



Getting Started with TI-Nspire™ Middle Grades Science

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Day One	Page #
1. Nspired Learning Exploration – Light Me Up!	
2. TI-Nspire™ CX CAS Introduction	5
3. Data Collection 1 – Evaporation	9
4. Data Collection 2 – Choose a, b, or c:	
a) Walk a Line	17
b) Match Me	29
c) Boyle's Law	41
5. Nailing Density	49
6. Summary Discussion	
7. Check/Install Software and OS	
Day Two	
1. Introduction to the TI-Nspire™ CX Navigator™ System	
2. Body Mass Index	61
3. Science Handheld Skills	71
4a. Radioactive Decay	77
4b. Radioactive Dating	83
5. Fahrenheit vs. Celsius	93
6. Getting Started with the TI-Nspire™ Family of Teacher Software	103
7. Carousel	
a) The River of Life	109
b) Sound and Waves	117
c) How Much Does It Weigh?	127
d) Energy of a Roller Coaster	129
e) Rolling Rates	147

Day Three	
1. Vernier – That’s the Way the Ball Bounces: Height and Time for a Bouncing Ball	157
2. Skills of Science – Creating Lab Reports	163
3. Final Activity	
4. Presentation	
5. Evaluation	
Appendix	
A. TI-Nspire™ CX Family Overview	171
B. Introduction to Data Collection	173
C. Interactive Math and Science Classrooms	177
D. Checking and Updating the OS	179
E. Press-to-Test	181
F. Transferring Documents Between Handhelds	183
G. Transferring Documents Using the TI-Nspire™ Family of Teacher Software	185
H. Inserting an Image into a TI-Nspire™ Document	187
I. TI-Nspire™ Keypad Shortcuts	189
J. Online Resources	193
K. Ticket Outta Here	195



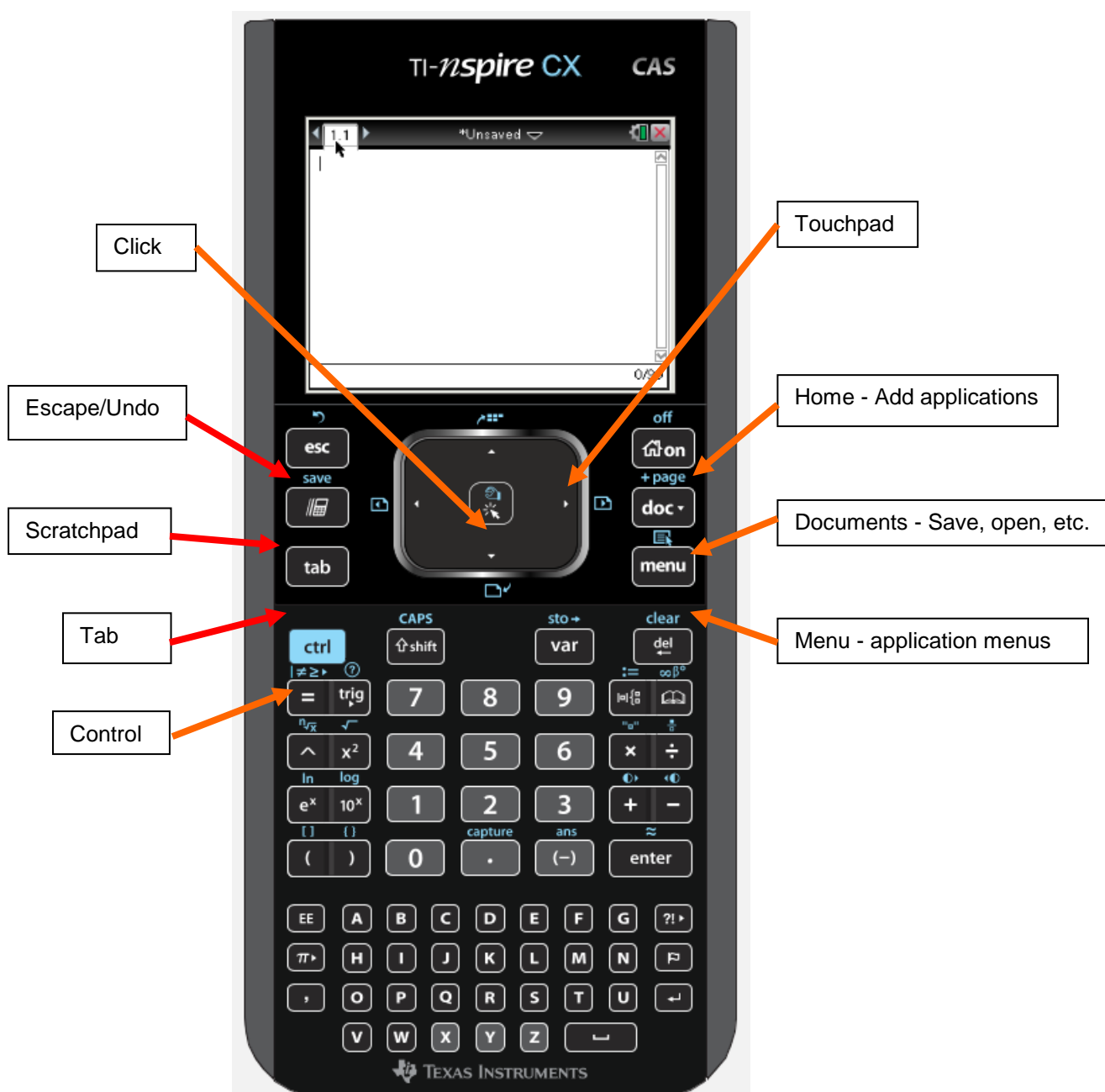
TI-Nspire™ CX CAS Introduction

TI PROFESSIONAL DEVELOPMENT

TEACHER NOTES

Activity Overview

In this activity you will become familiar with the most commonly used keys on the TI-Nspire™ CX CAS handhelds. You will also learn about each of the built-in applications.

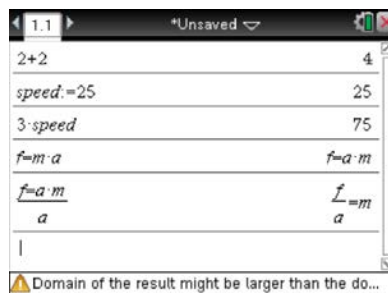




Built-In Applications

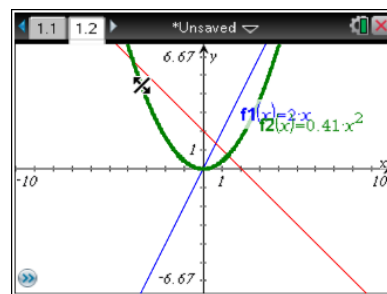
Calculator

- Typical mathematical calculations can be done.
- Variables can be defined and used throughout a document.
- On a CAS handheld, formulas can be written and equations can be solved.



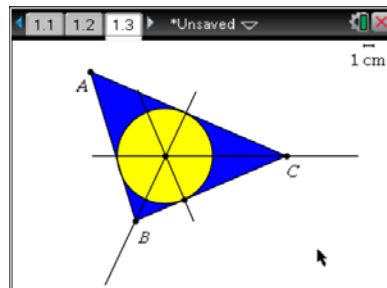
Graphs

- Equations such as $y=2x$ can be graphed.
- Functions $f(x)=2x$
- Equations can be manipulated by mousing over them, clicking and holding, and then dragging a finger across the Touchpad.
- Trace, intersect, minimum, and maximum can all be determined.
- The Menu button shows all of the tool possibilities for a graph.



Geometry

- Geometric constructions
- Construct simulations



Lists & Spreadsheet

- Typical spreadsheet calculations such as $\text{sum}(A1:A12)$, $\text{average}(A1:A12)$.
- Columns titles define data throughout the document.
- Diamond row (♦) are for performing calculations on the whole column. Functions such as sequence are powerful.

The screenshot shows the Lists & Spreadsheet application interface. It displays a data table with the following columns and rows:

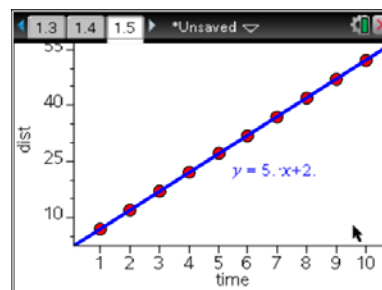
	time	dist		
♦	$\text{seq}(x, x, 1, \text{time} \cdot 5 + 2)$			
1	1	7		
2	2	12		
3	3	17		
4	4	22		
5	5	27		

Below the table, the formula bar shows $B1 = 7$.



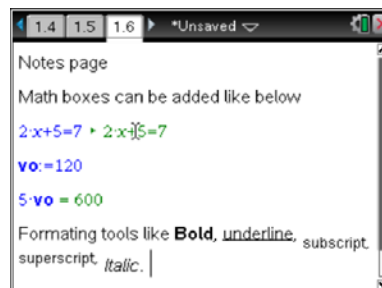
Data & Statistics

- Plot Data from Lists & Spreadsheets based on the column titles (variables).
- Regression equations and hand fit lines can be added to do analysis on a set of data.
- Multiple sets of data can be compared.



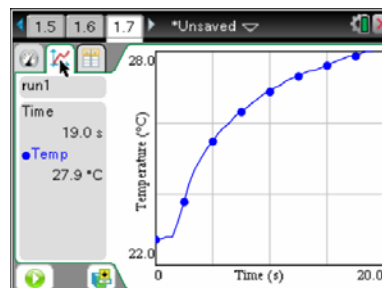
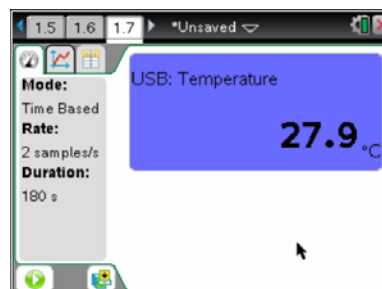
Notes

- Write text within a document
- Math boxes can be added to Notes pages to show calculations and define variables.
- ChemBox allows you to write chemical equations with appropriate subscripts and arrows and coefficients.
- Fonts can be changed.



Vernier DataQuest™

- Meter mode
 - Shows measurement
 - Collection Mode
 - Time based
 - Events with Entry
 - Selected Events
- Graph screen
 - Run #
 - Graph multiple runs
 - Graphical analysis
 - Tangent to data
 - Calculate Regressions
 - Draw predictions
 - Strike Data
- Spreadsheet
 - Run#
 - Add calculated columns



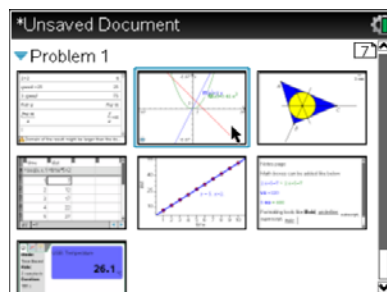
Spreadsheet screen showing data for 'run1'.

	Time	Temp
1	0	22.8
2	0.5	22.8
3	1.0	22.8
4	1.5	22.8
5	2.0	23.3
6	2.5	23.8



Document Navigation

- Control up Arrow (**ctrl** ▲) opens the Document Viewer.
- Control right arrow (**ctrl** ►) moves to the page to the right.
- Control left arrow (**ctrl** ◄) moves to the page to the left.





Activity Overview

Everyone is familiar with the effects of the wind on their wet body as they get out of the pool. The cooling effect is significant and is mimicked in warm climates with fine mists at bus stops to help patrons waiting for a bus keep cool. The effect is grander when there is a breeze and when the humidity is low. When we perspire, the body is using this phenomenon to help keep the person cool.

In this investigation, we will model this cooling by evaporation with a liquid other than water and explore if the “feeling” of being cool is real or just a perception, and we will try to quantify the effect with different liquid concentrations.

Create a New Document on your TI-Nspire handheld

Your Instructor might send you a starting Document that you could open as an option.

Press **ctrl** **I** to create new pages.

Step 1:

Press **on** and then select option **1: New Document**. If you are challenged to Save the current Document, choose the right choice.

Step 2:

Start with a Notes page from the Menu Options and key in the appropriate information to help document your team's work.

The Design

Step 3:

We want to collect data from the evaporation of a liquid on an object that is held in the ambient air. To do this, we will dip a metal temperature probe in our substance and then hold it in the air and monitor its temperature for a length of time.

Step 4:

Given this scenario, discuss with your partners what variables you see, and identify if you will be controlling them or if you will let them change. Once you have talked a bit, list these in a Notes page and share with the class.

