mathematical relationships that are occurring as the size of your "cell" changes. The underlying question is, "What happens to the ratio of surface area to volume as the volume increases?"

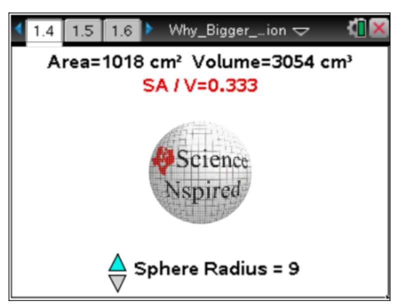
1. Follow the directions within the simulation TI-Nspire document on your handheld.

Move to pages 1.5 through 1.12.



Q1. What is the SA/V ratio when the radius is 1?

Q2. What is the SA/V ratio when the radius is 3?



Q3. What is the SA/V ratio when the radius is 5?

Q4. What is the SA/V ratio when the radius is 10?

Q5. As the radius of the sphere (cell) increased, what happened to the surface area AND the volume of the sphere (cell)?

Why Bigger Is Not Necessarily Better

TI PROFESSIONAL DEVELOPMENT

Name _______________

Class _______________

A. It increased. B. It decreased. C. It stayed the same.

Q6. If the sphere were a model for a cell, what would the "surface area" represent?

A. The nucleus B. The plasma membrane C. A ribosome D. A single cilium

Q7. As the radius of a sphere (cell) _______, the SA/V ratio of that sphere (cell) ________.

A. increases; increases B. decreases; decreases C. increases; decreases

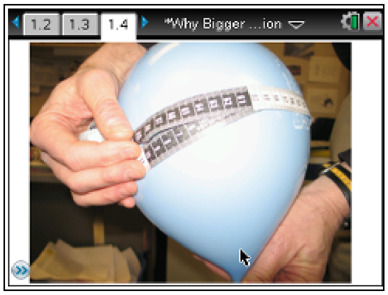
Open *Why_Bigger_Is_Not_Necessarily_Better_Data_Collection.tns* with Mathematical analysis.

Move to page 1.2.

- When asked if you want to save the simulation document, click No.

2. Work through the data collection activity in pairs. One person needs to be the “balloon inflater”, and other needs to be the “measurer”.

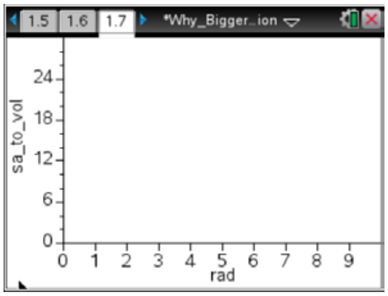
3. Inflate the balloon to six different sizes, measuring the circumference of the balloon to the nearest centimeter.



4. In the spreadsheet on Page 1.5, enter these circumferences into rows 1-6 of Column A. After entering the circumference measurement, also enter a decimal point.

5. What does the graph of volume as a function of radius look like? What does the graph of surface area as a function of radius look like?

6. Use your knowledge about the formulas for surface area and volume to predict what the graph of the ratio surface area to volume as a function of radius will look like. Sketch your prediction in the space to the right and write a sentence to explain your prediction.



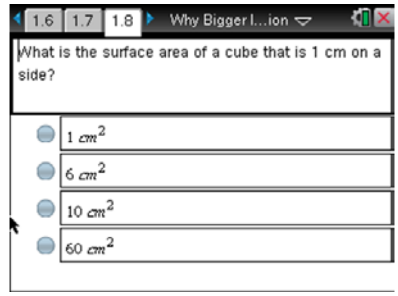
Why Bigger Is Not Necessarily Better

TI PROFESSIONAL DEVELOPMENT

Name ________________

Class ________________

Move to pages 1.8 through 1.17.



Q8. What is the surface area of a cube that is 1 cm on a side?

A. 1 cm^2 B. 6 cm^2 C. 10 cm^2 D. 60 cm^2

Q9. As your balloon got bigger, what happened to the surface area?

A. It got bigger. B. It got smaller. C. It stayed the same.

Q10. As your balloon got bigger, what happened to the volume?

A. It got bigger. B. It got smaller. C. It stayed the same.

Q11. As your balloon got bigger, what happened to the SA/V ratio?

A. It got bigger. B. It got smaller. C. It stayed the same.

Q12. If you know the circumference of a circle or a sphere, how can you calculate the radius?

A. Multiply the circumference by 2π

B. Divide the circumference by 2π

C. Multiply the circumference by πr^2

D. Divide the circumference by $2\pi r$

Q13. Measurements for _______ are expressed as $units^2$, while measurements for _______ are expressed as $units^3$.

A. volume; surface area B. surface area; volume C. surface area; diameter D. volume; radius

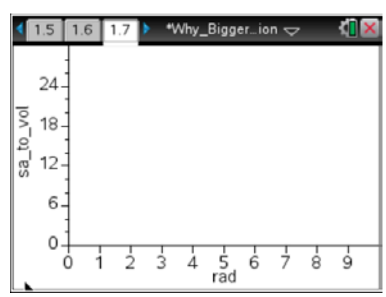
Q14. The formula for the SA of a sphere is $4\pi r^2$. The formula for the volume of a sphere is $(4/3)\pi r^3$. Plug these individual formulas into the fraction: SA/V. Then simplify the resulting fraction.

Q15. Two people are 6'3" tall. One weighs 170 pounds, while the other weighs 270 pounds. Which of these two people has a greater SA / V ratio?

A. The one weighing 170 pounds B. The one weighing 270 pounds

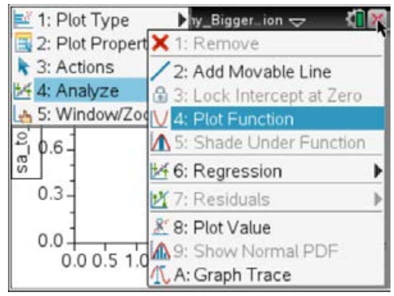
Mathematics Extension:

Next, you'll be graphing some of the data from the spreadsheet, so you can learn more about the relationship between the surface area and the volume of the balloon.



1. Move back in your document to Page 1.7, a Data & Statistics page. Click on the horizontal axis, and select **rad** for the independent variable.
2. Click on the vertical axis, and select **sa_to_vol** for the dependent variable. How does the plot compare with the prediction that you made earlier? Sketch the graph of surface area to volume as a function of radius in the space to the right.

3. Once you have plotted the data, determine an equation for the ratio of surface area to volume as a funciton of radius. Select **Menu > Analyze > Plot Function**. Enter the equation for the ratio as a function of the radius. You must use *x* for the radius in the equation. Does the function that you entered match the data? If not, make adjustments. Record the equation that matches your data.



4. What type of regression would match up with your data? Select **Menu > Analyze > Regression** and choose the appropriate model from the list. Record your equation and explain why it is appropriate.

Q16. In really hot weather, which of the two people from the previous question would have a tougher time cooling off by getting rid of body heat?

A. The one weighing 170 pounds B. The one weighing 270 pounds

Q17. Mammals that live in the desert tend to be "lanky" with large, thin ears. Those that live in the arctic tend to be "round" shaped with very small, hair-covered ears. Why?

A. Managing body temperature is critical to survival in both environments.
B. It helps both be better camouflaged.
C. It helps them avoid predators.

Write a summary about the mathematics and science concepts explored in this activity. Be sure to explain why bigger is not necessarily better.

Science Objectives

- Students will determine the relationship between the surface area and the volume of a sphere.
- Students will use an understanding of surface area and volume to explain cellular membrane dynamics.
- Students will use a graph to interpret and analyze a biological principle.
- Students will analyze data numerically, graphically, and symbolically.
- Students will apply the relationships between the radius of a sphere and its circumference, surface area, and volume.

Vocabulary

- radius
- circumference
- surface area
- volume
- cell membrane

About the Lesson

- This lesson involves examining the relationship between surface area and volume.
- As a result, students will:
    - Use two separate TI-Nspire documents—the first for simulation, the second for data collection.
    - Draw conclusions based on the simulation and their own data collection about the Surface Area to Volume relationship and why biological cells must remain small.

TI-Nspire™ Navigator™ System

- Use Class Capture to monitor student progress.
- Use Live Presenter to allow students to show their graphs to the class.

Activity Materials

- Latex balloons
- Tape measure (or meter sticks and string)

TI-Nspire™ Technology Skills:

- Download a TI-Nspire™ document
- Open a document
- Move between pages
- Entering and graphing data
- Tracing and interpolating

Tech Tips:

- Make sure the font size on your TI-Nspire handhelds is set to Medium.

Lesson Materials:

Student Activity

- Why_Bigger_is_Not_Necessarily_Better_PD_Student.pdf
- Why_Bigger_is_Not_Necessarily_Better_PD_Student.doc

TI-Nspire document

- Why_Bigger_is_Not_Necessarily_Better_Simulation.tns
- Why_Bigger_is_Not_Necessarily_Better_Data_Collection.tns

Discussion Points and Possible Answers (Simulation)

Move to page 1.4.

Q1. What is the SA/V ratio when the radius is 1?

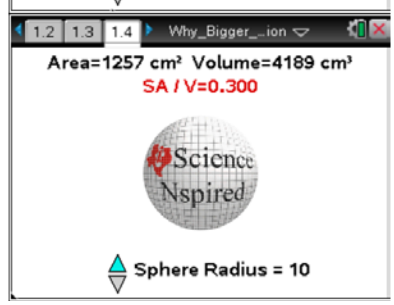
Answer: 3

Q2. What is the SA/V ratio when the radius is 3?

Answer: 1

Q3. What is the SA/V ratio when the radius is 5?

Answer: 0.6



Q4. What is the SA/V ratio when the radius is 10?

Answer: 0.3

Q5. As the radius of the sphere (cell) increased, what happened to the surface area AND the volume of the sphere (cell)?

Answer: They increased

Q6. If the sphere were a model for a cell, what would the "surface area" represent?

Answer: The plasma membrane

Q7. As the radius of a sphere (cell) _______, the SA/V ratio of that sphere (cell) ________.

Answer: increases; decreases

Discussion Points and Possible Answers (Data Collection)

Q8. What is the surface area of a cube that is 1 cm on a side?

Answer: 6 cm^2

Q9. As your balloon got bigger, what happened to the surface area?

Answer: It got bigger.

Q10. As your balloon got bigger, what happened to the volume?

Answer: It got bigger.

Q11. As your balloon got bigger, what happened to the SA/V ratio?

Answer: It got smaller.

Q12. If you know the circumference of a circle or a sphere, how can you calculate the radius?

Answer: Divide the circumference by 2π.

Q13. Measurements for _______ are expressed as $units^2$, while measurements for _______ are expressed as $units^3$.

Answer: surface area; volume

Q14. The formula for the SA of a sphere is $4\pi r^2$. The formula for the volume of a sphere is $(4/3)\pi r^3$. Plug these individual formulas into the fraction: SA/V. Then simplify the resulting fraction.

Answer: 3/r

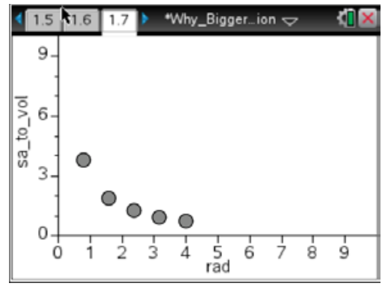
Q15. Two people are 6'3" tall. One weighs 170 pounds, while the other weighs 270 pounds. Which of these two people has a greater SA / V ratio?

Answer: The one weighing 170 pounds

Mathematics Extension:

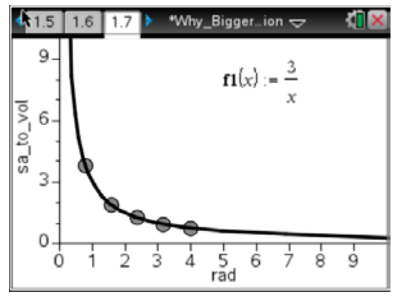
Next, you'll be graphing some of the data from the spreadsheet, so you can infer the relationship between the surface area and the volume of the balloon.

1. Move back in your document to Page 1.7, a Data & Statistics page. Click on the horizontal axis, and select **volume** for the independent variable.