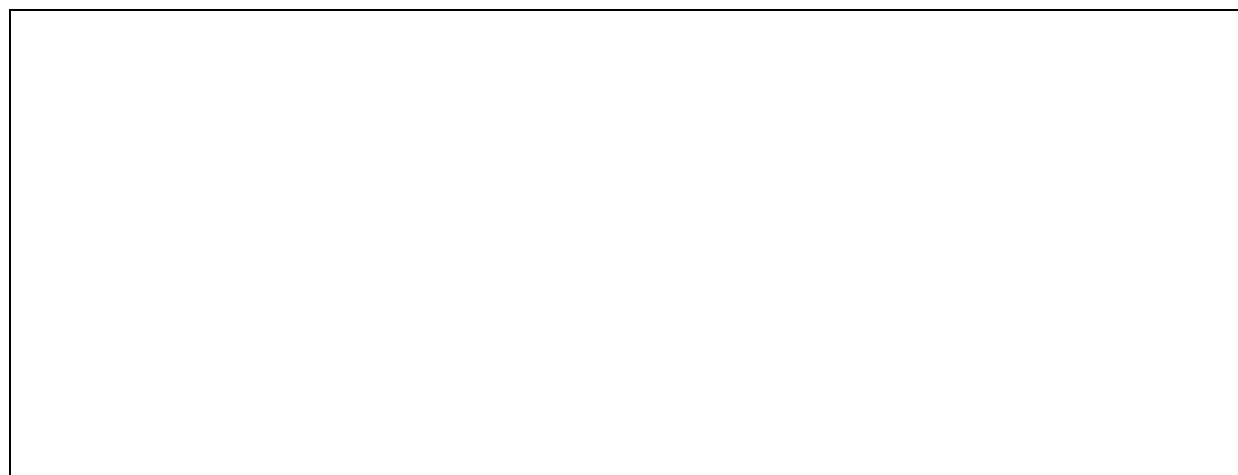
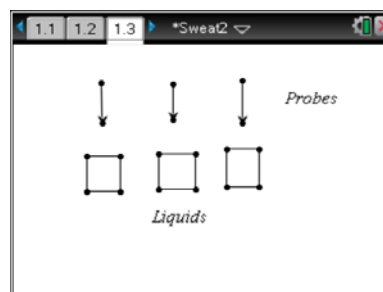
Step 5:

Did your group have the same variables as the others in your class? Did you see some that were not worthy? That you forgot?

Statements	Reasons
wind	control
temperature	

**Step 6:**

Make a sketch of how you will set up the data collection. Draw this below or on your TI-Nspire handheld in a Geometry page. Assume that you will have one Target and two Controls (air and water).

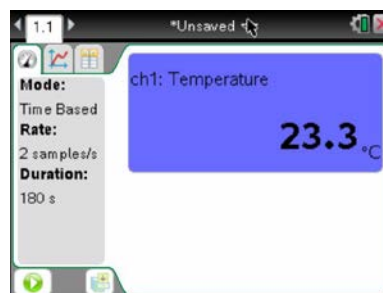
**Step 7:**

Share your design with the group and come to consensus on the set up.

The Time**Step 8:**

We now need to determine how long it will take to get enough data on the cooling event to see a pattern. Your teacher will provide you with a sample of the strongest concentration of the liquid you will be using.

- Place one temperature probe in the liquid and have one person hold it so that you don't get a spill.
- Slide the handheld into the TI-Nspire Lab Cradle™ Data Collection Cradle and plug one temperature probe into the port named ch 1.
- This should launch the Vernier DataQuest™ app and show the current temperature of the liquid (which should be at room temperature).





Evaporation


TI PROFESSIONAL DEVELOPMENT


TEACHER NOTES

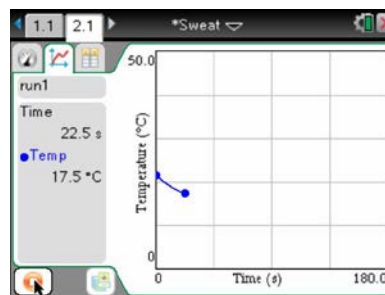
Step 9:

Note that the Mode is Time Based and that the Rate is 2 samples/second for 180 seconds.

To get a feel for the time needed, we will lift the probe out of the

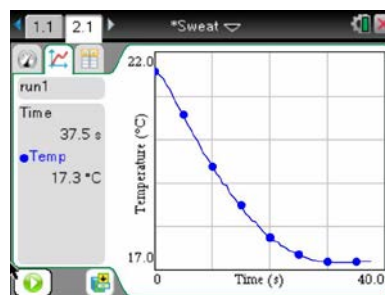
liquid and immediately press the Play button (). As the probe is hanging (without movement) in the air, the TI-Nspire will collect and display the temperature over time. Note that the Play

button has changed to a Stop button () and you can stop the experiment at any time.



Step 10:

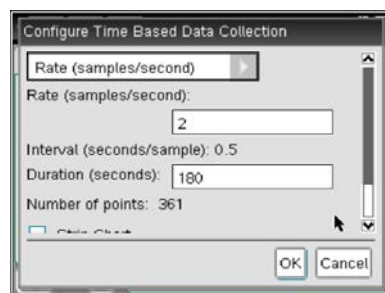
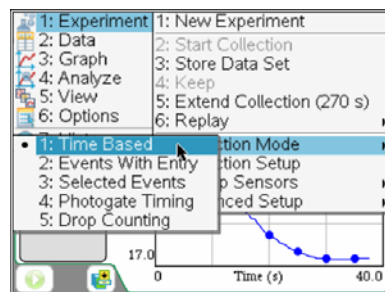
Looking at this data, determine the Time settings you want to use for the complete experiment where you will test two different liquids. Note that the other liquid will be at a weaker concentration and therefore might cause the cooling to occur more slowly.



Step 11:

Adjust the time setting for the experiment by selecting **Experiment > Collection Mode > Time Based**.

Share your settings with the class.





The Experiment

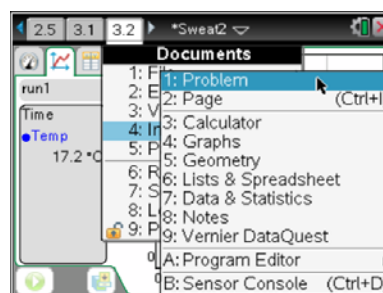
Step 12:

Now we are ready to perform the first complete data collection. You will be using three temperature probes, a sample of room temperature water and one of the liquids. In this experiment, we will use about 50 ml of water and 50 ml of Isopropyl Alcohol, and just air (a dry temperature probe).

- Why are we using water and air? Are these the Targets or Controls?

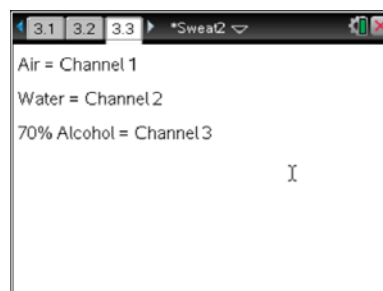
Step 13:

Introduce a new Problem for this experiment. Do this by pressing **doc** and selecting **Insert > Problem**. This will preserve your initial work for the record.



Step 14:

If the new Problem does not launch the Vernier DataQuest app, press **ctrl** **I**, and select the option. Now decide which probe will go with which item and report this on a Notes page in this document.



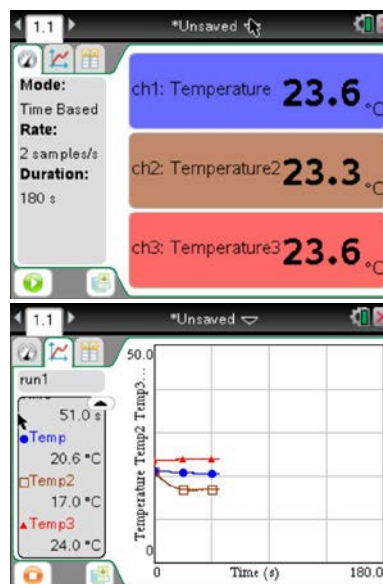
Step 15:

Plug the 2nd and 3rd probes into the appropriate channels one at a time. Place them in the locations they are designed for and wait until you get “about” the same readings.

Note: You might have trouble getting these to all be the same reading. How important is this?

Step 16:


Lift the probes into the air as per your set-up design and then immediately start the experiment. If your time choice was grand, you should let the experiment move to the end times. Make sure all of the variables you determined to be fixed – stay that way. Watch for movement of the probes and any air currents.



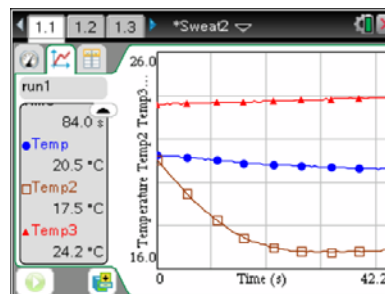


The Analysis

Step 17:

We should examine the data now, looking for patterns. Click or tap to the Table View () to look at the data.


- Would you say that the Target changed and the Controls did not (or only slightly changed)?
- How could you discuss the rate of change? What units does it have?

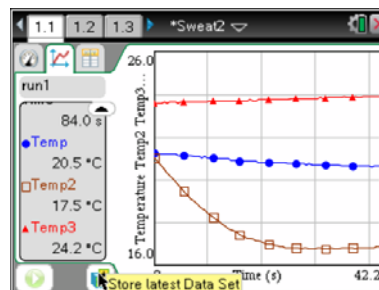


Time (s)	Temp (°C)	Temp2 (°C)	Temp3 (°C)
1	21.3	21.0	23.4
2	21.3	20.9	23.4
3	21.2	20.8	23.4
4	21.2	20.7	23.4
5	21.2	20.5	23.4

Run Two

Step 18:

Now we want to save this Run and repeat the experiment with the other concentration of Alcohol. Place the temperature probes, after wiping them off in a position to become one with the temperature of the room. Collect the new sample; and before you place the probes in the three containers, store the first run by clicking on the File Cabinet (). This will set you up for run 2.



Step 19:

Now place the probes in place, wait until they come to know each other, and then start the collection as before. Do you note any changes in the event as it is happening?

Has the temperature of the room/liquids changed? Will this matter?

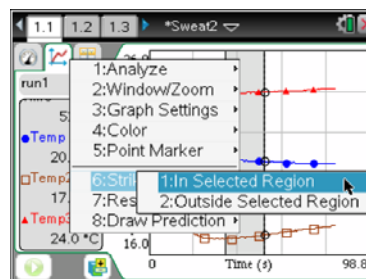
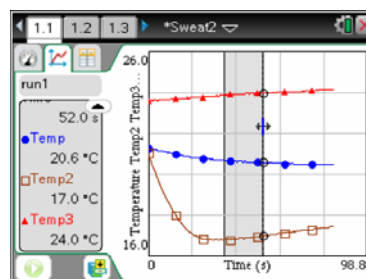


Striking Data

Step 20:

If your estimation of time was off, you may Strike the data to help in the analysis.

To strike data from the graph, you must move your cursor to the point where you want to start or end, click (⌘) then with the **ctrl** use the Touchpad to highlight the segment of interest. Then right-click to choose the in or out option.



Step 21:

Look at the table and note the results.

Time (s)	Temp (°C)	Temp2 (°C)
63	31.0	20.7
64	31.5	20.7
65	32.0	20.7
66	32.5	20.7
67	33.0	20.7

Step 22:

Note that the data is still in the handheld. Why is this important?

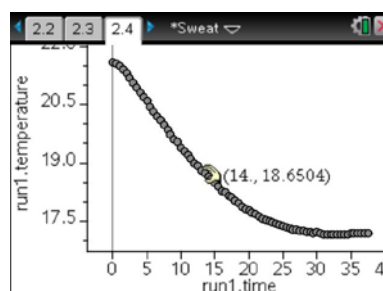
Note: This action may also take place in the table environment using the Menu.

Time (s)	Temp (°C)	Temp2 (°C)
0.0	21.3	20.1
1.0	21.2	20.1
1.5	21.2	20.1
2.0	21.2	20.1

The Rest of the Story

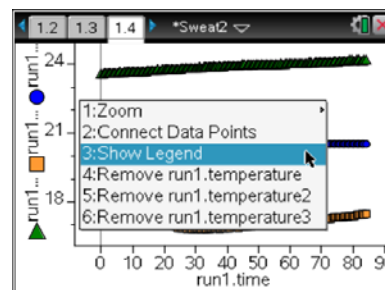
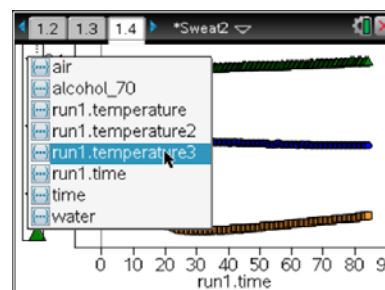
Step 23:

You can move into the rest of the TI-Nspire environment by introducing a new application page as before. If you select Data & Statistics, you can set up a plot to examine the data.

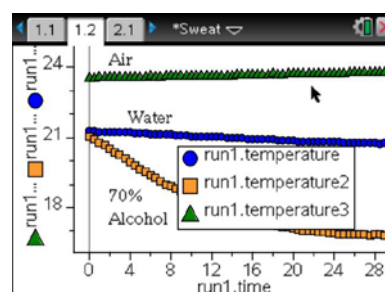
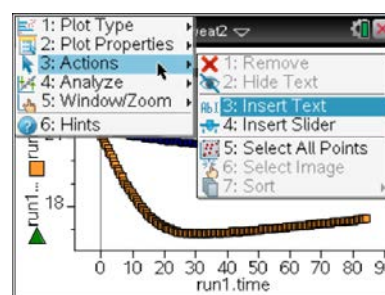


**Step 24:**

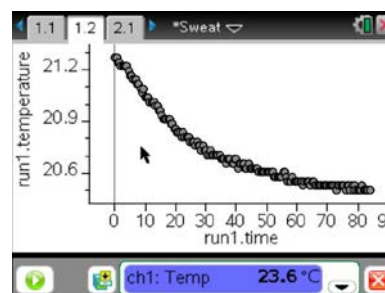
You can also set-up multiple plots using the right-click (ctrl menu) on the y-axis. In addition, you can add a legend by right-clicking on the center of the screen.