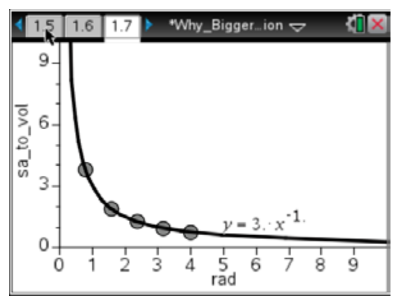
2. Click on the vertical axis, and select **sa_to_vol** for your dependent variable. How does the plot compare with the prediction that you made earlier? Sketch the graph of surface area to volume as a function of radius in the space to the right.

   <u>Sample Answer</u>: See sample data to the right.



3. Once you have plotted the data, determine an equation for the ratio of surface area to volume as a funciton of radius. Select **Menu > Analyze > Plot Function**. Enter the equation for the ratio as a function of the radius. You must use *x* for the radius in the equation. Does the function that you entered match the data? If not, make adjustments. Record the equation that matches your data.

   <u>Sample Answer</u>: Since $SA = 4\pi r^2$ and $V = \frac{4}{3}\pi r^3$, the ratio is $\frac{4\pi r^2}{\frac{4}{3}\pi r^3}$, the ratio is $\frac{3}{r}$.



4. What type of regression would match up with your data? Select **Menu > Analyze > Regression** and choose the appropriate model from the list. Record your equation and explain why it is appropriate.

   <u>Sample Answer</u>: A power regression gives the equation $y = 3 \cdot x^{-1}$.

Q16. In really hot weather, which of the two people from the previous question would have a tougher time cooling off by getting rid of body heat?

<u>Answer</u>: The one weighing 270 pounds

Q17. Mammals that live in the desert tend to be "lanky" with large, thin ears. Those that live in the arctic tend to be "round" shaped with very small, hair-covered ears. Why?

<u>Answer</u>: Managing body temperature is critical to survival in both environments

TI-Nspire™ Navigator™ Opportunity, *Class Capture*
Class Capture can be used to monitor students' progress.

Wrap Up

Be sure to discuss the “reality” that is not inherent in this activity. That is, very few cells are actually “spherical”. It is true that most animal cells are of a round-ish shape, but they tend to be flattened out, and often have projections from the membrane surface. This serves to dramatically increase surface area while having a negligible effect on the volume of the cell.

Assessment

Formative assessment will consist of questions embedded in the TI-Nspire document. The questions will be graded when the document is collected. The Slide Show can be utilized to give students immediate feedback on their assessment.

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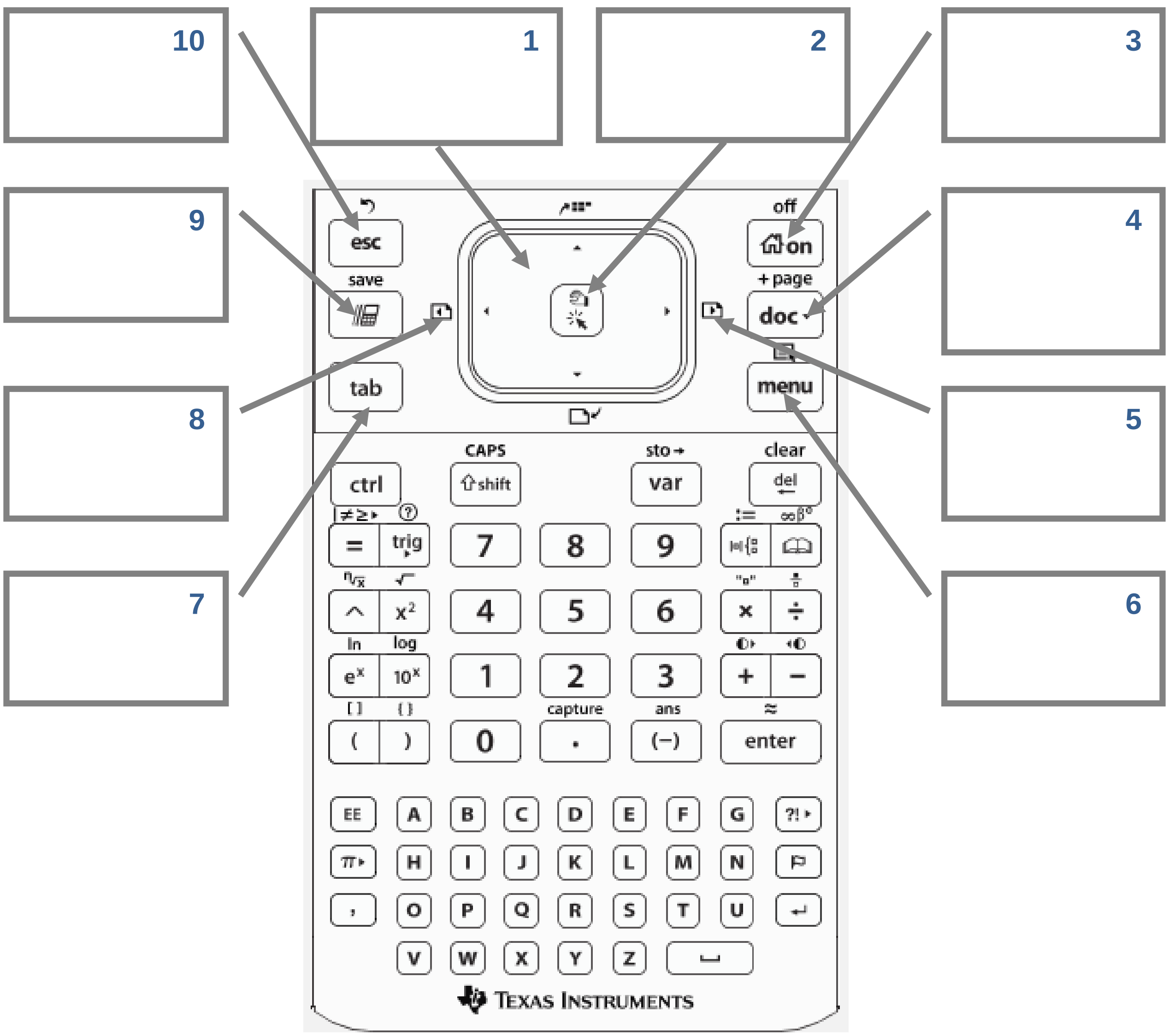
TI-Nspire™ CX Family Overview

TI PROFESSIONAL DEVELOPMENT

Activity Overview

In this activity you will become familiar with the most commonly used keys on the TI-Nspire™ CX family of handhelds.



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Checking and Updating the Operating System

TI PROFESSIONAL DEVELOPMENT

Activity Overview

In this activity, you will learn how to check the operating system (OS) on a TI-Nspire™ handheld and update it using the TI-Nspire™ family of Teacher Software.

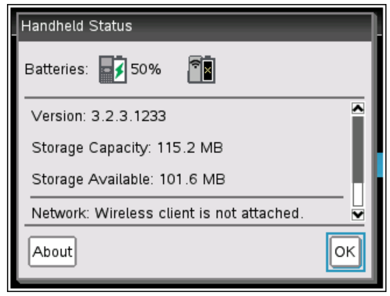
Materials

- TI-Nspire™ Teacher Software and USB connection cable

Viewing Handheld Status

The Handheld Status screen displays the battery status, (OS) version, available space, the network (if any), and your student login name and whether you are logged in.

To view the Handheld Status, press [on] and select **Settings** > **Status**. The Handheld Status dialog box opens.



Note: The About screen displays the handheld type and product ID. To view the About screen from the Handheld Status screen, click **About**. To return to the home screen, press [enter].

Updating the Handheld OS

You can update the OS on your TI-Nspire™ handheld using the TI-Nspire™ Teacher Software or by transferring the OS from one handheld to another. OS upgrades do not delete user documents. If there is not enough room on the receiving handheld for the upgrade, the sending handheld is notified. The only time documents can be affected by an OS installation is if the receiving handheld has a corrupted OS. It is a good practice to back up important documents and folders before installing an updated OS.

Important OS Download Information

In the TI-Nspire™ family of handhelds, different handheld types require different operating systems:

- The OS for the TI-Nspire™ CX handheld has the file extension *.tco*.
- The OS for the TI-Nspire™ CX CAS has the file extension *.tcc*.
- The OS for the TI-Nspire™ with Touchpad or Clickpad has the file extension *.tno*.
- The OS for the TI-Nspire™ CAS with Touchpad or Clickpad has the file extension *.tnc*.

Always install new batteries before beginning an OS download. When in OS download mode, the APD™ (Automatic Power Down) feature does not function. If you leave your handheld in download mode for an extended time before you begin the downloading process, your batteries may become depleted. You will then need to install new batteries before downloading the OS.

Checking and Updating the Operating System

TI PROFESSIONAL DEVELOPMENT

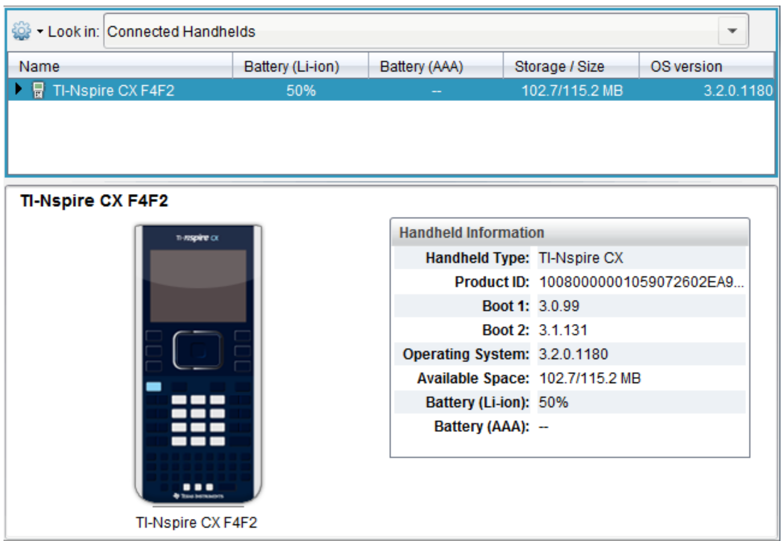
Finding Operating System Upgrades

Your TI-Nspire™ Teacher Software has convenient links to a number of useful Texas Instruments web sites, including those with handheld OS updates. You will need an Internet connection and the appropriate USB cable to download and install the updates.

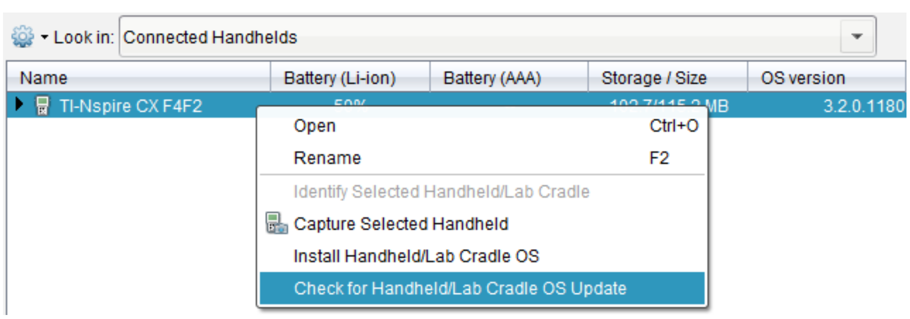
Using TI-Nspire Teacher Software to Update the Handheld OS

Open the TI-Nspire Teacher Software and connect a TI-Nspire handheld to the computer using the USB connection cable. Go to the Document Workspace, select the Content Explorer tab, and click **Connected Handhelds**. Multiple handhelds can be connected to the computer using multiple USB ports, USB hubs, or the TI-Nspire™ Docking Station. If multiple handhelds are connected to the computer, then multiple handhelds appear in the list of Connected Handhelds.

The connected handheld appears in the Content Window, along with battery, storage, and OS information. More detailed information appears in the Handheld Information window.



To see if a new OS is available, right-click the handheld and select **Check for Handheld OS Update**. To update the OS, right-click the handheld and select **Install Handheld OS**. A window appears that asks you to select the handheld OS file. Select the OS file and click **Install OS**. A window appears informing you that any unsaved data will be lost, and it asks if you want to continue. Select **Yes**.



The Press-to-Test Feature

TI PROFESSIONAL DEVELOPMENT

Activity Overview

The Press-to-Test feature enables you to quickly prepare student handhelds for exams by temporarily disabling folders, documents, and select features and commands. This activity enables Press-to-Test. To disable Press-to-Test, you will need to follow Steps 8-9 using either an additional TI-Nspire handheld or a computer with the TI-Nspire Teacher Software.

Materials

- TI-Nspire™ handheld-to-handheld or handheld-to-computer USB connection cable

Step 1:

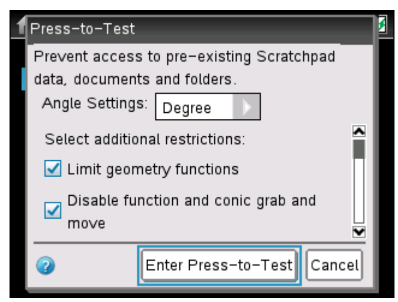
To enable Press-to-Test on the TI-Nspire™ with Touchpad and TI-Nspire CX™, first ensure that the handheld is turned off. Press and hold [esc] and [on] until the Press-to-Test screen appears.

Note: To enable Press-to-Test on TI-Nspire™ with Clickpad, press and hold [esc], [on], and [off on].

Step 2:

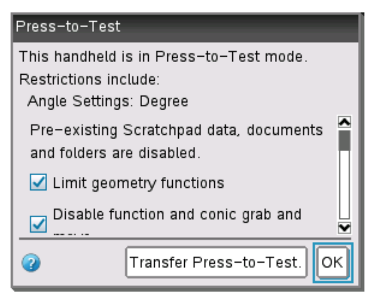
By default, Press-to-Test disables 3D graphing and pre-existing Scratchpad data, documents, and folders. The angle settings can be changed by pressing ▸, selecting the appropriate setting, and pressing ▸ or [enter].

By default, all of the commands and features listed are disabled. To enable a feature or command, uncheck its box. Keep all boxes checked. Enter Press-to-Test by clicking **Enter Press-to-Test**.



Step 3:

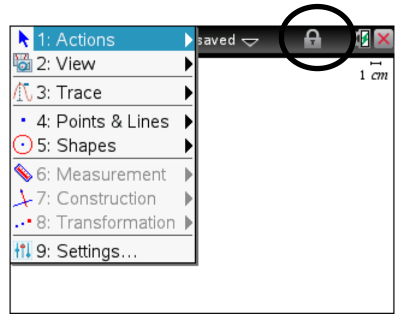
Once the handheld is in Press-to-Test mode, the handheld reboots. A dialog box confirms that the handheld is in Press-to-Test mode and the restrictions are listed. Click OK.



Step 4:

When in Press-to-Test mode, the LED at the top of the handheld begins blinking. Green indicates that all restrictions are selected (default), while yellow indicates that one or more restrictions are unselected. During the initial reboot, the LED alternates between red and, depending on the restrictions, either green or yellow.

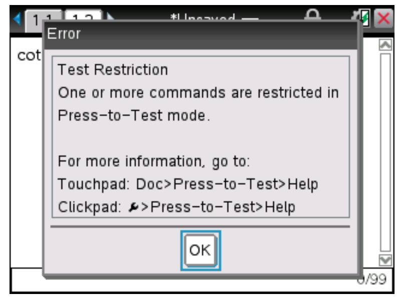
Step 5:



Create a new document, add a Geometry page, and press menu. Since geometry functions are limited, observe that the **Measurement**, **Construction**, and **Transformation** menus are not accessible.

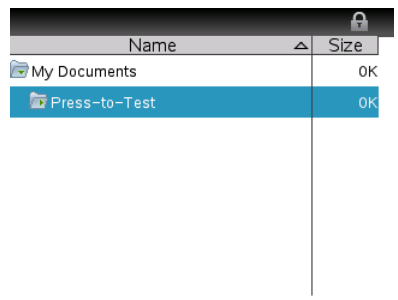
Note: The lock icon at the top of the screen indicates that the handheld is in Press-to-Test mode.

Step 6:



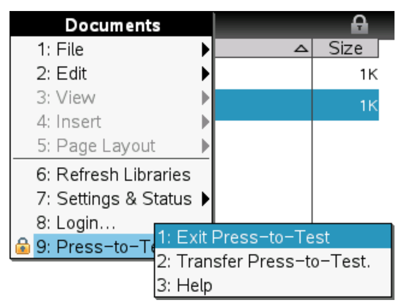
Add a Calculator application by selecting doc▾ **> Insert > Calculator**. Type **cot(*π*/2)** and press enter. Since trigonometric functions are limited, an error message appears. The dialog box tells students how to access additional information about the restrictions. Click on OK.

Step 7:



Select on **> My Documents.** While in Press-to-Test mode, a Press-to-Test folder appears in My Documents. All other folders and documents present on the handheld before Press-to-Test mode was entered are inaccessible.

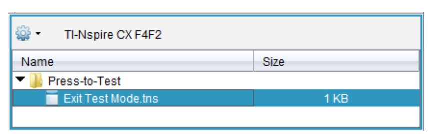
Step 8:



To exit Press-to-Test mode, connect two handhelds using the handheld-to-handheld USB connection cable. Then select doc▾ **> Press-to-Test > Exit Press-to-Test**. The Exit Press-to-Test option appears regardless of whether the other handheld is in Press-to-Test mode.

Press-to-Test can also be exited with the TI-Nspire™ Navigator™ Teacher Software. Once a class has been started, students can select doc▾ **> Press-to-Test > Exit Press-to-Test**.

Step 9:



Press-to-Test can also be exited with TI-Nspire Teacher Software or TI-Nspire Navigator Teacher Software by creating a document named ***Exit Test Mode.tns*** and transferring it to connected handhelds.

Note: The name of the TI-Nspire document must be spelled exactly as it is above.

Go to the Tools menu and select **Transfer Tool**. Click **Add to Transfer List** and select *Exit Test Mode.tns*. In the Edit Destination Folder, select the Press-to-Test folder and click Change. Then, click **Start Transfer.**

Transferring Documents Between Handhelds
TI PROFESSIONAL DEVELOPMENT

Activity Overview

In this activity, you will learn how to transfer a document from one TI-Nspire™ CX handheld to another.

Materials

- Two TI-Nspire CX handhelds
- Unit-to-unit connection cable (Mini A to Mini B USB)

Transferring a document or a folder

Documents can be transferred between two TI-Nspire CX handhelds by connecting them with the unit-to-unit mini USB cable. The USB A port is located at the top of the handheld on the right side.

Step 1:

Firmly insert the ends of the mini USB unit-to-unit cable into the USB A ports of the handhelds. The handhelds will automatically turn on when the cable is plugged in.

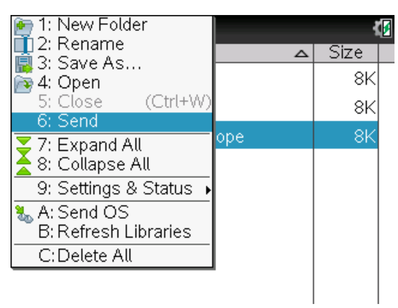
Step 2:

Open **My Documents** on the sending handheld.

Step 3:

Press the ▲ and ▼ keys to highlight the document or folder to send.

Step 4:



Press [menu] and select **Send**. No action is required by the user of the receiving TI-Nspire CX handheld. Once the transfer begins, a progress bar displays the status of the transfer. When the transfer is complete, a message displays on the receiving handheld. If the document was renamed on the receiving handheld, the new document name appears.

Note: When sending a folder from one handheld to another, the file structure in the sending folder is retained. If the folder does not exist on the receiving handheld, it will be created. If the folder does exist, files will be copied into it, with appended names added to any duplicate files.

Note: To cancel a transmission in progress, select **Cancel** in the dialog box of the sending handheld. To cancel a transfer from the receiving handheld, press esc. The receiving handheld, however, cannot cancel a transfer of folders. If an error message appears, press esc or enter to clear it.

Guidelines for transferring documents or folders

The guidelines for sending an individual document also apply to documents within folders that are sent.

- If you send a document with the same name as an existing document on the receiving TI-Nspire CX handheld, the system renames the sent document by appending a number to the name. For example, if you send a document named *Mydata* to another TI-Nspire handheld that already contains a document named *Mydata*, the document you send will be renamed *Mydata(2)*. Both the sending and receiving units display a message that shows the new name.
- There is a 255-character maximum length for a document name, including the entire path. If a transmitted document has the same name as an existing document on the receiving handheld and the document names contain 255 characters, then the name of the transmitted document will be truncated to allow the software to follow the renaming scheme described in the previous bullet.
- All variables associated with the document being transmitted are transferred with the document.
- Transmissions will time out after 30 seconds.

Transferring Documents Using the TI-Nspire™ Family of Teacher Software
TI PROFESSIONAL DEVELOPMENT

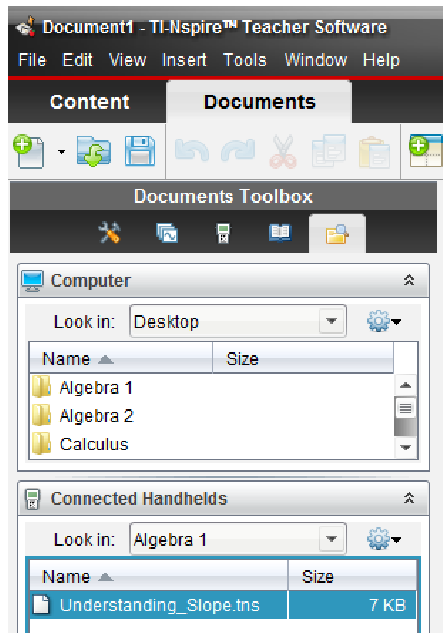
Activity Overview

In this activity, you will use the Documents and Content Workspaces of the TI-Nspire™ family of Teacher Software to transfer TI-Nspire™ documents between the computer and the handheld.

Materials

- TI-Nspire™ Teacher Software
- TI-Nspire™ handheld and USB connection cable

Transferring Documents in the Documents Workspace



Step 1:

Open the Teacher Software. Go to the Documents Workspace by clicking the **Documents** tab.

Step 2:

Connect a TI-Nspire™ handheld to the computer using the USB connection cable. Multiple handhelds can be connected using multiple USB ports, USB hubs, or the TI-Nspire™ Docking Station. If multiple handhelds are connected, then multiple handhelds appear in the Connected Handhelds panel.

Step 3:

Documents can be transferred between the computer and connected handhelds using the Content Explorer in the Documents Toolbox. Open the Content Explorer by clicking the  **Content Explorer** tab.

Step 4:

To transfer a TI-Nspire document from the computer to the handheld, locate the document in the Computer panel. Click, drag, and drop it into the handheld in the Connected Handhelds panel.

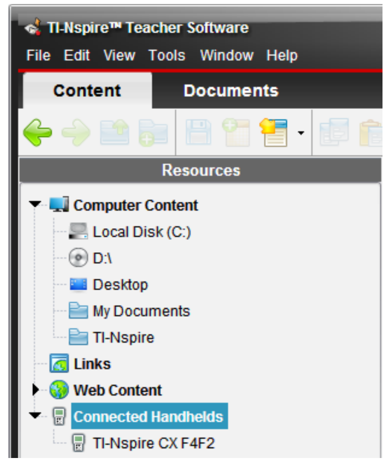
Step 5:

To transfer a TI-Nspire™ document from the connected handheld to the computer, locate the document in the Connected Handhelds panel. Click, drag, and drop it into the desired folder in the Computer panel.

Transferring Documents Using the TI-Nspire™ Family of Teacher Software

TI PROFESSIONAL DEVELOPMENT

Transferring Documents in the Content Workspace

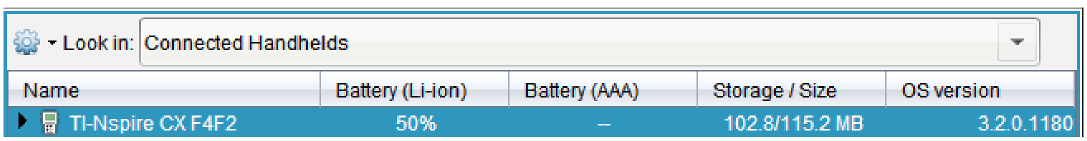


Step 6:

Go to the Content Workspace by clicking the **Content** tab. In the Resources panel, select **Connected Handhelds**.