**Step 25:**

Using the Menu options under Actions, you can also add text.

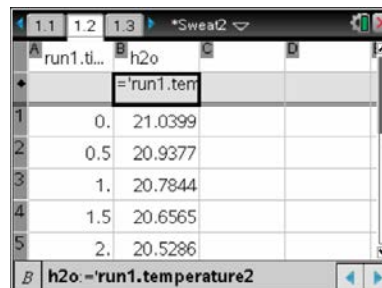
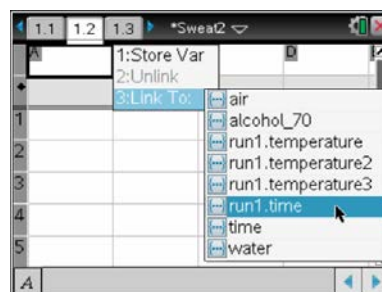
**Step 26:**

In some situations, the use of ctrl D will set up a plot for you automatically.



**Step 27:**

Data can also be placed in the List & Spreadsheet environment using the Header or Diamond Line with the **var** key. In the second case, you might want to name the list before you add the data.





Walk a Line Student Activity

Name _____

Class _____

Activity Overview

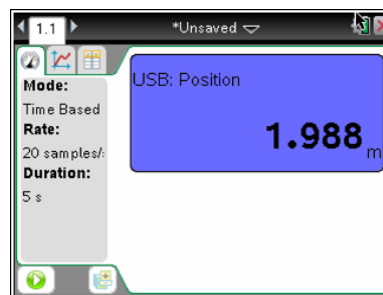
This activity will introduce the CBR 2™ and the Vernier DataQuest™ application. You will collect and analyze linear data.

Materials

- CBR 2
- USB Connection Cable for CBR 2

Step 1:

Connect the CBR 2 to the handheld with the USB cable. A Vernier DataQuest page will automatically open and the CBR 2 will begin measuring the position of the closest object.

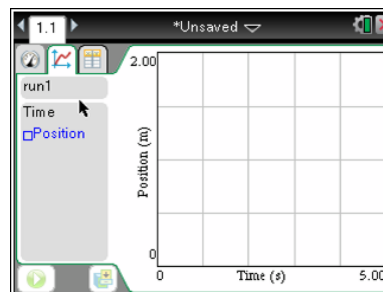


Step 2:


Work in groups of two. One person will operate the TI-Nspire™ and point the CBR 2 toward the other partner, the “walker.” The walker should be standing approximately two meters from the motion detector. The walker will walk slowly toward the motion detector at a constant velocity.

Step 3:

Before collecting the data, make a prediction of what the graph of position versus time should look like. Sketch your prediction on the grid to the right.



Step 4:

The calculator operator should click the green **Start** button  in the lower left corner of the screen. The walker should walk SLOWLY toward the CBR 2 at a constant velocity to close the gap in approximately 5 seconds. Don't go too fast or you will run out of room and need to try again. You must walk at the same velocity the entire time.



Walk a Line

Student Activity

Name _____

Class _____

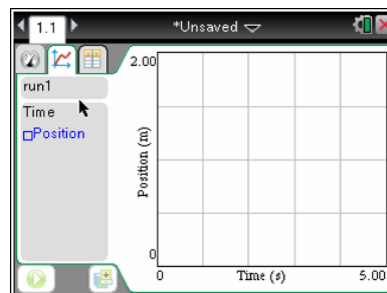
Step 5:

Graphs for position versus time and velocity versus time are created and displayed on the same screen. Repeat as necessary until you generate a graph for position versus time that is roughly linear. How does the graph compare with your prediction?

Step 6:

To display only the position versus time graph, press **Menu > Graph > Show Graph > Graph 1**.

Sketch the actual graph of your position versus time graph on the grid shown to the right.



Step 7:

Manual Analysis of Data

- How can you estimate the average velocity of the walker?
- What was the position of the walker at time $t = 0$ seconds? At time $t = 5$ seconds?
- Show your work to calculate the slope of the graph using your positions at time $t = 0$ seconds and $t = 5$ seconds.
- What does the slope of the graph represent physically?
- Why is the velocity negative?



Walk a Line

Student Activity

Name _____

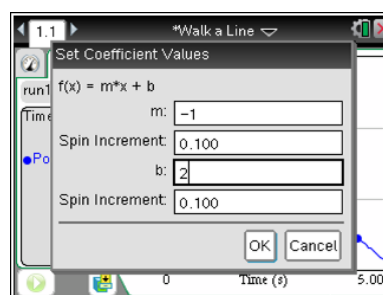
Class _____

- f. Linear functions are usually written in the form $f(x) = mx + b$. Determine the y -intercept of your line and write an equation that you think will model the data.

- g. What does the y -intercept represent?

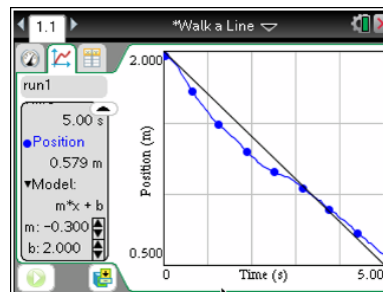
Step 8:

Press **Menu > Analyze > Model**. Select $m^*x + b$ to create a linear model by clicking **OK**. Type your values calculated manually from above in the fields for m and b and click **OK**.



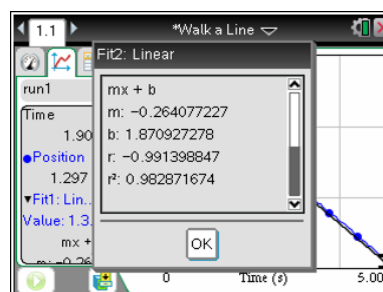
Step 9:

The model can be adjusted by clicking the slider arrows on the left side of the screen or by changing the values of m and b manually. See the sample shown to the right. If you made adjustments, record the new values below.



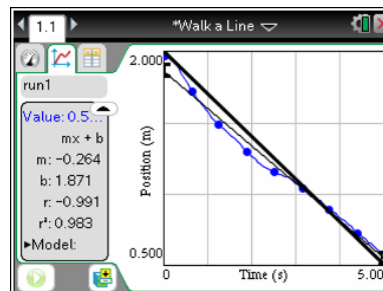
Step 10:

To analyze the data with a regression, a linear curve fit can be performed within the Vernier DataQuest™ application. Press **Menu > Analyze > Curve Fit > Linear**. This will give the equation of the linear regression model. You will have to scroll down the dialog box to see the values of m and b for the linear model. Record the values for m and b below.



Step 11:

Click **OK** to see the graphical results of the regression. How does your linear regression compare with the equation you found in Step 9? How do the values for m and b compare?





Walk a Line

Student Activity

Name _____

Class _____

Discussions/Explorations

1. As you may have gathered from your practice trials, the CBR 2 collects data measuring how far an object is located from the sensor. By walking in front of the CBR 2, collect a set of data which appears linear and has a positive slope. Provide a detailed description of your walk. Be sure to discuss the real-world connections for the slope and y -intercept of the model.
2. By walking in front of the CBR 2, collect a set of data that appears linear and has a slope that is approximately zero. Provide a detailed description of your walk, including the connection between slope and y -intercept and the physical actions.
3. By walking in front of the CBR 2, collect a set of data that represents a piecewise function with two parts, both of which are linear—one with a positive slope and one with a negative slope. Provide a detailed description of your walk, including the connections between slope and y -intercept and the physical actions.



Math and Science Objectives

- Students will find the slope and y-intercept of a linear equation to model position versus time data.
- Students will explain the relationship between a position-time graph and the physical motion used to create it.
- Students will model with mathematics. (CCSS Mathematical Practice)

Vocabulary

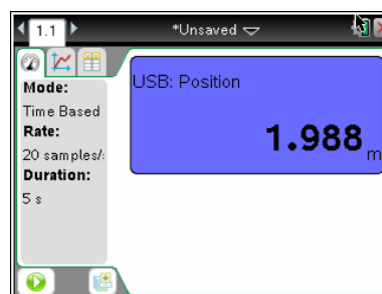
- linear equation
- position
- speed
- velocity
- average velocity

About the Lesson

- In this lesson, students collect data by moving at a constant velocity in front of a CBR 2™.
- As a result, students will:
 - Develop a linear model for a scatter plot of position versus time data
 - Make a real-world connection between a linear equation used to model the data and the physical motion involved in the data collection process

Materials

- 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.
- 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 Lab Cradle, you can even connect multiple motion detectors to extend your exploration.



TI-Nspire™ Technology Skills:

- Collect motion data with the Vernier DataQuest™ app.
- Run a linear regression in the Vernier DataQuest app.

Tech Tips:

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

Lesson Files:

Student Activity
 Walk_a_Line_Student.pdf
 Walk_a_Line_Student.doc



TI-Nspire™ Navigator™ System

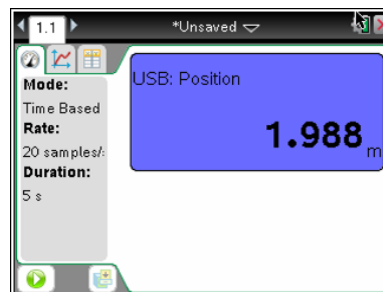
- Use Class Capture to monitor student progress and compare students' mathematical models.
- Use Live Presenter so that a student may demonstrate various steps in the modeling process.
- Share data via File Transfer, if desired.

Discussion Points and Possible Answers

Tech Tip: The Vernier DataQuest application is user-friendly. It should launch when the CBR 2™ is connected. To begin the data collection, click the green Play button (▶) in the lower-left corner of the screen.

Step 1:

Connect the CBR 2 to the handheld with the USB cable. A Vernier DataQuest page will automatically open and the CBR 2 will begin measuring the position of the closest object.



Teacher Tip: When the CBR 2 is first connected, it begins clicking and recording measurements. Have the students move the CBR 2 and point 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. We call this the position of the object with respect to the CBR 2. Be aware that it reads the position of the closest object in its path, so students should have an open area between the CBR 2 and the student whose position they will measure.

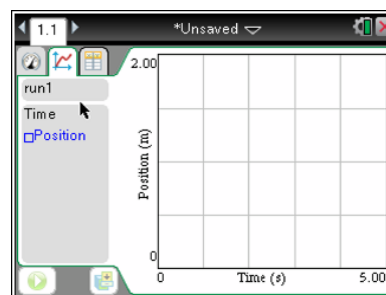
Step 2:

Work in groups of two. One person will operate the TI-Nspire handheld and point the CBR 2 toward the other partner, the “walker.” The walker should be standing approximately two meters from the motion detector. The walker will walk slowly toward the motion detector at a constant velocity.

Step 3:

Before collecting the data, make a prediction of what the graph of position versus time should look like. Sketch your prediction on the grid to the right.


Answer: Predictions will vary.





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

Step 4:

The calculator operator should click the green Start button  in the lower left corner of the screen. The walker should walk SLOWLY toward the CBR 2 at a constant velocity to close the gap in approximately 5 seconds. Don't go too fast or you will run out of room and need to try again. You must walk at the same velocity the entire time.

Teacher Tip: Students often cannot get the timing right at the beginning of this activity. You may want to suggest that the recording partner press the enter key to begin data collection after the walker starts walking. This gives students a better opportunity to collect linear data for the entire collection time period. You may also want to remind students that they must walk slowly at a constant velocity.

Step 5:

Graphs for position versus time and velocity versus time are created and displayed on the same screen. Repeat as necessary until you generate a graph for position versus time that is roughly linear. How does the graph compare with your prediction?

Sample answer: Comparisons can include function type (linear, quadratic, etc.), y-intercept, and whether the graph is increasing or decreasing.

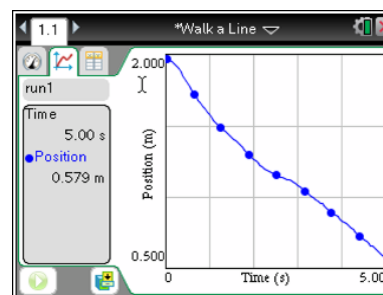
Tech Tip: If the students are not satisfied with their results, they can repeat the data collection by clicking the **Play** button again. This will overwrite the previous trial.

Step 6:

To display only the position versus time graph, press **Menu > Graph > Show Graph > Graph 1**.

Sketch the actual graph of your position versus time graph on the grid shown to the right.

Sample answer: A sample graph is shown to the right. Since students are all walking toward the CBR 2, all graphs should show a negative slope.



**Step 7:****Manual Analysis of Data**

- a. How can you estimate the average velocity of the walker?

Answer: Find the change in the position (final – initial) and divide that change in position by the elapsed time.

- b. What was the position of the walker at time $t = 0$ seconds? At time $t = 5$ seconds?

Sample answer: At time $t = 0$, the position was 2 meters. At time $t = 5$, the position was 0.579 meters. Answers for $t = 5$ will vary but should be a positive value less than 5 given in meters.

- c. Show your work to calculate the approximate slope of your line using your positions at time $t = 0$ seconds and $t = 5$ seconds.

Sample answer: $\frac{0.579 - 2}{5 - 0} = \frac{-1.421}{5} = -0.2842$

Answers will vary, but the slope should be negative.

- d. What does the slope of the graph represent physically?

Answer: The slope represents the velocity of the walker.

Teacher Tip: Some students may answer “speed.” This is a great opportunity to explain the difference between speed and velocity. Speed indicates how fast the walker is moving but 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. It includes both speed and direction. Velocity can be positive or negative for a person moving back and forth along a line. Velocity is positive when the walker moves away from the motion detector, increasing the position, and negative when the walker moves toward the motion detector, decreasing the position.

- e. Why is the velocity negative?

Answer: The velocity is negative because the position between the walker and the CBR 2 is decreasing.



- f. Linear functions are usually written in the form $f(x) = mx + b$. Determine the y -intercept of your line and write an equation that you think will model the data.

Sample answer: The y -intercept is 2; $y = -0.2842x + 2$. Equations will vary but should have $b = 2$ and y = the slope from part c in Step 7.

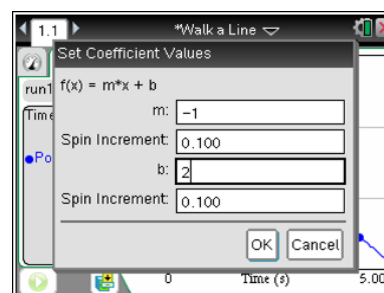
- g. What does the y -intercept represent?

Answer: The y -intercept represents the initial or starting position—the distance, in meters, of the walker from the motion detector at time $t = 0$ seconds.

Teacher Tip: Students should determine an equation by hand first to practice finding slope and to help make the connections between the physical actions and the mathematical equation. Students will better understand the meaning and physical representations of the slope and y -intercept if they write their own model rather than simply run a linear regression.

Step 8:

Press **Menu > Analyze > Model**. Select $m \cdot x + b$ to create a linear model and click **OK**. Type your values calculated manually from above in the fields for m and b and click **OK**.

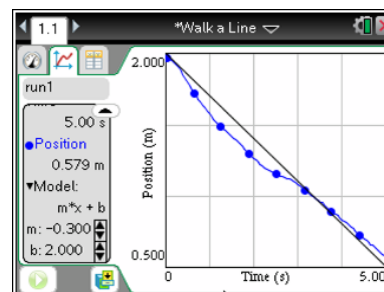


TI-Nspire™ Navigator™ Opportunity: Live Presenter
See Note 1 at the end of this lesson.

Step 9:

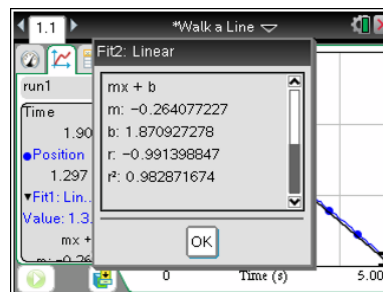
The model can be adjusted by clicking the slider arrows on the left side of the screen or by changing the values of m and b manually. See the sample shown at the right. If you made adjustments, record the new values below.

Sample answer: $m = -0.3$, $b = 2$; $y = -0.3x + 2$



**Step 10:**

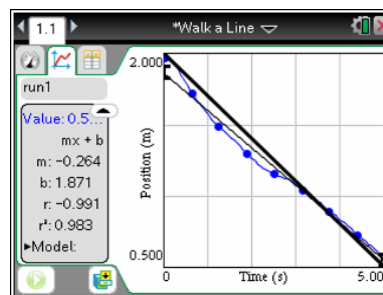
To analyze the data with a regression, a linear curve fit can be performed within the Vernier DataQuest™ application. Press **Menu > Analyze > Curve Fit > Linear**. This will give the equation of the linear regression model. You will have to scroll down the dialog box to see the values of m and b for the linear model. Record the values for m and b below.



Sample Answer: $m = -0.264077227$; $b = 1.870927278$

Step 11:

Click **OK** to see the graphical results of the regression. How does your linear regression compare with the equation you found in Step 9? How do the values for m and b compare?



Sample answer: The linear regression is similar to the equation from Step 9 but not exactly the same. The value of m in the linear regression is slightly greater (less negative) than in Step 9. The value of b is less than in Step 9. Answers will vary.

Teacher Tip: The regression equation should be similar to the students' equations. In some ways a student's equation may appear to be a better fit because the regression equation may not go through the actual starting position.

Discussions/Explorations

- As you may have gathered from your practice trials, the CBR 2 collects data measuring how far an object is located from the sensor. By walking in front of the CBR 2, collect a set of data that appears linear and has a positive slope. Provide a detailed description of your walk. Be sure to discuss the real-world connections for the slope and y-intercept of the model.

Sample answer: The walker stands close to the CBR 2 and slowly walks away at a steady rate. The y-intercept is the walker's distance from the CBR 2 at time $t = 0$ seconds. The slope is the walker's average velocity.

- By walking in front of the CBR 2, collect a set of data that appears linear and has a slope that is approximately zero. Provide a detailed description of your walk, including the connection between slope and y-intercept and the physical actions.

Answer: The walker stands still in front of the CBR 2 and does not move for the entire experiment. The y-intercept is the walker's distance from the CBR 2. Since there is no movement toward or away from the CBR 2, the slope is 0.



3. By walking in front of the CBR 2, collect a set of data that represents a piecewise function with two parts, both of which are linear—one with a positive slope and one with a negative slope. Provide a detailed description of your walk, including the connections between slope and y-intercept and the physical actions.

Sample answer: The walker starts close to the CBR 2 and slowly walks away at a steady velocity and then changes direction and heads back toward the CBR 2 at a steady velocity. This could be reversed so that the walker started walking toward the CBR 2 and then walked away. The y-intercept is the walker's distance from the CBR 2 at time $t = 0$ seconds. The slopes are the walker's average velocities—positive when walking away from the CBR 2 and negative when walking toward it. During the change in direction, the graph will not be linear.

Wrap Up

Upon completion of the discussion, the teacher should ensure that students understand:

- That the y-intercept of a graph of position versus time shows starting position
- That the slope of a position-versus-time graph shows velocity
- How negative, zero, and positive slopes relate to motion in a graph of position versus time

Assessment

Explain why the y-intercept on a position-versus-time graph can never be negative.

TI-Nspire™ Navigator™

Note 1

Step 8, Live Presenter: You may wish to use **Live Presenter** here to allow students to share how well their equations fit the data points.

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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

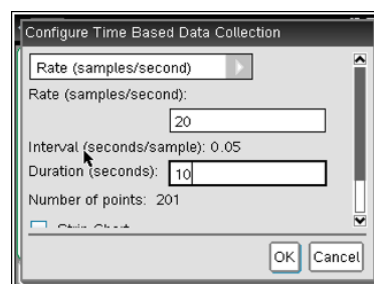
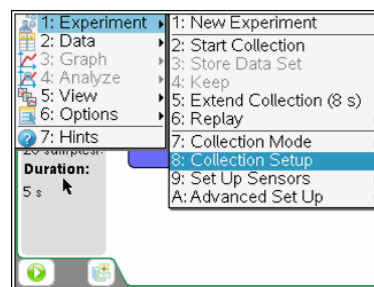
To utilize the built-in, easy-to-use **Motion Match** activity, first turn on the TI-Nspire handheld and choose **New Document**. Then, plug in the CBR 2 and the Vernier DataQuest™ app for TI-Nspire will automatically launch.

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. Press **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?

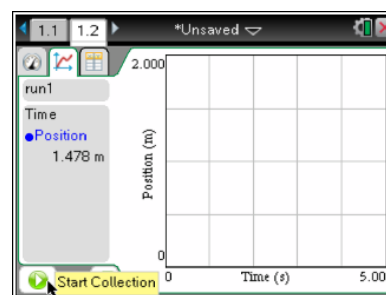
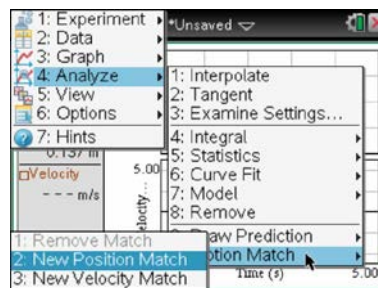
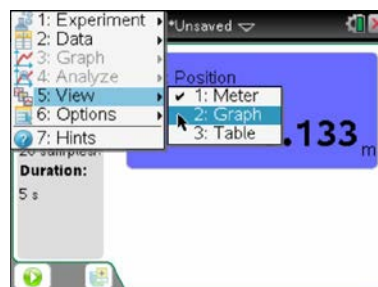
Draw your Position Match on the graph to the right.

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?





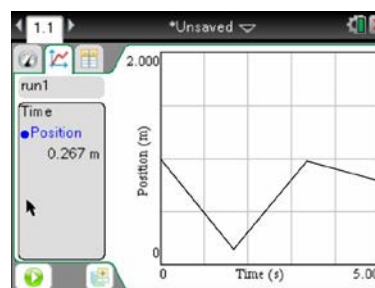
Match Me Student Activity

Name _____
Class _____

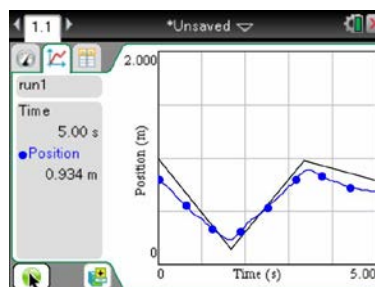
- Press the **Start Collection**  arrow in the lower-left corner of the screen. Point the CBR 2 at a wall and move back and forth until your graph matches the Position Match graph as closely as possible. If you are not pleased with your first attempt, press **Start Collection** again to repeat. You may 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.
- 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.


- 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?



- 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**.

- 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
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 Match_Me_Student.doc

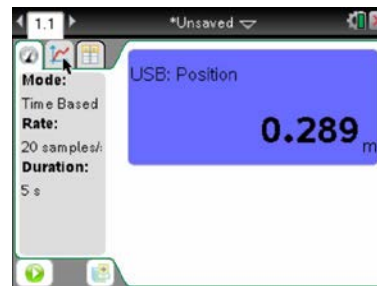



Discussion Points and Possible Answers

Part 1—Step-by-step setup

To utilize the built-in, easy-to-use **Motion Match** activity, 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.



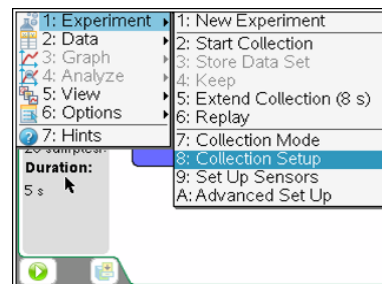
Tech Tip: The Vernier DataQuest app is user-friendly. It should launch when the CBR 2 is connected. To begin the data collection, click the green **Start Collection**  arrow in the lower-left corner of the screen.

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.

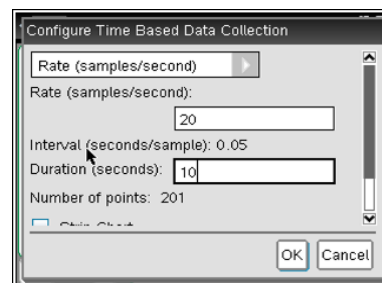
Teacher Tip: When the CBR 2 is first connected, it begins clicking and displays a measurement. Have the students move the CBR 2 by pointing it at different objects. Ask them what the motion detector is doing. It should be measuring the distance from the CBR 2 to the object directly in front of it. Be 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**.

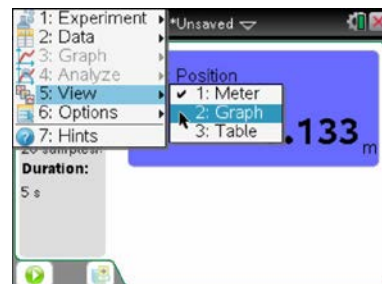




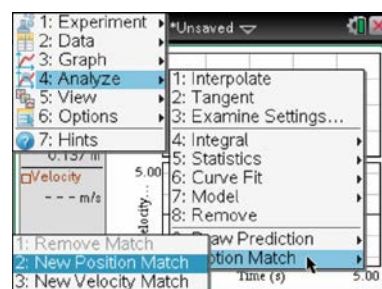
Change the duration to 10 seconds.



Now, set up the graph. Press **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

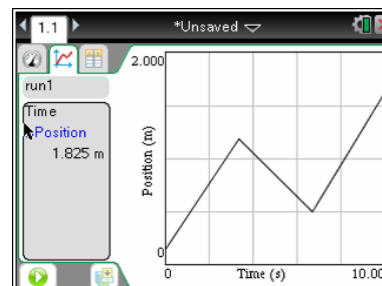
Answer: B. position in meters

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.

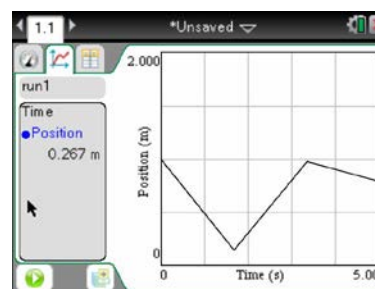
- Press the **Start Collection**  arrow in the lower-left corner of the screen. Point the CBR 2 at a wall and move back and forth until your graph matches the Position Match graph as closely as possible. If you are not pleased with your first attempt, press **Start Collection** again to repeat. You may 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.