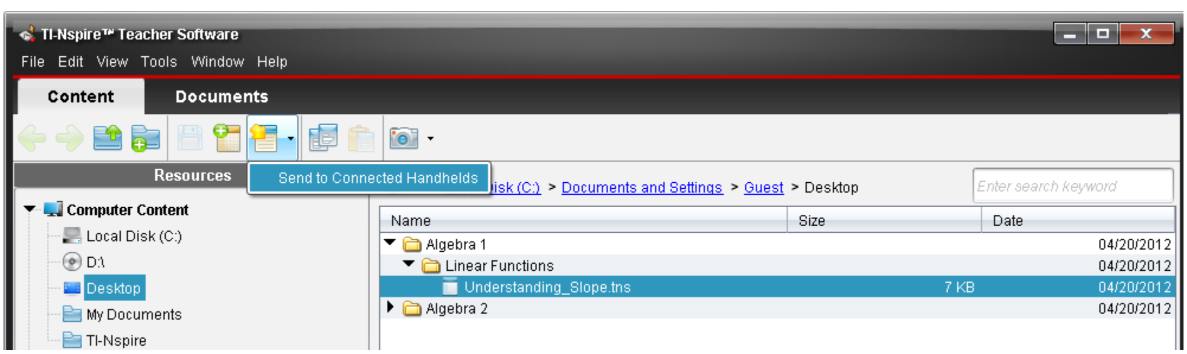
Step 7:

The connected handheld appears in the Content window, along with battery, storage, and OS information. To view the documents on a connected handheld, right-click it and select Open.



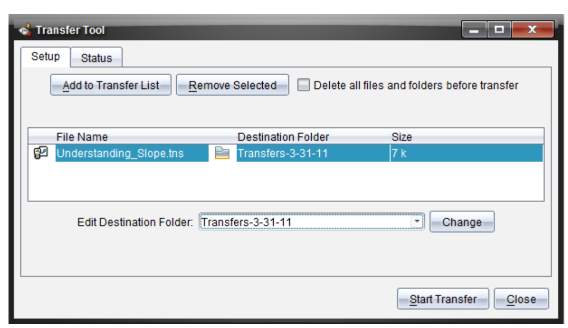
Step 8:

Locate a TI-Nspire™ document on your computer by browsing Computer Content in the Resources panel. Send the document by dragging and dropping it to the connected handheld. The document can also be sent by right-clicking it and selecting **Send to Connected Handhelds**.



Step 9:

The Transfer Tool window appears with the current document. Documents can be added to or removed from the transfer list, and the destination folder on the handheld(s) can be edited or changed. To send the document to the handheld(s), click **Start Transfer**. Once the Status tab indicates that the transfer is complete, click **Stop Transfer**.



Inserting an Image into a TI-Nspire™ Document

TI PROFESSIONAL DEVELOPMENT

Activity Overview

In this activity, you will learn how to use the TI-Nspire™ family of Teacher Software to insert images into the Graphs and Geometry applications. You will also learn how to move, resize, compress, and stretch an image, as well as make it appear more transparent.

Materials

- TI-Nspire™ Teacher Software

Step 1:

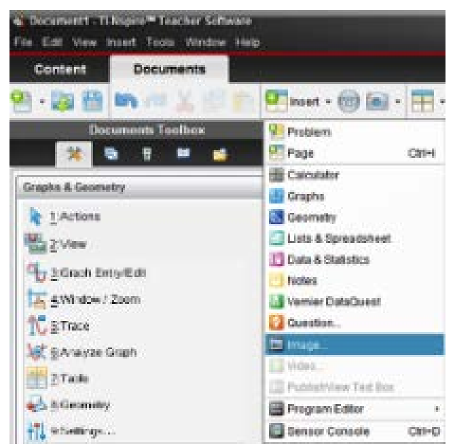
Open the Teacher Software. If the Welcome Screen appears when the software is opened, click to create a new document with a Graphs application as its first page. Otherwise, insert a Graphs application by selecting **Insert >** **Graphs**.

Note: Images can be inserted into Graphs, Geometry, Data & Statistics, Notes, and Question applications.

Step 2:

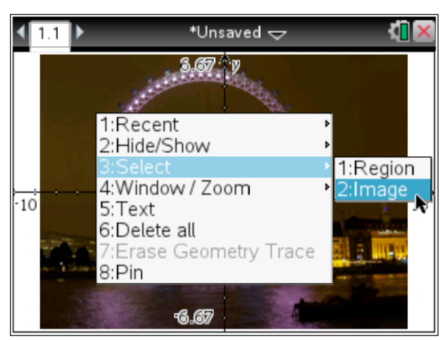
Insert an image into the Graphs application by selecting **Insert >** **Image**. A selection of images is preloaded in the **My Documents >TI-Nspire > Images** folder. Select **Ferris Wheel.jpg** and click Open.

Note: Although the Teacher Software comes with a selection of preloaded images, all jpg, jpeg, bmp, and png images are supported. The optimal format is .jpeg 560 × 240. Larger images may take the document longer to load on the handheld. Images appear in grayscale for TI-Nspire™ handhelds with Touchpads and Clickpads.



Step 3:

Images can be moved, resized, and vertically or horizontally stretched or compressed. To select an image in the Graphs, Geometry, or Question application, right-click on the image and choose **Select > Image**. To select an image in the Notes application, click the image. To move the image, grab and move the image. To resize the image, grab and move a corner. To vertically stretch or compress the image, grab and move the top or bottom edge. To horizontally stretch or compress the image, grab and move the left or right edge.

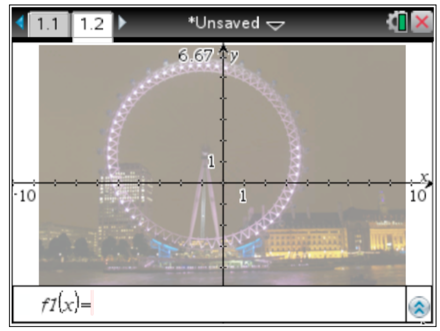


Note: To right-click an object on a handheld, press ctrl menu. To grab an object, press ctrl [grab]. To let go of an object, press esc.

Step 4:

To make an image appear more transparent, insert the image in a Geometry application, and then change the page to a Graphs application.

Select **Insert > Geometry**. Then insert an image by selecting **Insert > Image**. Again, choose **Ferris Wheel.jpg.** To change the Geometry application to a Graphs application, select **View > Graphing**.



Creating a Question Document

TI PROFESSIONAL DEVELOPMENT

Activity Overview

In this activity, you will create a question document using the Question application of the TI-Nspire™ family of Teacher Software. As the document is created, properties of the six question types – Multiple Choice, Open Response, Equations and Expressions, Coordinate Points & Lists, Image, and Chemistry – will be explored.

Materials

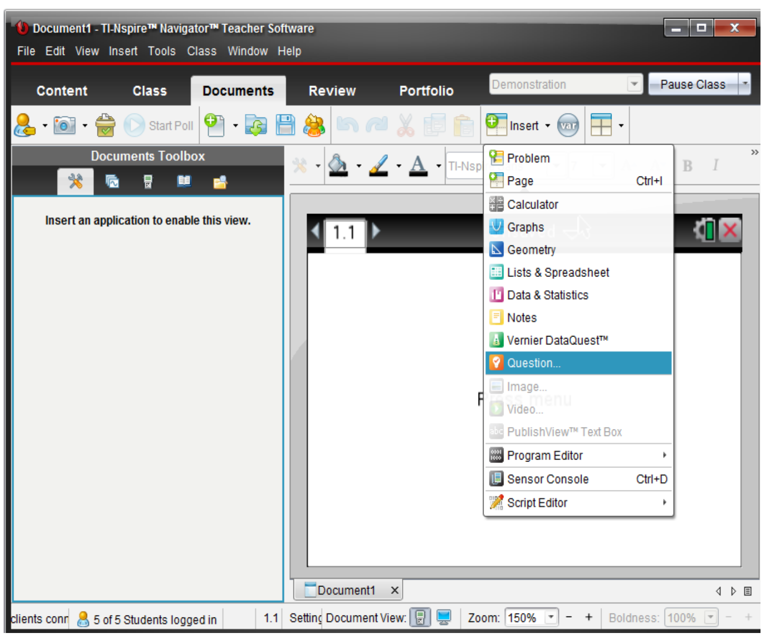
- TI-Nspire™ Teacher Software

Step 1:

Open the Teacher Software. If the Welcome Screen appears, click to create a new document with the Question application as the first page.

Otherwise, go to the Documents Workspace and create a new document by clicking the New Document icon, .

Insert a Question application by selecting **Insert > Question**.



Note: TI-Nspire™ document pages with the Question application can only be created with Teacher Software. The Question application is not available in the TI-Nspire™ Student Software.

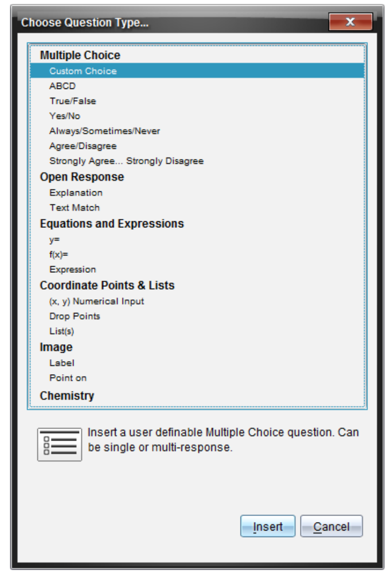
Creating a Question Document

TI Professional Development

Step 2:

The Choose Question Type dialog box appears. Select **Custom Choice** and click **Insert**.

Note: A brief description of the highlighted Question Type appears at the bottom of the window.



Step 3:

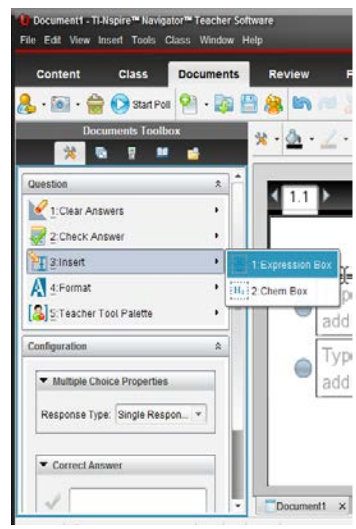
Enter the following problem by typing "Solve for *x*:" and inserting an Expression Box.

Solve for *x*: $\frac{9}{5}x+32=212$

To type the equation into an Expression Box, click on the **Document Tools** pane in the Documents Toolbox. Select **Insert > Expression Box**. Enter the equation. Then, to close an Expression Box, press Enter.

Note: An Expression Box can also be inserted by pressing **Ctrl+M**.

Note: A variety of math templates can be accessed by selecting the Utilities pane in the Documents Toolbox.

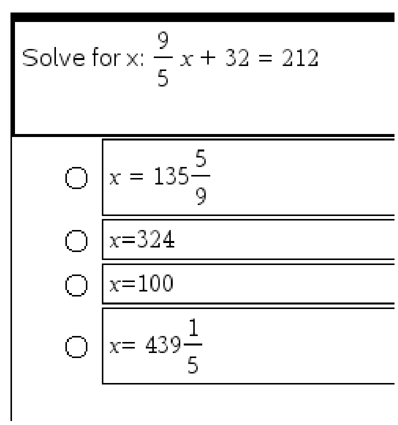


Step 4:

Click in the first answer field. Insert an Expression Box. Type the first answer choice. Press Enter to close the Expression Box. To move to the next answer field, click in the next field or press Enter. Continue to type the following answer choices.

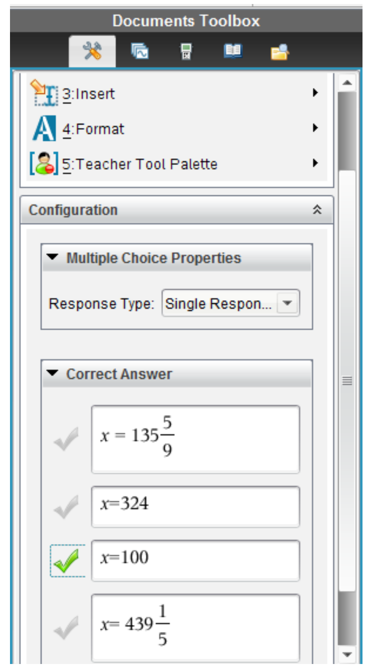
$x=135\frac{5}{9}$, $x=324$, $x=100$, $x=439\frac{1}{5}$

Note: To remove an empty answer field, click in that field and press the Backspace key.