- 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.



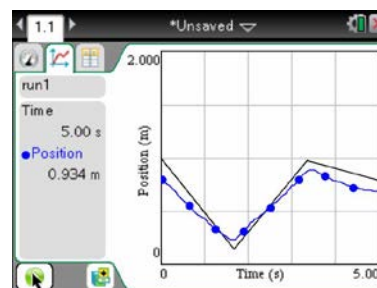
- Describe how you would need to walk in order to match that graph with your motion. Be sure to include information about the y-intercept, position at various times, velocity, and direction. For what times does the graph depict the slowest motion and the fastest motion?

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.

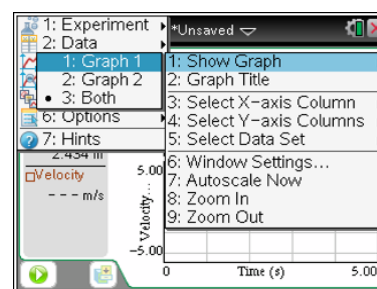
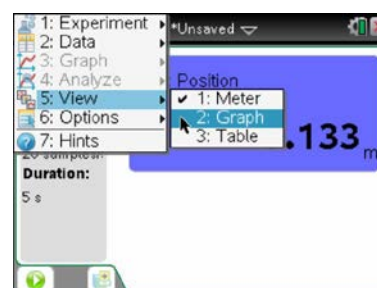
Sample answer: Answers will vary depending upon the graph generated.



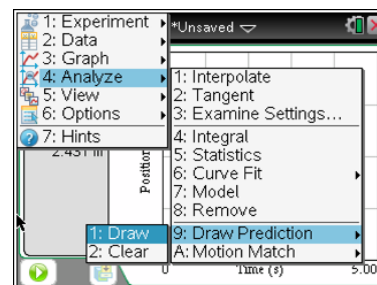
Teacher Extension

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. Press **Menu > View**. Choose the **Graph** view. Then press **Menu > Graph > Show Graph > Graph 1**.

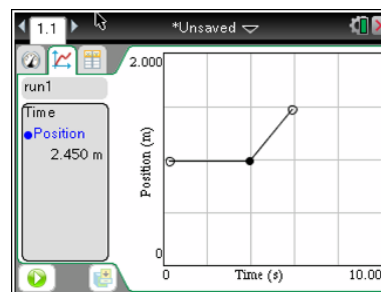


4. To draw your own graph to be matched, press **Menu > Analyze > Draw Prediction > Draw**.

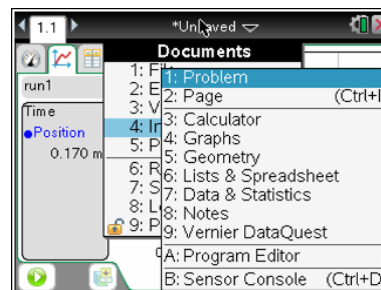




5. A pencil appears on the grid. Move the pencil to a point just off the vertical axis on the left side of the grid, and click to set the initial position. Use the pencil to draw the path that you want students to match. Click at each point to set the end point of a segment. Use the **[esc]** key to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





Boyle's Law

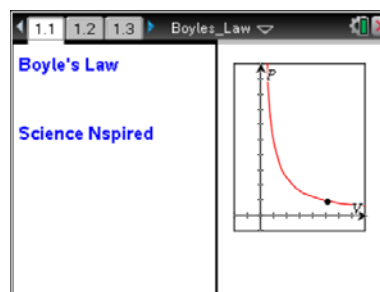
Student Activity

Name _____

Class _____

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

In this activity, you will use a Gas Pressure Sensor to measure the pressure of an air sample inside a syringe. Using graphs, you will apply your results to real-world examples.



What is the mathematical relation between volume and pressure for a confined gas? To answer this question, you will perform an experiment with air in a syringe connected to a Gas Pressure Sensor. When the volume of the syringe is changed by moving the piston, the change in the pressure will be measured. It is assumed that temperature and moles of gas will be constant throughout the experiment. Pressure and volume data pairs will be collected during this experiment and then analyzed. Using the data and the graph, the type of mathematical relationship between pressure and volume of the confined gas can be determined. Historically, this relationship was first established by Robert Boyle in 1662 and has since been known as Boyle's law.

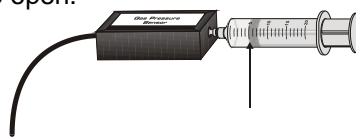
Move to page 1.6.

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

Q1. As volume increases, pressure:

- A. increases B. decreases C. remains the same

- With the syringe disconnected from the Gas Pressure Sensor, move the piston of the syringe until the front edge of the inside black ring (indicated by the arrow in the picture to the right) is positioned at the 10.0 mL mark.
- Turn on your TI-Nspire handheld, and close any documents that are open.
- Attach the syringe to the probe as shown to the right. (Do not twist too tightly—the syringe just needs to be secure.)



- Plug the pressure probe into the EasyLink™, and plug the EasyLink into the USB port in the top of the handheld. The DataQuest APP should open automatically.
 - What is the default unit for collection with this sensor?
- Select **Menu > Experiment > Collection Mode > Events with Entry**.
- Type in **volume** for Name, press **tab**, and type **mL** for Units. Press **enter**.
- Click the green start arrow to initiate data collection.

Time to collect pressure and volume data. It is best for one person to take care of the syringe and for another to operate the handheld.




Boyle's Law

Student Activity

Name _____

Class _____

8. To collect your first data reading, click on the "camera" icon  in the lower left of the screen ("Keep current reading"). Enter a value of 10, since you set the syringe at 10 mL earlier. Click on OK, or press .
9. Depress and hold the plunger to the 9 mL mark. When the pressure value on the left side of the screen has stabilized, keep this reading, type in 9, and press .
10. Continue this procedure, collecting data at 8, 7, 6, and 5 mL. After you have collected data for 5 mL, click on the stop button in the lower left corner of your TI-Nspire screen.
 - Your pressure/volume graph should now be displayed.

Move to page 2.3.

Q2. Which variable is considered to remain constant during a Boyle's Law Experiment?

- A. pressure B. volume C. temperature D. all of these

Q3. When a quantity of gas is compressed, the pressure of the gas is expected to _____.

- A. decrease B. remain the same C. increase D. double

Q4. The expected mathematical relationship between pressure and volume is _____.

- A. direct B. inverse C. indirect D. impossible to determine

Move to page 3.2.

Q5. If the volume is doubled from 5 to 10 mL, what does the data show happens to the pressure?

- A. increases B. decreases C. doubles D. cut in half

Q6. If the volume is tripled from 5.0 mL to 15.0 mL, what does the data show happened to the pressure?

- A. Increases B. decrease C. triples D. is cut to one third

Q7. If the volume is halved from 20 to 10 mL, what does the data show happens to the pressure?

- A. increases B. decreases C. doubles D. cut in half



Boyle's Law

Student Activity

Name _____

Class _____

Q8. From the answers to the above three questions and from the shape of the curve of the plot, of pressure vs. volume, what is the relationship between the pressure and volume of a confined gas?

- A. inverse B. direct C. quadratic D. impossible to determine

Q9. Based on the data, what would be expected to happen to the pressure if the volume in the syringe were increased from 10 to 40 mL?

- A. increase B. decrease C. quadruple D. cut to 1/4th

Q10. What TWO experimental factors are assumed to be constant in this experiment?

- A. Pressure B. volume C. moles of gas D. temperature

Q11. Summarize what you have learned about the relationship between pressure and volume.

Move to page 4.1.

Extension: Effect of Temperature on Boyle's Law

Follow the instructions on Pages 4.1-4.3 for the simulation, and then answer the following questions from Pages 4.4 and 4.5:

Q12. When the temperature is doubled, how does the pressure change?

- A. The pressure doubles. B. The pressure is reduced by $\frac{1}{2}$.
C. The pressure is 4X larger. D. The pressure does not change.

Q13. At a higher temperature, the relationship between pressure and volume is a(an) _____ relationship.

- A. direct B. inverse C. quadratic D. impossible to determine

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Boyle's Law

TI PROFESSIONAL DEVELOPMENT

TEACHER NOTES

Science Objectives

- Use a Gas Pressure Sensor and a gas syringe to measure the pressure of an air sample at several different volumes.
- Determine the relationship between gas pressure and volume.
- Use the results to predict the pressure at other volumes.

Math Objectives

- Describe the relationship between gas pressure and volume.
- Interpret the graph of pressure and volume.
- Make predictions based on trends in the data.

Materials Needed

- Vernier® EasyLink™
- Vernier Gas Pressure Sensor
- 20 ml syringe

Vocabulary

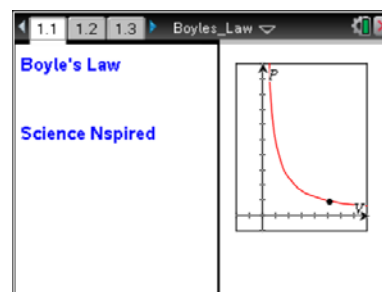
- pressure
- volume
- inverse

About the Lesson

- This activity makes use of the Gas Pressure Sensor in an inquiry activity that enables the student to understand Boyle's Law through experimentation and data collection.
- As a result, students will:
 - Observe the plot of the data which forms an inverse relationship.
 - Predict outcomes based on the data they have gathered.
 - Apply Boyle's Law to the real-life situation of human respiration.

TI-Nspire™ Navigator™ System

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



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.
- You can bring up the data collection console at any time by pressing **ctrl** **D**.

Lesson Materials:

Student Activity

- Boyles_Law_MG_Student.pdf
- Boyles_Law_MG_Student.doc

TI-Nspire document

- Boyles_Law_MG.tns

Visit www.sciencenspired.com for lesson updates and tech tip videos.

**Activity Overview**

- Please print the student worksheet and make available to students before beginning the lab. Lab background information as well as lab procedures are included only in the student worksheet. Always remember to review any safety precautions thoroughly with your students prior to starting the lab.
- Students may answer the questions posed in the .tns file and submit for grading with TI-Nspire Navigator (optional) or students may answer directly on the student worksheet
- Ensure that students collect data on the 5 known substances and look at the graph before they actually measure the absorbance of the unknown solution. This will allow them to make predictions and to look at the graph of the data first.

Discussion Points and Possible Answers

TI-Nspire Navigator Opportunity

Use the TI-Nspire Navigator System to monitor student progress using Class Capture.

Pre-lab Information and Questions.

Have students read the background information on pages 1.2 – 1.5. Then, they should answer the pre-lab question on page 1.6.

Q1. As volume increases, pressure _____.

Answer: decreases

Lab Procedure.

The lab procedure is in the student worksheet and is not duplicated here. Please refer to the student handout.

Boyles Law Lab.tns

Have students move to pages 2.3 – 2.5 and answer the questions in the .tns file or on the worksheet.

Q2. Which variable is considered to remain constant during a Boyle's Law experiment?

Answer: temperature

Q3. When a quantity of gas is compressed, the pressure of the gas is expected to _____.

Answer: increase



Q4. The expected mathematical relationship between pressure and volume is _____.

Answer: inverse

Q5. If the volume is doubled from 5 to 10 mL, what does the data show happens to the pressure?

Answer: cut in half

Q6. . If the volume is tripled from 5.0 mL to 15.0 mL, what does the data show happened to the pressure?

Answer: is cut to one third

Q7. If the volume is halved from 20 to 10 mL, what does the data show happens to the pressure?

Answer: doubles

Q8. From the answers to the above three questions and from the shape of the curve of the plot, of pressure vs. volume, what is the relationship between the pressure and volume of a confined gas?

Answer: inverse

Q9. Based on the data, what would be expected to happen to the pressure if the volume in the syringe were increased from 10 to 40 mL?

Answer: cut to 1/4

Q10. What two experimental factors are assumed to be constant during this experiment?
(select two)

Answer: moles of gas and temperature

Q11. Summarize what you have learned about the relationship between pressure and volume.

Answer: Answers will vary. Students should indicate the inverse relationship between pressure and volume



Q12. When the temperature is doubled, how does the pressure change?

Answer: The pressure doubles.

Q13. At a higher temperature, the relationship between pressure and volume is a(an) _____ relationship.

Answer: inverse (same as before)

TI-Nspire Navigator Opportunity: *Class Capture*

See Note 1 at the end of this lesson.

Wrap Up

Use Boyle's Law to offer a practical application such as human breathing.

Assessment

Formative assessment will consist of questions embedded in the pre-lab TI-Nspire document. Summative assessment questions are found in the lab and post-lab TI-Nspire document. The questions will be graded when the TI-Nspire documents are retrieved. The Slide Show can be utilized to give students immediate feedback on their assessment.

TI-Nspire Navigator Notes

Note 1 Class Capture

Class Capture can be used to monitor students.