Step 5:

As you type answer choices, they automatically appear in the Correct Answer fields in the Configuration panel of the Document Tools. Select the correct answer by clicking on the check mark in front of the answer choice.



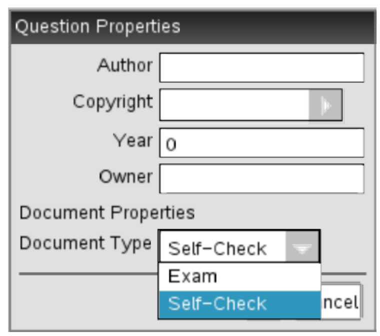
Note: In the Configuration panel, the Multiple Choice Properties can be changed to allow a different Response Type. Single Response allows one correct answer, while Multiple Response allows multiple correct answers. The Multiple Choice Properties and Correct Answer fields can be collapsed by clicking ▾ and expanded by clicking ▸.

Step 6:

There are two types of question documents: Exam and Self-Check. Exam documents can be scored using the TI-Nspire™ Navigator™ System or TI-Nspire™ Navigator™ NC System.

A Self-Check document allows students to check their answers after they select or enter a response. The default setting for the Document Type is Exam.

e a Self-Check Question document, select **Teacher Tool Palette > Question Properties**. Change the Document Type to **Self-Check** and click OK.



Note: The document type selected applies to all questions in the current document.

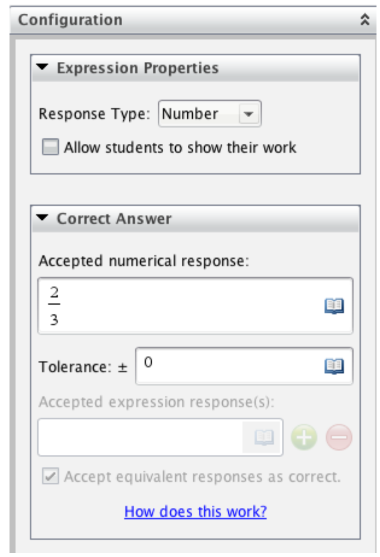
Note: After students answer a question in a Self-Check document, they can check their answers by selecting **Check Answer** from the Menu. A message ("Your current answer is correct." or "Your current answer is incorrect.") is displayed. If the answer is incorrect, two options appear: Show Correct Answer and Try Again.

Note: In Self-Check documents, the Explanation response type (not scored) question does not display the correct or incorrect answer message when students select **Check Answer**. However, any suggested response entered by the teacher will be displayed. The Text Match response type (scored) requires students to exactly match the correct answer, including templates, if applicable. When students select **Check Answer**, the correct or incorrect answer message will be displayed.

Step 7:

Insert a new question by clicking **Insert** and selecting **Question > Equations and Expressions > Expression**. Type the following problem into the question field, inserting an Expression Box for the equation:

What is the slope of the line $2x - 3y = 12$?



Step 8:

In the Configuration panel, under Expression Properties, change Response Type to **Number**. Type $\frac{2}{3}$ in the Correct Answer field.

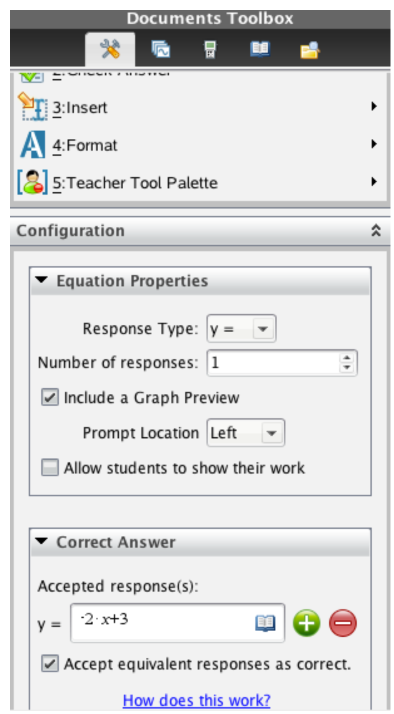
If desired, change the Tolerance from ±0 to ±0.001.

Note: Math templates and symbols can also be accessed by clicking the Utilities icon in the Correct Answer field.

Step 9:

Insert a new question by clicking **Insert** and selecting **Question > Equations and Expressions > *y* =**. Type the following problem into the question field.

Write the equation of a line whose slope is –2 and whose *y*-intercept is 3.



Step 10:

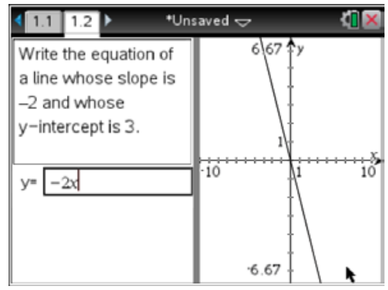
In the Configuration panel, under Equation Properties, check the box for **Include a Graph Preview**. In the Correct Answer field, type $-2x + 3$ as an accepted response. Check the box for **Accept equivalent responses as correct**.

Note: In the Configuration panel, under Equation Properties, the Response Type options include *y* = and *f*(*x*) = notation. The number of responses and prompt location can be changed, and students can be allowed to show their work in a series of blank fields.

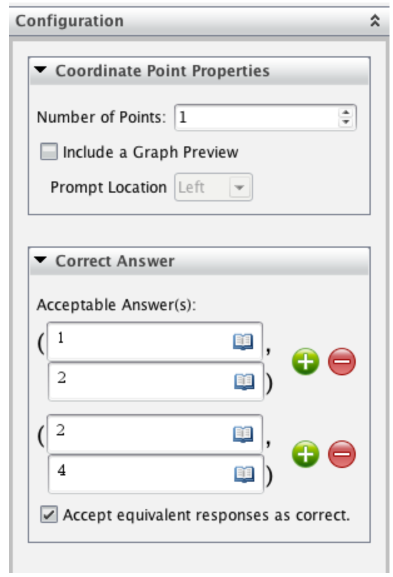
Note: When might you choose not to check the box for **Accept equivalent responses as correct**?

Creating a Question Document

TI Professional Development



Note: By changing the Equation Properties to **Include a Graph Preview**, the page layout of the question is automatically changed and a Graphs application is inserted on the right side of the screen. When an expression is typed into the y = field, the function is automatically graphed. If Enter is pressed, another y = field appears.



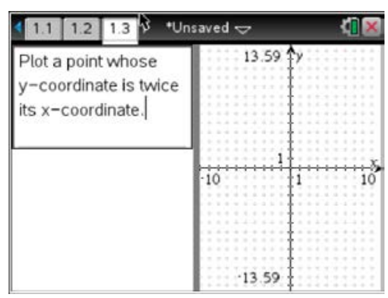
Step 11:

Insert a new question by clicking **Insert** and selecting **Question > Coordinate Points & Lists > Drop Points**. Type the following problem into the question field.

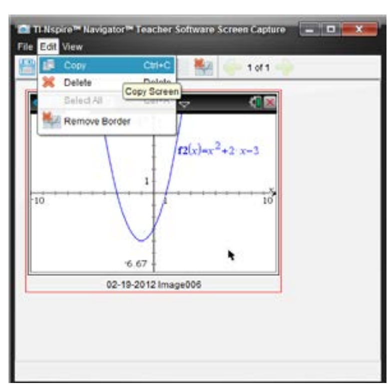
Plot a point whose *y*-coordinate is twice its *x*-coordinate.

Step 12:

In the Correct Answer field, enter (1, 2) as an acceptable answer. Add an additional acceptable answer field by clicking the green addition icon. Enter (2, 4) as an acceptable answer. Check the box for **Accept equivalent responses as correct**.



Note: The **Drop Points** question type automatically includes a Graphs application with a grid.



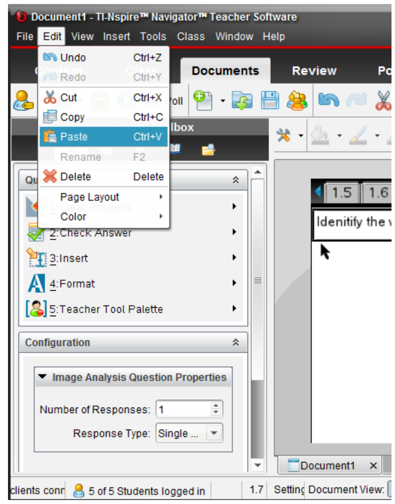
Step 13:

Insert a Graphs page by clicking **Insert** and selecting **Graphs**. Graph the function $f1(x) = x^2 + 2x - 3$. Press **CTRL+J** to capture the graph. The image is automatically copied to the clipboard.

Creating a Question Document

TI PROFESSIONAL DEVELOPMENT

Step 14:



Insert a new question by clicking **Insert** and selecting **Question > Image > Point on**. Type the following problem into the question field.

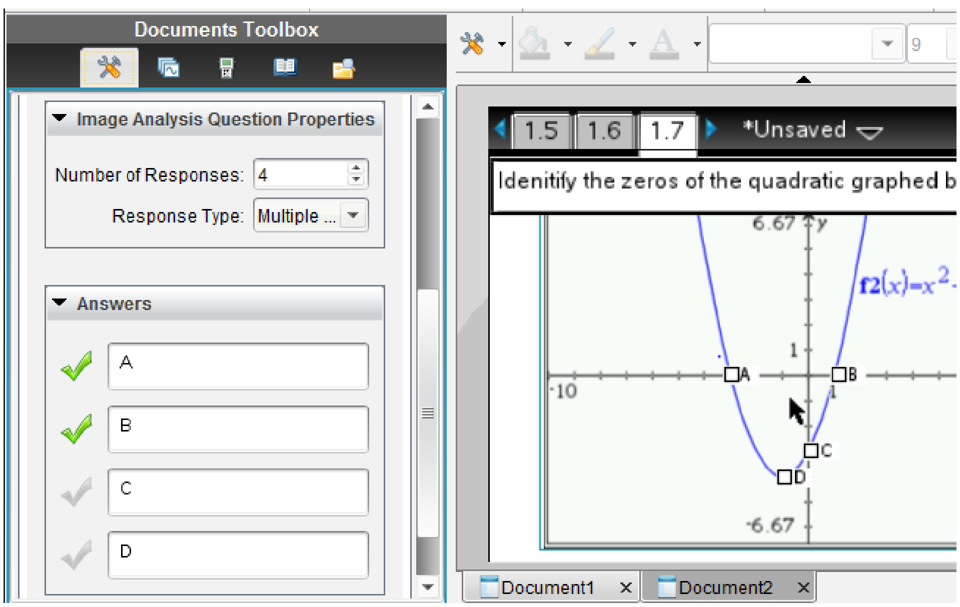
Identify the zeros of the quadratic graphed below.

Click on the bottom half of the screen and choose **Edit > Paste** from the drop-down menu at the top of the screen.

Step 15:

In the Configuration menu change the number of responses to four. This will place four points on the image. Move the points so that two of the points are on the two *x*-intercepts, one is on the *y*-intercept, and the final point is on the vertex.

In the **Answers** menu, click the check boxes to identify the correct answer(s).



Note: Delete the extra Graphs page by changing to the Page Sorter View in the Documents Toolbox, right-clicking on the extra page, and selecting **Delete**.

Creating a Question Document
TI PROFESSIONAL DEVELOPMENT

Step 16:

Insert a new question by clicking **Insert** and selecting **Question > Chemistry**. Type the following problem into the question field:

What is the chemical formula for water?

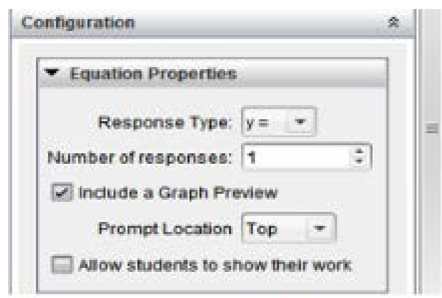
In the Correct Answer field type H20. The Chem Box will automatically convert the “2” to a subscript. Chem Boxes can be used on Question and Notes pages to support chemical formulas.