Nailing Density

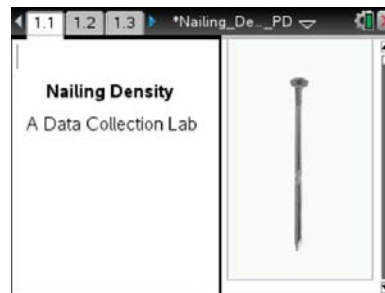
TI Professional Development

Name _____

Class _____

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

You will determine the mass and volume of five nails. The mass and volume of each nail will be graphed. By analyzing the graph you will discover a physical property of the nails.



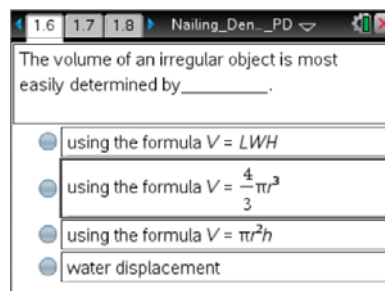
Move to pages 1.2–1.5.

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

Read the introduction describing mass, volume, and density.

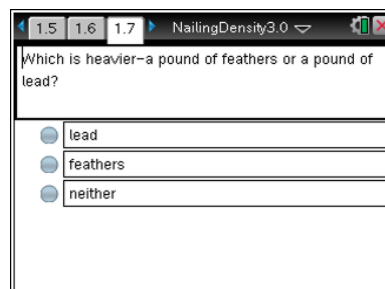
Move to page 1.6.

Answer the question on page 1.6.



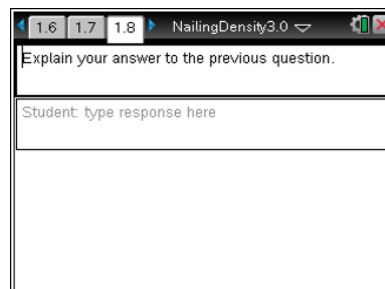
Move to page 1.7.

Answer the question on page 1.7.



Move to page 1.8.

Answer the question on page 1.8.





Move to page 1.9.

Answer the question on page 1.9.

Density is defined as _____.
☐ volume per unit mass
☐ mass per unit volume
☐ the heaviness of an object

Move to page 1.10.

Answer the question on page 1.10.

Which one of the following is NOT a unit of density?
☐ $\frac{g}{mL}$
☐ $\frac{g}{cm^3}$
☐ $\frac{g}{cm}$
☐ g

Move to pages 1.11–1.12.

Read the objectives of the experiment and the list of materials.

Move to pages 1.13–1.19.

Procedure:

1. Obtain five different nails.
2. Add enough water to the graduated cylinder to cover the tallest nail. Read the initial volume to the nearest 0.1 mL and record under **volw** for 0 nails on page 1.15.
3. Measure the mass of the first nail to 0.01 g and record under **massn** for 1 nail.
4. Gently let the nail 1 slide head first into the tilted graduate. Measure the new volume under **volw** for 1 nail.
5. Repeat this procedure for the four remaining nails accumulating the nails in the graduated cylinder.
6. Calculate the total mass of nails by adding each to the previous total using cell notation (in cell C2 enter **=C1+B2**). Repeat for the four remaining nails.
7. Calculate the volume of each nail by subtracting the previous water volume from the current (in cell E2 enter **=D2-D1**). Repeat for the remaining four nails.

	nail	massn	massst	volw	voln	dens
1	0	0	0			
2	1					
3	2					
4	3					
5	4					
At	0					



Nailing Density

TI Professional Development

Name _____

Class _____

8. Calculate the density of the nails by dividing the mass of the nail by its volume (enter = **massn/voln** in the formula bar under **dens**).
9. On the Data & Statistics page that follows (page 1.18), explore some graphs by clicking near an axis and choosing the variable you wish to plot.
10. Plot **massn** vs. **voln** and determine the best fit line for the nails' volume and mass relationship. Select **Menu > Analyze > Regression > Show Linear(mx + b)**.
11. Plot **masst** vs. **volw** and again find the best line. Cycle between the last two graphs to see the similarities and differences.

Move to page 1.20.

Answer the question on page 1.20.

1.18 1.19 1.20 Nailing_Den_PD

What is the regression equation for your masst vs. volw graph?

Student: Type response here.

Move to page 1.21.

Answer the question on page 1.21.

1.19 1.20 1.21 NailingDensity3.1

What is the slope of the line?

Student: type response here

Move to page 1.22.

Answer the question on page 1.22.

1.22 1.23 1.24 NailingDensity3.1

What would the units of the slope be?

Student: type response here



Move to page 1.23.

Answer the question on page 1.23.

Why does your graph not pass near the origin?

Student: type response here

Move to page 1.24.

Answer the question on page 1.24.

The formula for Density is: $D = \frac{m}{V}$, where D is density, m is mass, and V is volume. Rearrange the formula to isolate mass instead of density.

Student: Type response here.

Move to page 1.25.

Answer the question on page 1.25.

Rewrite the regression equation from the Data and Statistics page replacing the "x" variable with V for volume and the "y" variable with m for mass. Leave out the "b" (y-intercept) value as it is just a correction to account for the non-zero initial volume.

Student: Type response here.

Move to page 1.26.

Answer the question on page 1.26.

How does the rearranging $D = \frac{m}{V}$ equation compare to the equation that you wrote in the previous question? Explain.

Student: type response here

Move to page 1.27.

Answer the question on page 1.27.

What does the slope of the mass vs. volume graph on the Data and Statistics page represent?

Student: Type response here.



Move to page 1.28.

Answer the question on page 1.28.

1.26 1.27 1.28 NailingDensity3.0

What unit(s) would be assigned to the slope of this graph?

Student: type response here

Move to page 1.29.

Answer the question on page 1.29.

1.27 1.28 1.29 Nailing_Den._PD

Why are the densities calculated for each nail not exactly the same and not exactly equal to the slope of the line?

- ☐ Because the nails have different masses
- ☐ Because of experimental errors in the mass and volume of the nails
- ☐ Because the nails are made of

Move to page 1.30.

Answer the question on page 1.30.

1.28 1.29 1.30 Nailing_Den._PD

Use the Internet to go to:
http://www.engineeringtoolbox.com/metal-alloys-densities-d_50.html
 to identify the element or metal alloy whose properties would match the density that you calculated for the nail. Remember that $1 \text{ kg/m}^3 = 0.001 \text{ g/cm}^3$ and that $1 \text{ cm}^3 = 1 \text{ mL}$.

Student: Type response here.

Move to page 1.31.

Answer the question on page 1.31.

1.29 1.30 1.31 Nailing_Den._PD

Refer to the data that was collected. What effect does increasing the volume of the nail have on the mass of the nail?

- ☐ The mass decreases.
- ☐ The mass is unchanged.
- ☐ The mass increases.
- ☐ The mass sometimes increases and sometimes decreases.

Move to page 1.32.

Answer the question on page 1.32.

1.30 1.31 1.32 Nailing_Den._PD

Refer to the data that was collected. What effect does increasing the volume of the nail have on the density of the nail?

- ☐ The density decreases.
- ☐ The density is unchanged.
- ☐ The density increases.
- ☐ The density sometimes increases and sometimes decreases.



Move to page 1.33.

Answer the question on page 1.33.

1.31 1.32 1.33 NailingDensity3.0

Which of the following is NOT true of the density of a substance?

- ☐ intensive property
- ☐ extensive property
- ☐ characteristic or identifying property
- ☐ temperature dependent

Move to page 1.34.

Answer the question on page 1.34.

1.32 1.33 1.34 NailingDensity3.0

Summarize what you have learned about density from this experiment.

Student: type response here

Move to pages 1.35–1.36.

Extension:

Obtain the following information:

1. Slope and vertical and horizontal axes intercepts from **massn** vs. **voln** from the best fit line
2. Slope and vertical and horizontal axes intercepts from **masst** vs. **volw** from the best fit line
3. Mean value of **dens** (insert a Calculator page and use the Statistics menu)

Answer the following questions:

1. What do the intercepts of each graph mean?
2. What do the slopes of each graph mean?
3. How do the slopes compare to each other and to the mean density calculated from the **dens**?
4. What are the statistical implications of these results?
5. What gives you the best result for density?



Science Objectives

- Determine the relationship between mass and volume.
- Mathematically describe the relationship between mass and volume.
- Relate the slope of a line to a physical property (density).

Math Objectives

- Generate a linear least-squares line from mass and volume data.
- Analyze a linear mathematical relationship.

Materials Needed

- Five (5) different-size nails of the same material
- 0.01 g balance
- 10- or 50-mL graduated cylinder (depending on the size of the nails)

Vocabulary

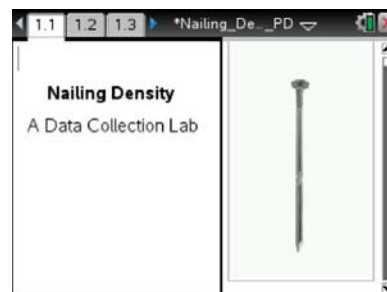
- mass
- volume
- density

About the Lesson

- The student determines the masses and volumes of five nails. The mass and volume of each nail is graphed. By analyzing the graph the student will discover a physical property of the nails.
- As a result, students will:
 - Determine the relationship between mass and volume.
 - Mathematically describe the relationship between mass and volume.
 - Generate a linear least-squares line from mass and volume data.
 - Relate the slope of a line to a physical property (density).

TI-Nspire™ Navigator™ System

- Class Capture to monitor student progress
- Live Presenter allows students to show their graphs to the class



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

- Nailing_Density_PD.pdf
- Nailing_Density_PD.doc

TI-Nspire document

- Nailing_Density_PD.tns

Visit www.sciencenspired.com/ for lesson updates and tech tip videos. (optional)



Discussion Points and Possible Answers

Move to page 1.6.

Answer: water displacement

1.6 1.7 1.8 Nailing_Den_PD

The volume of an irregular object is most easily determined by_____.

- ☐ using the formula $V = LWH$
- ☐ using the formula $V = \frac{4}{3}\pi r^3$
- ☐ using the formula $V = \pi r^2 h$
- ☐ water displacement

Move to page 1.7.

Answer: neither

1.5 1.6 1.7 NailingDensity3.0

Which is heavier—a pound of feathers or a pound of lead?

- ☐ lead
- ☐ feathers
- ☐ neither

Move to page 1.8.

Answer: Neither a pound of feathers nor a pound of lead is heavier—their masses both are equal to one pound.

However, the lead has a much greater density since the volume of one pound of lead would be much less than the volume of pound of feathers.

1.6 1.7 1.8 NailingDensity3.0

Explain your answer to the previous question.

Student: type response here

Move to page 1.9.

Answer: mass per unit volume

1.7 1.8 1.9 NailingDensity3.0

Density is defined as_____.

- ☐ volume per unit mass
- ☐ mass per unit volume
- ☐ the heaviness of an object



Move to page 1.10.

Answer: $\frac{\text{L}}{\text{g}}$

Which one of the following is NOT a unit of density?

- $\frac{\text{g}}{\text{mL}}$
- $\frac{\text{g}}{\text{cm}^3}$
- g

Move to page 1.20.

Answer: $y = 7.52x - 161.8$

Sample Data:	27.0	0
	27.5	4.3
	28.5	11.36
	29.5	19.09
	30.8	28.73
	32.8	43.86

What is the regression equation for your mass vs. volw graph?

Student: Type response here.

Move to page 1.21.

Answer: $6.07 \frac{\text{g}}{\text{mL}}$

What is the slope of the line?

Student: type response here

Move to page 1.22.

Answer: $\frac{\text{g}}{\text{mL}}$

What would the units of the slope be?

Student: type response here

Move to page 1.23.

Answer: The volume for zero nails is not zero. The volume for zero nails is the initial volume of water in the graduated cylinder.

Why does your graph not pass near the origin?

Student: type response here



Move to page 1.24.

Answer: $m = D \cdot V$

1.22 1.23 1.24 Nailing_Den._PD

The formula for Density is: $D = \frac{m}{V}$, where D is density, m is mass, and V is volume. Rearrange the formula to isolate mass instead of density.

Student: Type response here.

Move to page 1.25.

Answer: $m = 7.52$

1.23 1.24 1.25 Nailing_Den._PD

Rewrite the regression equation from the Data and Statistics page replacing the "x" variable with V for volume and the "y" variable with m for mass. Leave out the "b" (y-intercept) value as it is just a correction to account for the non-zero initial volume.

Student: Type response here.

Move to page 1.26.

Sample answer: The equations are the same since mass is graphed on the y-axis and volume on the x-axis and the relationship is linear.

1.24 1.25 1.26 NailingDensity3.0

How does the rearranging $D = \frac{m}{V}$ equation compare to the equation that you wrote in the previous question? Explain.

Student: type response here

Move to page 1.27.

Answer: the density of the nail

1.25 1.26 1.27 Nailing_Den._PD

What does the slope of the mass vs. volw graph on the Data and Statistics page represent?

Student: Type response here.

Move to page 1.28.

Answer: $\frac{\text{g}}{\text{mL}}$

1.26 1.27 1.28 NailingDensity3.0

What unit(s) would be assigned to the slope of this graph?

Student: type response here



Move to page 1.29.

Answer: Because of experimental errors in the mass and volume of the nails

Move to page 1.30.

Answer: iron and steel

Move to page 1.31.

Answer: The mass increases.

Move to page 1.32.