Note: Chemical symbols are automatically recognized. Subscripts are created automatically when numbers are typed after chemical symbols. Exponents are created by using [^]. The equivalence arrow is created by pressing [=].

Step 17:

Insert a Question application by clicking **Insert > Question.** In the **Equations and Expressions** question type**,** select ***y* =**.

To change the question properties in the Document Tools pane, go to the Configuration panel in the Equation Properties panel. Select **Include a Graph Preview** and change the **Prompt Location** to **Top**.

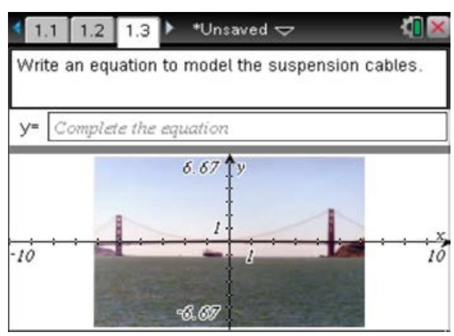


Note: To maximize the area of the Graph Preview, grab and move the gray bar separating the question and answer fields from the Graph Preview.

Step 18:

Insert an image into the Graph Preview by clicking the graph and then selecting **Insert > Image**. Choose **Bridge1.jpg** and click **Open**. Type the following problem into the question field.

Write an equation to model the suspension cables.



Save the document.

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After reading this guide you will have a wealth of ideas about how you can use the TI-Nspire^{TM} to collect and analyze data for the experiments in this AP Chemistry lab manual.

Data Collection – Getting Started

1. Decide what sensor(s) is(are) appropriate for your experiment. Most likely you will be using one or more of the following sensors in an AP Chemistry experiment: temperature, pH, conductivity, voltage or the colorimeter.
2. Choose the appropriate interface device (EasyTemp^{TM}, EasyLink^{TM} cable, TI-Lab Cradle^{TM}) and attach it to the Nspire.

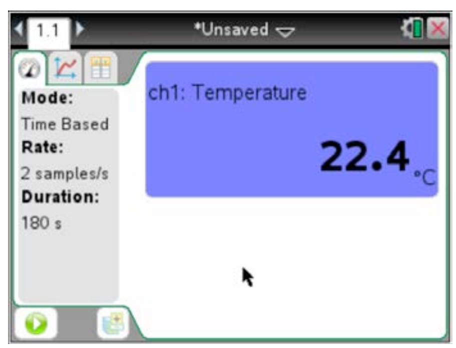
EasyTemp

EasyLink

TI-Lab Cradle

3. Connect the sensor(s) to the interface device. (When using the Lab Cradle and only one sensor, it is best to plug the sensor into Channel 1.)
4. Launch the DataQuest^{TM} application. (Note: In most cases the DataQuest application will launch automatically. If not, from the home screen on the Nspire, select **1** for **New Document** and then choose the DataQuest application from the applications available.)

Data Collection – How Do I Collect Data?



There are three main methods of data collection:

1. Use the meter window.
2. Perform a "Time Based" experiment.
3. Perform an "Events with Entry" experiment.

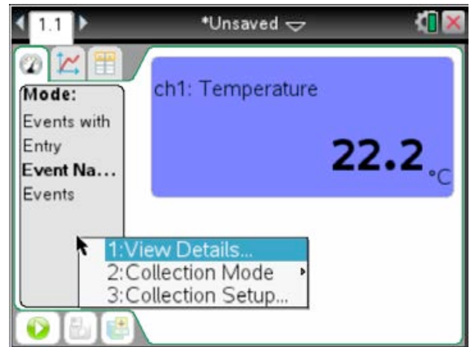
Using the Meter Window

There will be some experiments in which you will need to collect only one sample of data from a chemical substance or solution. For example, maybe you need to measure the conductivity of an ionic compound in solution. In that case, using the live readout of data in the meter window (shown above) is appropriate.

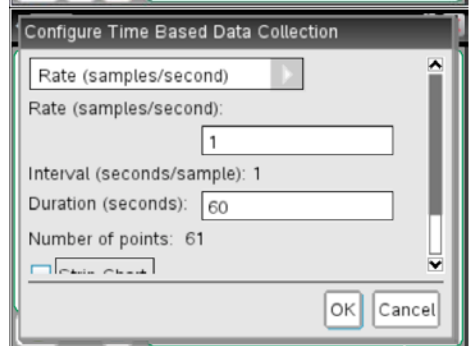
Performing a "Time-Based" Experiment

There will be some experiments in which you will want to study a variable over a certain period of time. For example, what if you were asked to determine the effect of the amount of water on the rate at which an effervescent tablet reacts in water? How would you set up the collection of data for that experiment? On the next page you will learn about the various steps needed to carry out that process.

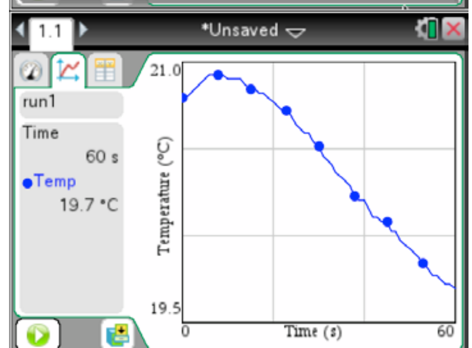
1. Be sure that the mode is set to "Time Based." (The fastest way to change the experiment mode is to "right click" on the **View Details** area on the left side of the screen. Perform a "right click" by pressing the **ctrl** button followed by the menu button.) Select **2:Collection Mode > 1:Time Based**.



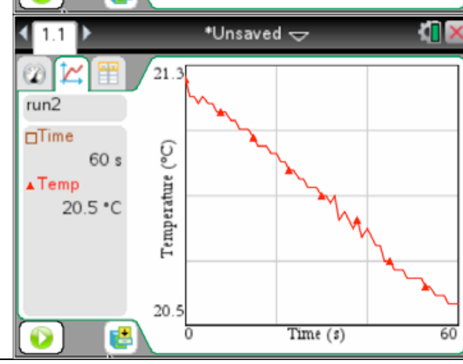
2. Now set up the parameters of how you will collect data in your experiment. For example, in the effervescent tablet experiment, we might want to view the temperature changes over a 60 second period. The rate could be set to 1 sample/second and the duration set to 60 seconds. Click OK when you are finished.



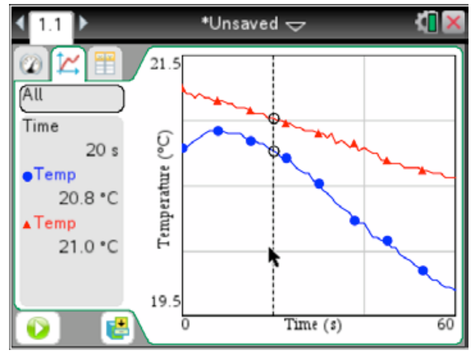
3. Click the **Play** button to begin collecting data. Once data collection begins the Meter view switches to the Graph view and then the graph will autoscale when data collection is complete. *(The graph at the right shows how the temperature changes as a tablet is added to 50 mL of room temperature water.)*



4. If you are finished with the experiment, press the **Stop** button. If not, store the first run of data by clicking the **Store** button. Press **Play** to collect a second run of data. *(The graph at the right shows how the temperature changes as a new tablet is added to a new sample of 100 mL of room temperature water.)*



5. It is possible to see all of the runs that you collected at one time. Click on the current run at the left (**run2** in this case) and select **All.** Both runs of data will appear on the screen simultaneously and you will be able to compare temperatures at a given time by clicking somewhere in the graph. A vertical line will appear and the **View Details** area will indicate the temperatures at that time.

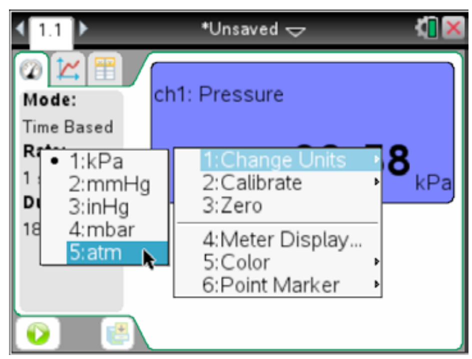


Later in this guide you will see how the Nspire can be used to analyze the data that you have collected in this mode.

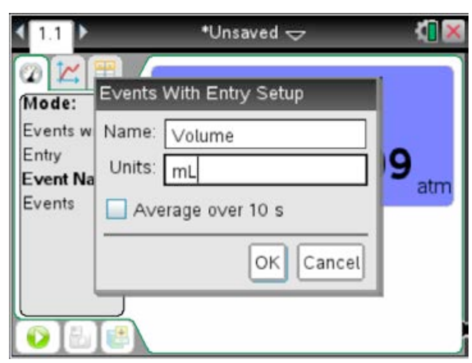
<u>Performing an "Events with Entry" Experiment</u>

There will be some experiments in which time is NOT an important factor when collecting data. You may wish to collect data at one set of conditions and then under a different set of conditions. For example, what if you were interested in knowing the effect of changing the volume of a specific amount of gas on the pressure of that gas? It wouldn't really matter how long it took you to change a gas from 4 mL to 20 mL (in 2 mL increments) but you might want the Nspire to record the actual pressure at each volume. "Events with Entry" would be the mode that you would want to use. Below you will see step-by-step directions on how to collect data in this manner.

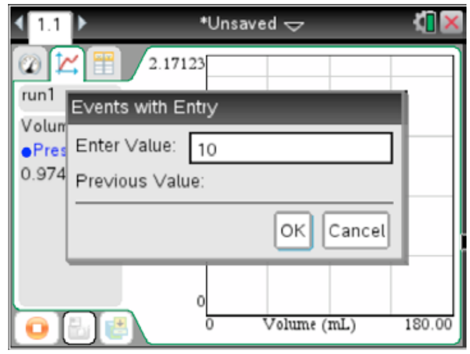
1. Before we set up the collection mode, it might be helpful to know that you can "right click" in other areas of the screen as well. For example, in this experiment we may want to change the default units for pressure (kPa) to atmospheres (atm). Simply press **ctrl** menu with the cursor over the **Meter** window, select **1:Change Units** followed by the preferred units.



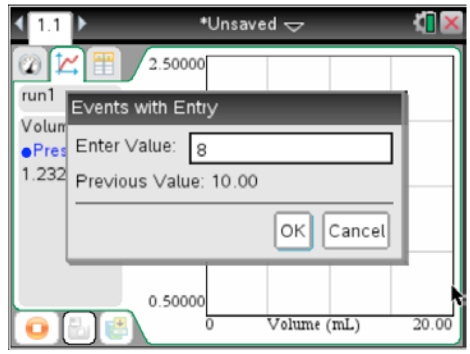
2. Okay, let's set up the data collection mode. With the cursor in the **View Details** area, press **ctrl** menu and select **2:Collection Mode > 2:Events with Entry**. The "event" is the variable that you are manipulating. Input the appropriate name and units of the event and then click OK. In this case we are changing the volume of 10 mL of air trapped in a plastic syringe. We will be studying the effect of changing this volume on the pressure of the gas.



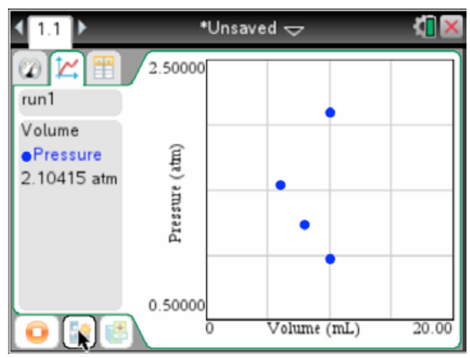
3. Click the **Play** button to begin. Once data collection begins the Meter view switches to the Graph view. Notice that in this mode a new icon is visible. This is the **Keep** button and it allows you to take a snapshot of the data when you are ready. *(The graph at the right shows what the screen looks like when the **Keep** button is pressed. The value of 10 mL is entered to represent the 10 mL of air trapped in the syringe.)*



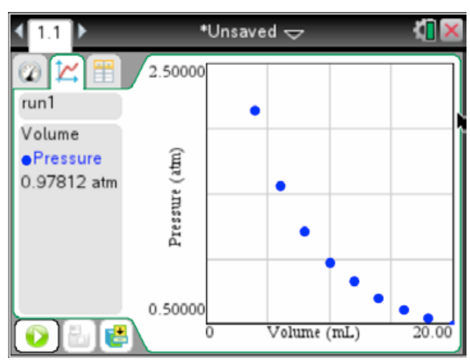
4. When you are ready to record data at a new set of conditions press the **Keep** button again. *(Important: Do NOT press the **Stop** button !!! This is a common mistake made by new users. If you press **Stop** you will need to start the entire experiment over again.)* Notice that when you press **Keep**, the window will remind you of the previous event value that you entered.