Answer: The density is unchanged.

Move to page 1.33.

Answer: extensive property

1.27 1.28 1.29 Nailing_Den._PD

Why are the densities calculated for each nail not exactly the same and not exactly equal to the slope of the line?

- ☐ Because the nails have different masses
- ☐ Because of experimental errors in the mass and volume of the nails
- ☐ Because the nails are made of

Use the Internet to go to:
http://www.engineeringtoolbox.com/metal-alloys-densities-d_50.html
 to identify the element or metal alloy whose properties would match the density that you calculated for the nail. Remember that $1 \text{ kg/m}^3 = 0.001 \text{ g/cm}^3$ and that $1 \text{ cm}^3 = 1 \text{ mL}$.

Student: Type response here.

1.29 1.30 1.31 Nailing_Den._PD

Refer to the data that was collected. What effect does increasing the volume of the nail have on the mass of the nail?

- ☐ The mass decreases.
- ☐ The mass is unchanged.
- ☐ The mass increases.
- ☐ The mass sometimes increases and sometimes decreases.

1.30 1.31 1.32 Nailing_Den._PD

Refer to the data that was collected. What effect does increasing the volume of the nail have on the density of the nail?

- ☐ The density decreases.
- ☐ The density is unchanged.
- ☐ The density increases.
- ☐ The density sometimes increases and sometimes decreases.

1.31 1.32 1.33 NailingDensity3.0

Which of the following is NOT true of the density of a substance?

- ☐ intensive property
- ☐ extensive property
- ☐ characteristic or identifying property
- ☐ temperature dependent



Move to page 1.34.

Sample answer: The density of a substance is a constant independent of mass and volume that only changes only with temperature. Density is an intensive property that is characteristic of a substance. Density can be used to identify a substance.

Pages 1.35-1.36

Extension

Answers: (For the sample data)

massn vs. **voln**: slope = $7.31 \frac{\text{g}}{\text{mL}}$, y-intercept = 0.30 g, x-intercept = -0.03 mL

masst vs. **volw**: slope = $7.52 \frac{\text{g}}{\text{mL}}$, y-intercept = -202.9 g, x-intercept = 27.0 mL

Mean of **dens**: $7.67 \frac{\text{g}}{\text{mL}}$

1. The intercepts for the **massn** vs. **voln** should be zero. For the **masst** vs. **volw** graph the y-intercept is -(initial volume) · (slope) and the x-intercept is initial volume.
2. The slopes are the density of the nails.
3. $7.31 < 7.52 < 7.67 \frac{\text{g}}{\text{mL}}$
4. The experimental errors for individual nails have a greater effect on the **massn** vs. **voln** graph and on the mean of **dens**.
5. The best result for density is from the **masst** vs. **volw** graph.

TI-Nspire Navigator Opportunity: Class Capture can be used to monitor students.

Wrap Up

Give examples of how density can be used to identify unknown metals.

Assessment

Formative and summative assessment questions are embedded in the TI-Nspire™ document. The questions will be graded when the documents are collected. The Slide Show can be utilized to give students immediate feedback on their assessment.



Body Mass Index

Student Activity

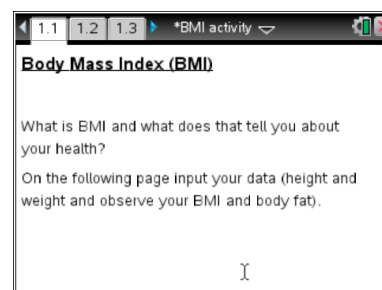
Name _____

Class _____

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

Body mass index (BMI) is a calculation related to a person's height and body weight. Percent body fat is the percentage of a person's weight that is body fat. This calculation can be made using the person's height and weight.

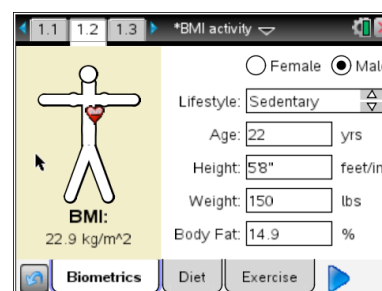
What is BMI and what does it tell you about your health?



Move to page 1.2.

Input data about your lifestyle, age, height, and weight.
Observe your BMI and percent body fat.

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



Move to page 1.3.

When your weight increases what happens to your BMI and percent body fat?

- BMI increases and body fat decreases.
- BMI decreases and body fat decreases.
- BMI increases and the body fat increases.
- BMI decreases and percent body fat increases.

Move to page 1.4.

Does your age make a difference in your BMI or percent body fat?

- Yes
- No



Body Mass Index Student Activity

Name _____

Class _____

Move to page 1.5.

If a male is the same height and weight as a female,

- the male has more body fat.
- the female has more body fat.
- the male and female have the same body fat.

Move to page 2.3.

- Set the height to your height.
- Set the weight to 100 lb and observe the percent body fat.
- Insert a Lists & Spreadsheet page after the BMI calculator. Title the columns appropriately.
- Change the weight to 110, 120, 130, 140, 150, and 160, and enter weight and percent body fat into the spreadsheet.

Move to page 2.5.

What is the independent variable in the simulation?

Move to page 2.6.

What is the dependent variable in the simulation?

Move to page 2.7.

- Add your partner's percent body fat to the spreadsheet on page 2.4.
- Add a Data & Statistics page and plot your data appropriately.
- Create a moveable line on the graph and fit the line to your data.

Move to page 2.9.

What is the equation of the line that fits the data for your height?

Move to page 2.10.

What is the slope of your graph?



Body Mass Index

Student Activity

Name _____

Class _____

Move to page 2.11.

What is the y-intercept in your graph?

Move to page 2.12.

What does the slope represent in your graph?

- ☐ weight
- ☐ percent body fat
- ☐ ratio of weight to percent body fat
- ☐ ratio of percent body fat to weight

Move to page 2.13.

If the slope of a graph is 0.28, this means

- ☐ for every 0.28 lb there is 1% body fat.
- ☐ for every 0.28% body fat there is 1 lb.
- ☐ that there is 0.28 lb.
- ☐ that there is 0.28% body fat.

Move to page 2.14.

If you and your partner have different initial body fat percentages, what generalization can you make about body fat percentage, weight and height?

This page intentionally left blank



Science Objectives

- Students will explore the body mass index (BMI) as it relates to weight, height, and age.
- Students will compare weight to percent body fat

Vocabulary

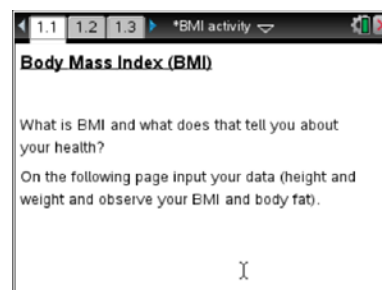
- body mass index
- percent body fat

About the Lesson

- This lesson involves students exploring the BMI calculator.
- As a result, students will . . .
 - be able to determine the relationship between their height, weight, and percent body fat .
 - plot percent body fat versus weight and determine the conversion for their weight to percent body fat.

TI-Nspire™ Navigator™ System

- Send a TI-Nspire document to students.
- Quick Poll to determine if age affects BMI.
- Make a student the Live Presenter and have him or her operate the BMI calculator as the teacher explains how to read the screen.



TI-Nspire™ Technology Skills:

- Download a TI-Nspire™ document
- Open a document
- Move between pages
- Grab and drag a point

Tech Tips:

- Make sure the font size on your TI-Nspire handhelds is set to Medium.
- You can hide the entry line by pressing **ctrl** **G**.

Lesson Files:

Student Activity

- Body_Mass_Index_Student.pdf
- Body_Mass_Index_Student.doc

TI-Nspire Document

- Body_Mass_Index.tns

Visit www.sciencenspired.com for lesson updates and tech tip videos.



Discussion Points and Possible Answers

Tech Tip: Students can create a spreadsheet after the BMI calculator and alternate between the two pages to enter the weight and percent body fat.

Move to page 1.2.

Input data about your lifestyle, age, height, and weight.
Observe your BMI and percent body fat.

Move to page 1.3.

When your weight increases what happens to your BMI and body fat?

Answer: BMI increases and the body fat percentage increases.

Move to page 1.4.

Does your age make a difference in your BMI or body fat percentage?

Answer: No

Move to page 1.5.

If a male is the same height and weight as a female,

Answer: The female has more body fat.

Move to page 2.3.

- Set the height to your height.
- Set the weight to 100 lb and observe the percent body fat.
- Insert a Lists & Spreadsheet page after the BMI calculator. Title the columns appropriately.
- Change the weight to 110, 120, 130, 140, 150, and 160, and enter weight and percent body fat into the spreadsheet.



Body Mass Index

SCIENCE NSPIRED

TEACHER NOTES

Students will add a spreadsheet and record the weight and percent body fat. Title the columns **weight** and **body_fat**.

	weight	body_fat
1	100	10
2	110	11.9
3	120	13.8
4	130	15.7
5	140	17.6
6	150	19.5

Move to page 2.5.

What is the independent variable in the simulation?

Answer: weight

Move to page 2.6.

What is the dependent variable in the simulation?

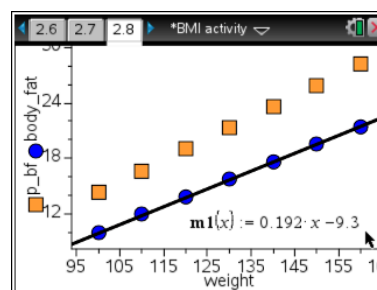
Answer: percent body fat

Move to page 2.7.

Add your partner's percent body fat to the spreadsheet on page 2.4.

	weight	body_fat	p_bf
1	100	10	14.3
2	110	11.9	16.6
3	120	13.8	19
4	130	15.7	21.3
5	140	17.6	23.6
6	150	19.5	25.9

Add a Data & Statistics page and plot percent body fat versus weight.



Move to page 2.9.

What is the equation of the line that fits the data for your height?



Sample answer: Answers will vary depending on the student's height. For a student 6 feet tall, the equation might be $y = 0.19x - 9.3$.

Move to page 2.10.

What was the slope of your graph?

Sample answer: Answers will vary depending on the student's height. For a student 6 feet tall, the slope might be 0.19.

Move to page 2.11.

What is the y-intercept in your graph?

Sample answer: Answers will vary depending on the student's height. For a student 6 feet tall, the y-intercept might be -9.3 .

Move to page 2.12.

What does the slope represent in your graph?

Answer: ratio of percent body fat to weight

Move to page 2.13.

If the slope of a graph is 0.28 this means

Answer: for every 0.28% body fat there is 1 lb.

Move to page 2.14.

If you and your partner have different initial body fat percentages, what generalization can you make about body fat percentage, weight and height?

Answer: The taller a person is the heavier they can be and have a lower body fat percent.



Teacher Tip: After they have worked through the activity, talk to students about the importance of the slope being a conversion factor between body fat percent and weight. Each student's slope will be based on his or her height. The taller the student, the smaller the ratio of the percent body fat weight.

TI-Nspire Navigator Opportunity: *Live Presenter*

See Note 1 at the end of this lesson.

Wrap Up

Students should gain an understanding that the taller a student is, the heavier that student can be and have a lower percent body fat. Also, the taller the student is, the smaller the ratio between percent body fat and weight.

TI-Nspire Navigator

Note 1

Page 2.14, *Live Presenter*

Make a student the Live Presenter and discuss the different slopes for two different people and why they are different.

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Objectives

- Participants will become familiar with the TI-Nspire™ CX keypad.
- Participants will explore several of the TI-Nspire applications.
- Participants will use many features of the Calculator and Notes applications in a problem-based exploration.

The TI-Nspire™ CX handheld is much more than a calculator. In this workshop, you will see how students can display data (entered or collected) to discover trends and create and evaluate models. In the CAS models (these include a Computer Algebra System), units can be included making dimensional analysis a powerful tool for understanding process and results.

In this activity, you will begin to become comfortable with and to explore the features of the TI-Nspire CX CAS applications and some of the detailed capability of the Calculator and Notes applications.

Step 1:

Begin by turning the handheld on by pressing **on**.

- To navigate the screen, you can use the **tab** key, the arrow keys () or the Touchpad mouse control.
- Clicking will perform the highlighted action.
- Note the Home Screen features. Also note the important variety of keys on the keypad.
- Explore!

Step 2:

Now press **on** > **New Document** > **Calculator**. You have just started to make a new TI-Nspire document by creating a blank Calculator page.

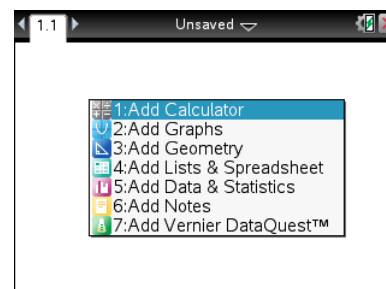
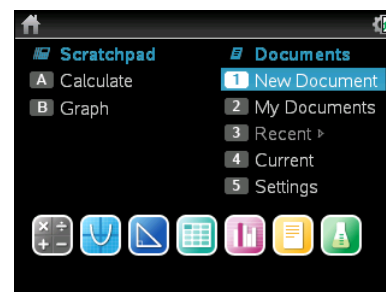
TI-Nspire™ Technology

Skills:

- Use the keypad efficiently
- Insert new application pages
- Find Menu items
- Move between pages

Tech Tips:

- Using the Touchpad takes practice. Go slowly at first.
- , , and Right-click () are your best friends when you are just starting.