5. Continue collecting data until you are finished and then press the **Stop** button. Notice that every time you enter a new event value, the screen returns to the graph view. It will display all of the data points that you have recorded plus the current event that you are about to record. *(The screen at the right shows blue dots for pressures recorded at 10 mL, 8 mL and 6 mL of volume. The "odd" point is the pressure of the air confined to 4 mL of space. The reason that it is in the center of the screen is that the **Keep** button has not yet been pressed and the value of 4 mL has not yet been entered.)*



6. You have now finished recording data in Events with Entry mode. Notice that the button in the lower left corner of the screen has returned to the **Play** button. *(The screen at the right shows all of the Pressure and Volume data for a 10 mL sample of air.)*



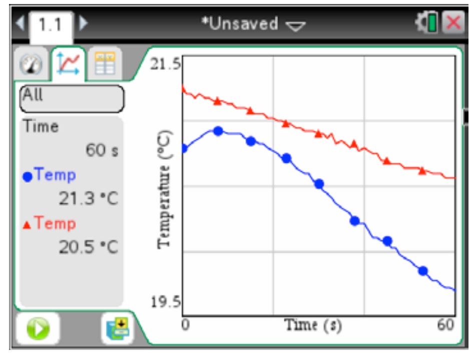
Later in this guide you will see how the Nspire can be used to analyze the data that you have collected in this mode.

Data Analysis

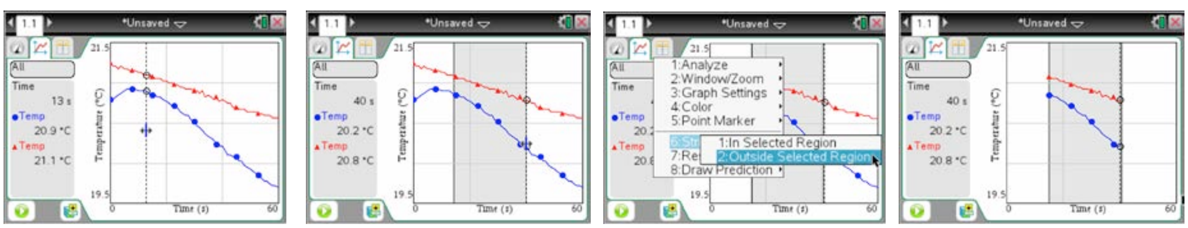
There are a few different tools available in the DataQuest application that make it very easy and quick to analyze the data that you have collected. Two important methods will be presented in this section.

Method 1: Striking Data

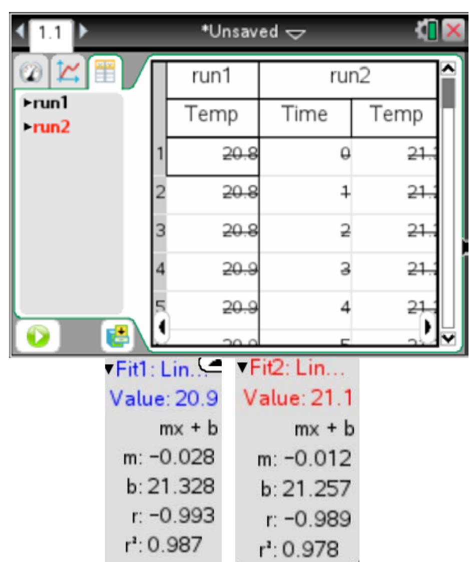
Remember the effervescent tablet experiment? Part of the graph looked very linear and it might be interesting to know the slope of the two temperature curves in the middle of the experiment. We could then compare the rate at which the temperature dropped in each situation (a tablet dropped in both 50 mL and 100 mL of room temperature water).

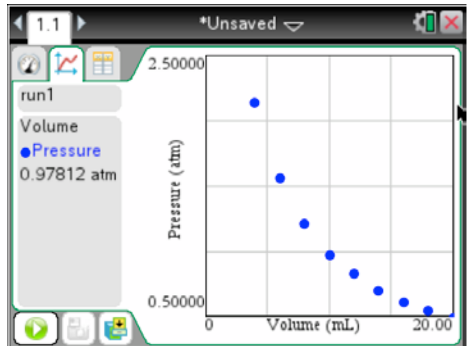


1. Click in the graph to create a vertical line. Click in the center of the touchpad for about 1 second until you see a double arrow appear on the line.
2. Let go of the center of the touchpad and run your finger lightly from left to right across the touchpad to select the area of the graph you would like to study.
3. Right click and select **Strike Data > Outside Selected Region**. When finished your graph will only show the portion of the data that you selected.



4. Don't worry. Your data is still there (as you can see from the Table view on the right). Striking data allows you to analyze just a portion of the data set without completing removing the information.
5. Now you are able to analyze each linear portion of the temperature graph to determine the different rates at which the temperature was dropping. Select **Menu > Analyze > Curve Fit > Run1.Temperature** and press OK. Select **Menu > Analyze > Curve Fit > Run2.Temperature** to see the other information. Now the rate (the "m" values) can be compared in the View Details window for each graph.

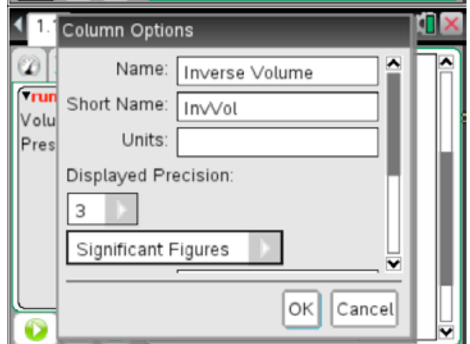




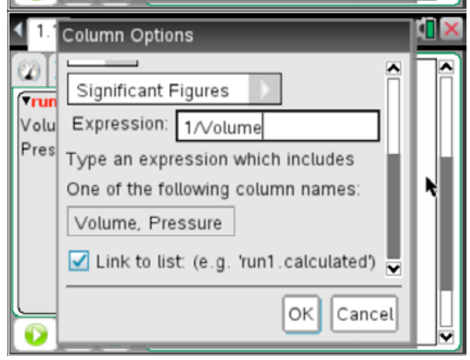
Method 2: Adding a Calculated Column in Table View

Getting back to the pressure/volume experiment, you'll recall that we created a curve of pressure versus volume values. To determine the equation of a graph, sometimes it is helpful to "linearize" the data. In this section we will explore how a new calculated column of data can be added in Table View and how that new variable can be selected for study in Graph view.

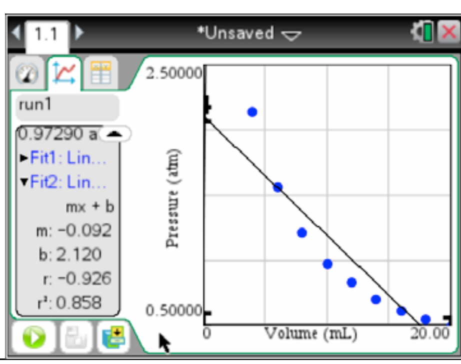
1. Click on the Table view tab . Then "right click" on the **View Details** area followed by **Add Calculated Column**.
2. Type in a name for the new column and any other fields that you find appropriate.

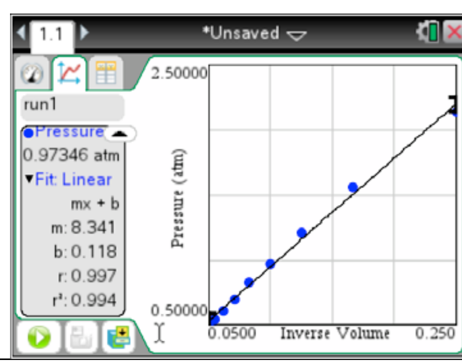


3. In the same window, scroll down until you see the **Expression** field. Enter the mathematical expression for the new column. (In this case, since it is possible to "linearize" the data by graphing Pressure vs. Inverse Volume, the expression entered is 1/Volume.) When finished click OK.



4. Click on the Graph view tab to analyze the data. Press **Menu > Analyze > Curve Fit > Linear**. Obviously the data of pressure vs. volume do not fit the line created as is evidenced by the poor r^2 value of 0.858. (Data points with a good linear fit show an r^2 value of 1.00.)
5. Click on the x-variable at the bottom of the graph (in this case, volume) and select the calculated column variable (inverse volume). Now we have a very linear graph and we can see that Pressure = 8.341 * (1/Volume) + 0.118.





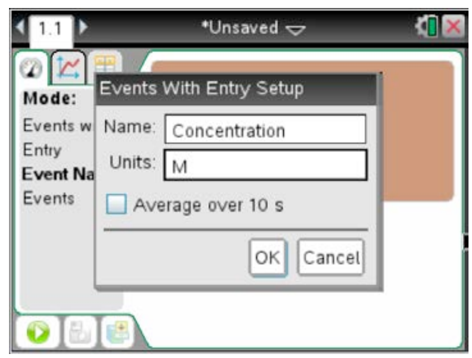
AP Chemistry Lab Manual

A Guide to Using TI-Nspire™ for Data Collection and Analysis

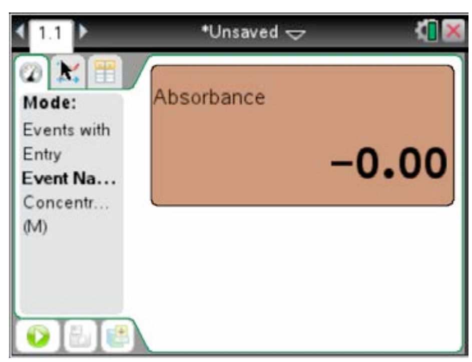
Data Collection and Analysis – Using the Colorimeter

The colorimeter (shown at right) is used to collect information about how much light of a certain wavelength is absorbed by a solution. This sensor uses Events with Entry mode but has a few extra steps involved to set it up for use. The following procedure will highlight using the colorimeter to collect concentration and absorbance data using various solutions of green food coloring in water. First, data about four solutions of known concentration will be collected and then absorbance data of a solution of unknown concentration will be collected.

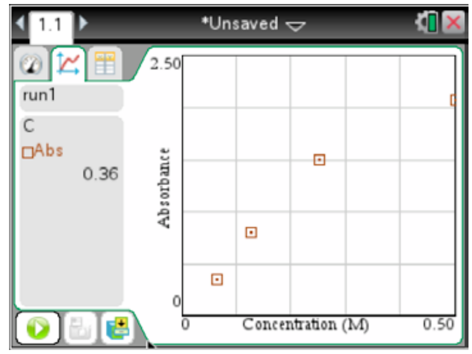
1. Connect the colorimeter to the Nspire using an EasyLink cable or a TI-Lab Cradle.
2. Select an appropriate wavelength of light to be used in the experiment by pressing the left or right arrows on the colorimeter. (You will want to use a different color other than the color of the solution. For example, if we passed green light (565 nm) through a green solution, most of it would be absorbed and we wouldn't see much difference in the data. An ideal color of light to pass through a green solution would be red (635 nm).)
3. With the cursor in the **View Details** area, press **ctrl** menu and select **2:Collection Mode > 2:Events with Entry**. Enter the variable name for the event (usually Concentration) and the appropriate units and click OK.



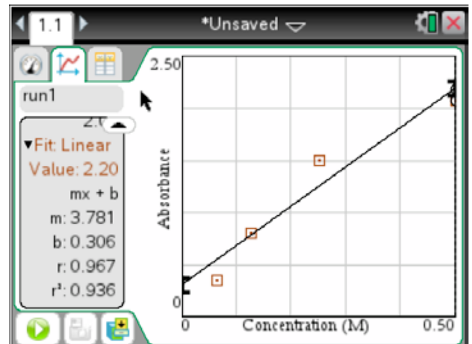
4. Now the device must be calibrated with the solvent being used in the solutions. Fill a plastic cuvette about ¾ with the appropriate solvent (most likely this will be water) and place the cuvette in the holder inside the colorimeter. It is important that one of the smooth sides of the cuvette is pointed towards the white arrow at the top of the inside of the colorimeter. Also be sure that the smooth sides are free of oil or smudges from skin. Close the colorimeter door and press the CAL button until the red light stops blinking. This will take about 5 seconds. The absorbance reading in the meter view should read 0.00.



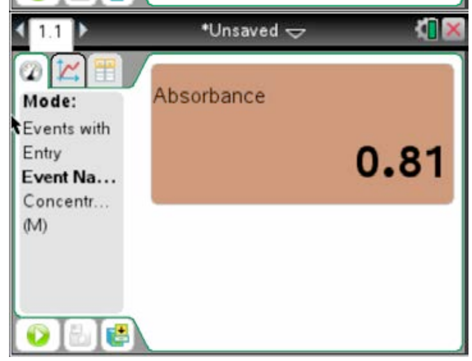
5. When ready to begin collecting data, press **Play** . Replace the water cuvette with the first sample of known concentration being tested. Close the door, wait for the absorbance reading to stabilize, and then press Keep . Input the concentration of the known solution and press OK. Remove the first sample, replace it with the second sample, close the door, and press **Keep**. Repeat this process with the other samples of known concentration. When you are finished with all of the samples of known concentration, press Stop . *(The screen to the right shows absorbance readings for known solutions with concentrations of 0.500M, 0.250M, 0.125M and 0.0625M.)*



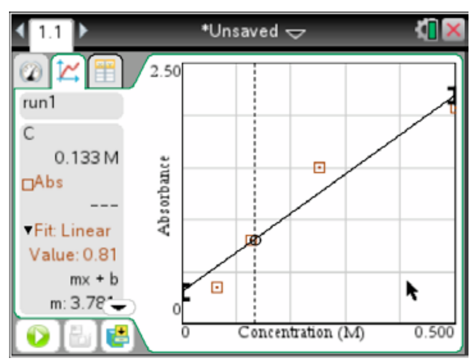
6. Find the best fit line through the data points. To do this press **Menu > Analyze > Curve Fit > Linear**.



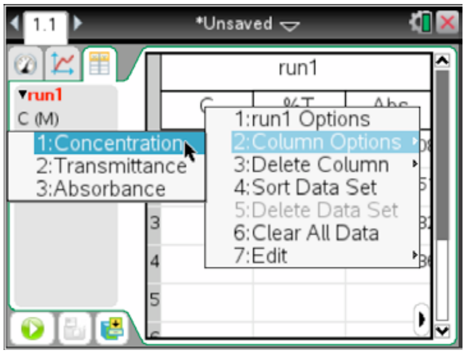
7. Put the sample of unknown concentration in the colorimeter and close the door. Note the absorbance reading once it stabilizes.

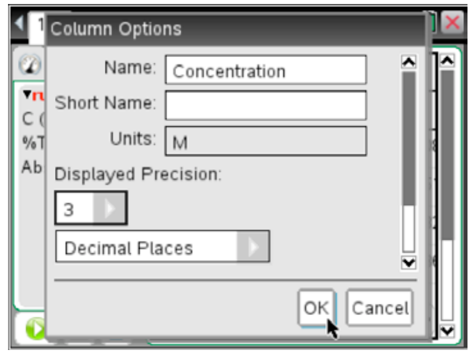


8. To determine the concentration at this absorbance click in the Graph view tab (at the top left of the screen). Then press **Menu > Analyze > Interpolate**. Click somewhere in the graph to see a vertical line. Press the left or right side of the touchpad to move the line around on the graph. When you have moved the cursor to the appropriate place the Fit Linear Value will correspond to the absorbance of the solution. You will then be able to read the concentration value at the top of the **View Details** window. (Note that since the unknown solution showed an absorbance of 0.81 the vertical line was moved into place until the Fit Linear Value was also 0.81. The concentration at this absorbance was 0.133 M.)



Note: To display the concentration at a higher precision, click on the Table View icon, "right click" on the column label for concentration (C), select **Column Options > Concentration**. Change the displayed precision to an appropriate value (in this case 3 decimal places) and click OK. Now the concentration will be displayed with a higher level of precision.





In Conclusion:

Hopefully you have found the information in this appendix about how you can collect and analyze data using the TI-Nspire to be helpful.

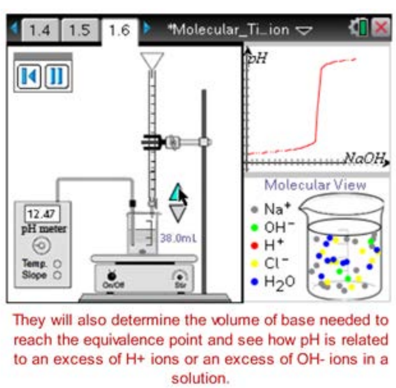
For further information about other applications within the TI-Nspire handheld, visit:

http://www.atomiclearning.com/k12/en/ti_nspire

For further information about the Vernier sensors that you will use with these experiments, visit:

http://www.vernier.com/products/sensors/

You might also want to visit the Science Nspired page at Texas Instruments' website (http://education.ti.com/calculators/tisciencenspired/) where you'll find some great simulations that can help you better understand concepts important to the AP Chemistry curriculum.



Example Shown: Molecular Titration Simulator

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Online Resources

TI PROFESSIONAL DEVELOPMENT

Activity Overview

In this activity, you will explore resources available at education.ti.com. You will browse for activities at Math Nspired, Science Nspired, and TI-Math. You will search for activities using the Standards Search and Textbook Search, and you will explore additional information regarding professional development.

Materials

- Computer with Internet connection

Step 1:

Go to **education.ti.com > Downloads & Activities**. Select **Math Nspired** or **Science Nspired**, which can also be accessed directly at mathnspired.com and sciencenspired.com. Select a subject on the left.

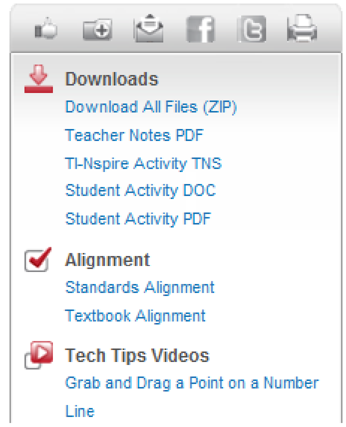
Step 2:

Select a unit from the list. When a unit is selected, a table appears with an image from each activity. The table contains links to download, recommend, and save each activity. It also identifies each activity type:

Icon	Type	Description
	Bell Ringer	Bell ringers are short lessons designed to help transition quickly into class after the bell rings.
	Action Consequence Simulation	Interactive, engaging lessons allow students to perform actions on a mathematical object or scientific simulation, observe consequences, and make conjectures. Each lesson contains a pre-made TI-Nspire™ document, a Student Activity, and Teacher Notes.
	Create Your Own	In addition to the Student Activity and Teacher Notes, the lesson also includes step-by-step instructions on how to create the TI-Nspire document.
	Data Collection with Probes	Data Collection Labs give students the opportunity to collect and analyze real-world data with more than 50 data collection sensors from Vernier Software and Technology™.
	TI-Nspire™ Navigator™ Compatible	The Teacher Notes identify opportunities to use the TI-Nspire Navigator System, including opportunities for Quick Polls, Class Captures, and Live Presenter.

Online Resources
TI PROFESSIONAL DEVELOPMENT

Step 3:

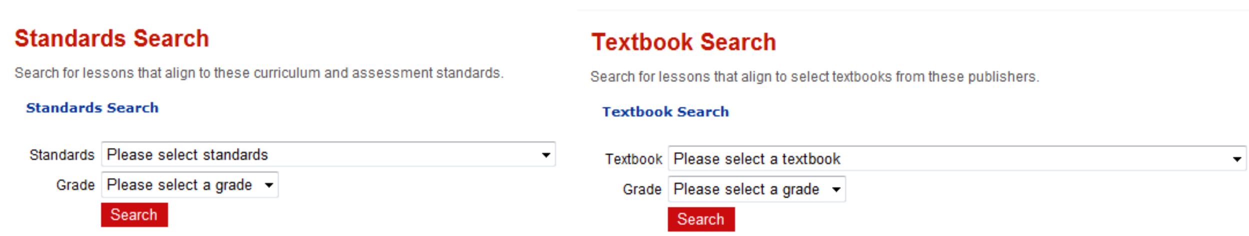


Select an activity from the list. The activity page shows objectives, relevant vocabulary, and additional information. A video offers a preview of the lesson, and related lessons are recommended below.

Icons above the Downloads section allow you to recommend, save, email, and print an activity. Links to Facebook and Twitter are also available. The Downloads section contains links to activity files. Links for Standards Alignment, Textbook Alignment, and relevant Tech Tip Videos are also available.

Step 4:

Explore the Standards and Textbook Search channels on the left. Select a set of standards or a textbook from the drop-down box, select a grade, and click **Search**.



Step 6:

Go to **Downloads & Activities > TI Math**, which can also be accessed directly at www.timath.com. Featured TI-Nspire™ and TI-84 Plus activities for various subjects appear in the center of the page. Links to activity archives for each subject appear on the left. Click one of the featured activities.

Step 7:

Go to **Professional Development > Online Learning**.

The Tutorials page contains link to free Atomic Learning video tutorials. There are video tutorials for the TI-Nspire™ handheld, the TI-Nspire™ software, and the TI-Nspire™ Navigator™ System.

The Webinars page contains links to upcoming, free PD webinars. The Archive page contains recordings of past webinars. Associated webinar documents are available for download.

Step 8:

Explore each of the following pages by clicking the appropriate tab: Products, Downloads & Activities, In Your Subject, Professional Development, Funding & Research, and Student Zone.

TI graphing calculators are permitted on important college entrance exams.

education.ti.com/go/testprep

TEXAS INSTRUMENTS

TI-Nspire™ CX	TI-Nspire™ CX CAS	TI-Nspire™	TI-Nspire™ CAS	TI-84 Plus C Silver Edition	TI-84 Plus Silver Edition	TI-84 Plus	TI-83 Plus	TI-89 Titanium
SAT*	SAT	SAT	SAT	SAT	SAT	SAT	SAT	SAT
AP*	AP	AP	AP	AP	AP	AP	AP	AP
ACT®*		ACT		ACT	ACT	ACT	ACT	
IB®* Exam		IB Exam		IB Exam	IB Exam	IB Exam	IB Exam	
Praxis™*		Praxis		Praxis	Praxis	Praxis	Praxis	

SAT*

MAY 2013	JUN 2013	OCT 2013	NOV 2013
4	1	5**	2**

DEC 2013	JAN 2014	MAR 2014	MAY 2014
7**	25**	8**	3**

For deadlines and registration, visit **collegeboard.com/testing**.

** These anticipated test dates are provided for planning purposes and are subject to final confirmation. The finalized, confirmed test dates, when announced, may differ from the dates shown.

ACT®*

JUN 2013	SEP 2013	OCT 2013	DEC 2013
8	21	26	14

FEB 2014	APR 2014	JUN 2014	SEP 2014
8***	12	14	13

For deadlines and registration, visit **act.org**.

***No test centers are scheduled in New York for the February test dates.

AP*

MAY 2013	MAY 2013	MAY 2013	MAY 2013
6 *Chemistry*	8 *Calculus AB/BC*	10 *Statistics*	13 *Physics B/C*

MAY 2014	MAY 2014	MAY 2014	MAY 2014
5 *Chemistry*	7 *Calculus AB/BC*	9 *Statistics*	12 *Physics B/C*

For deadlines and registration, visit **apcentral.collegeboard.com**.

International Baccalaureate®* (IB) Exam/Praxis™*

For information on the IB test and test dates, visit ibo.org.

For information on the Praxis test and test dates, please visit ets.org/praxis.

Testing agencies are responsible for respective testing dates; Texas Instruments is not responsible for any testing date changes.

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TI presents, as accurately as possible, its current products and services, including hardware, software, screen shots and related support offerings. TI reserves the right to modify or discontinue products or services at any time without prior notice.

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T^3 Ticket Outta Here

2.71828

I have learned …

My question is …

My next steps are …

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T^3 Ticket Outta Here

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