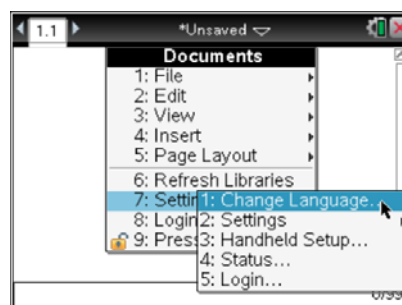
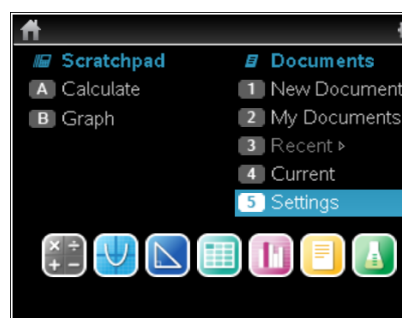
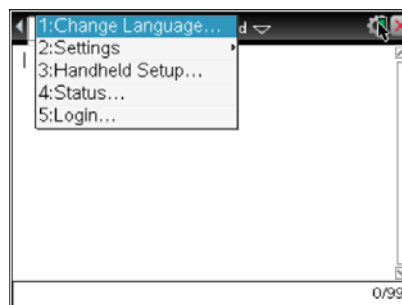




Step 3:

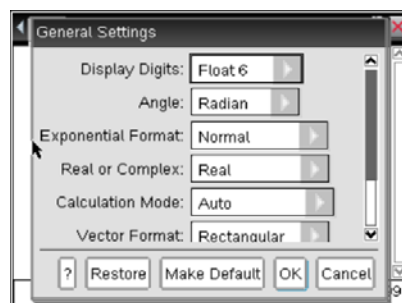
We want to determine the settings for this Document and adjust them as needed. In this environment, we have three options to adjust settings:

- Option #1: Move the cursor to the gear icon in the upper right-hand corner of the screen and click.
- Option #2: Return to the Home Screen and select option 5.
- Option #3: Press the **doc** key.



Step 4:

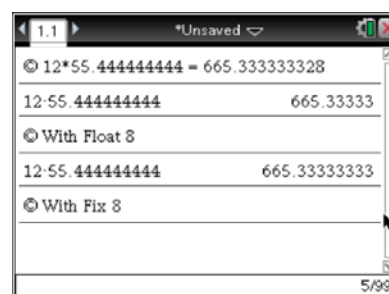
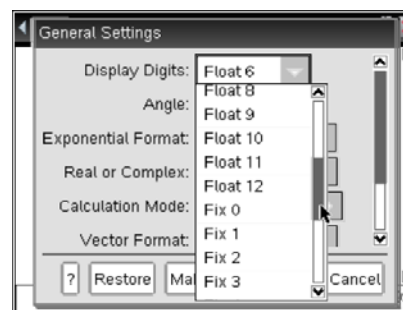
For now we will just take note of the possibilities, and return to change them as we need in particular investigations. Using the Float and Fix options are the most common use for science teachers, as well as the use of radians or degrees.





Step 5:

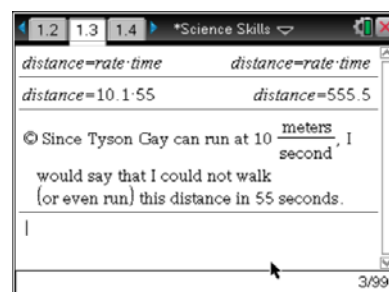
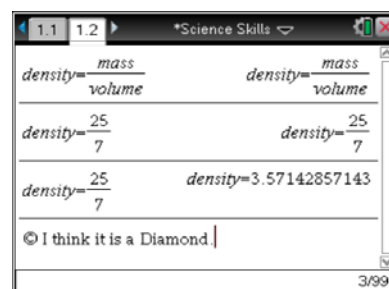
When you set **Fix** to 8, you get 8 digits to the right of the decimal in your answer. With **Float** set at 8, you just get up to 8 digits in your answer as shown in the image to the right. Note that the default is just Float.



Step 6:

What kinds of calculations and features are important to Middle Grades Science? Perform the following calculations as shown in the screen capture:

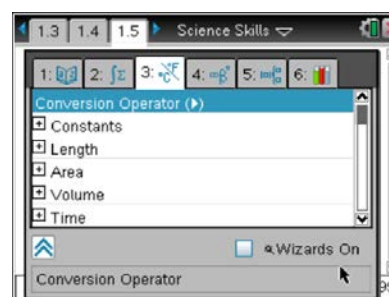
- What is the Density of a material that has a mass of 25 grams and a volume of 7 cubic centimeters? What material do you think it is? [Hints: Use **ctrl** **÷** to get a fraction. Select **Menu > Actions > Insert Comment** option to get the © so you can write text. Use **ctrl** **enter** to get an approximate value.]
- How far would you travel if you could move at 10.1 meters per second and you did it for 55 seconds? Could you walk this distance in that time?



Step 7:

You may also, with CAS, use built-in constants and units using the underscore (get this off of the Symbol List **ctrl** **⏏**) or by using **ctrl** **⏏** before the unit abbreviation or the constant symbol.

- See **⏏** (the Catalogue) for the extensive list of units and constants under option 3. [Note: You must press the number **3** or click on the option to access it.]





- Using Newton's Second Law determine the weight of a 95 kilogram person on Earth.
- How far will you go if you drive at 99 miles per hour for 7.7 hours?

Step 8:

Conversions work on the CAS version as well. In the Settings, you default to SI units, but this can be changed. Using the Conversion Operator (►) will allow you to get units other than the default.

- Convert 777 inches to Meters.
- Convert your weight in pounds to Newtons.
- Convert your answers from problem 5 above to Pounds and Miles.
- Convert 28 miles per gallon to kilometers per liter.

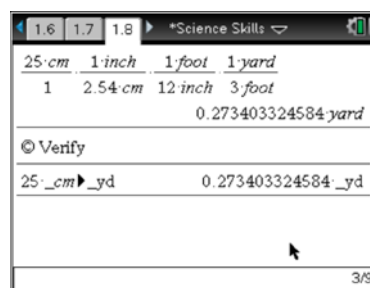
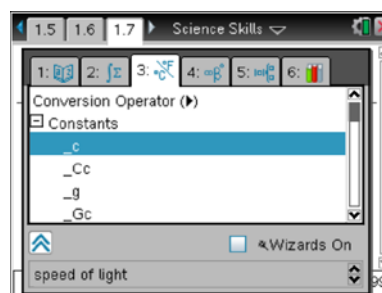
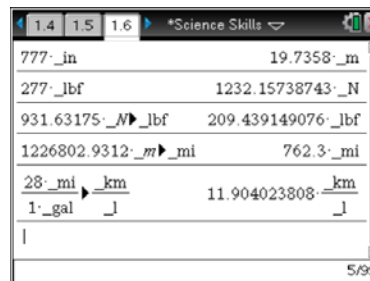
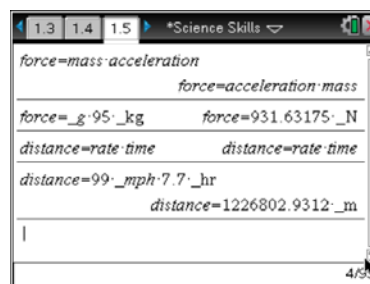
Hint: Use your right or left arrows to open or collapse the folders for types of units when in the Units environment.

Step 9:

Also use conversions that you know and Unit Analysis to convert. This technique taps into the way that the CAS handhelds deal with variable names.

- In the non-CAS handhelds, you cannot use variables like distance or d until they are defined as having a specific numerical value.
- With the CAS handhelds, you can work with the variable names while they are undefined.
- Convert 25 centimeters to yards using the conversion facts that 1 inch = 2.54 cm and that 1 foot = 12 inches, and 3 feet = 1 yard.
- Try converting Furlongs per Fortnight to Light Years per Millennium.

Another task with units might be to ask the students to convert 1 million seconds into the best units and see how they did. Would it be years, weeks, minutes? Then try it with a billion seconds.





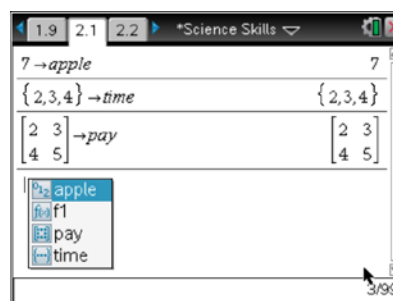
Step 10:

The TI-Nspire handheld can handle many types of variables. They can be defined in many ways, and you will experience some of them.

- To see the list of variables in a document (which are uniquely defined for each problem in a document), use the **[var]** key. This is best done in the Calculator app since not all variables are available in all apps.
- Use the STO key **[ctrl] [var]** to get **[sto→]** as one way to create a variable – there are many other ways as well.

In the image to the right, you will see the following variable types:

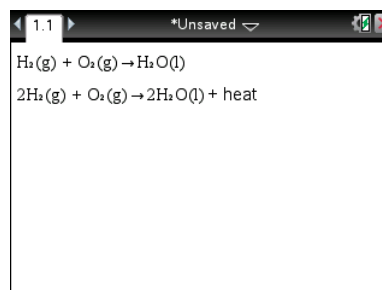
- apple is a Real
- f1 is a Function
- time is a List
- pay is a Matrix



Step 11:

Another Nspire feature is the Chem box that can be used in the Notes App. Introduce a Notes page by pressing **[ctrl] [I]** and selecting Add Notes. Select **[menu] > Insert > Chem Box** to insert a Chem Box in the Notes page.

- Enter the first reaction as shown in the screen capture.



Step 12:

You can key in text on the Notes page (or copy and paste from another TI-Nspire document, or with the software, copy and paste from other sources).

- Create another Notes page and key in this text or ask the instructor to perform a copy and paste and send you the document.

Earth and Space: The student knows characteristics of the universe. The student is expected to describe components of the universe, including stars, nebulae, and galaxies, and use models such as the Hertzsprung-Russell diagram for classification. This is a Readiness Standard.

Now interact with the Text by making key words stand out.

-



Radioactive Decay

Student Activity

Name _____

Class _____

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

In this activity, you will conduct an experiment to simulate the process of radioactive particle decay. You will learn how to predict the leftover particles based on the decay rate and the initial population.



Radioactive decay occurs when heavy elemental particles, such as Uranium and Plutonium, reach critical mass and begin to break down into smaller elements at a constant rate. Each atom within the element has the same probability of breaking down. We can't predict exactly which atoms will break down, but on average, all of them will break down at the *same rate*.

Move to pages 1.2, 1.3, and 1.4.

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

1. Acquire a half cup of M&M[®]s from your teacher.
2. Pour the M&Ms out onto a flat surface and count them. Enter the count on the spreadsheet on Page 1.4.
3. Place the M&M's back in the cup, shake, and pour all of them out again.
4. Remove the candies that landed M-side up, and count the remaining M&Ms (with no M showing).
5. Repeat steps 3 and 4 until no M&M's remain to put back into the cup.
6. Record each trial in the data table on Page 1.4.

Note: Do not enter the trial where you have no M&M's left.

Move to page 1.5.

7. Plot the *number* vs. the *trial* on the Data & Statistics page.

Move to pages 1.6 and 1.7.

8. What is the independent variable?
9. What is the dependent variable?



Radioactive Decay

Student Activity

Name _____

Class _____

Move to page 1.9.

10. What observations can you make about the data? Is it linear? Non-linear?

Move to pages 1.10 through 1.15.

11. What is the meaning of the y -intercept?

12. What is the meaning of the x -intercept?

13. How many trials did it take to get to approximately half of your original amount? What does this represent?

14. How did the number of sides impact the half life? Hypothesize how the half life would be impacted if there were three sides with only one side marked?

15. Summarize your conclusions about the pattern of the relationship in this decay model.



Radioactive Decay

TI PROFESSIONAL DEVELOPMENT

TEACHER NOTES

Science Objectives

- Students will count the number of decaying particles, which are modeled by M&M's®.
- Students will graph the particles (M&M's) vs. the trials.
- Students will determine a decay curve and the variables that affect the curve.

Vocabulary

- decay
- exponential
- population
- growth rate
- growth factor

About the Lesson

- This lesson involves the idea of exponential decay.
- As a result, students will:
 - Observe particles decaying (in the form of M&M's).
 - Calculate a relationship between the time and the number of M&M's.
 - Analyze the pattern of the graph for their sample.
 - Determine what each variable in the decay graph represents.

TI-Nspire™ Navigator™ System

- Use the Quick Poll to send a list out to the students and gather the data from their trials.
- Use TI-Nspire™ Navigator™ Teacher Software to review student TI-Nspire documents.



TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Grab and drag a point

Tech Tips:

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

Lesson Files:

Student Activity

Radioactive_Decay_Student.pdf

Radioactive_Decay_Student.doc

TI-Nspire document

Radioactive_Decay_MG.tns



Discussion Points and Possible Answers

Move to pages 1.2, 1.3, and 1.4.

1. Acquire a half cup of M&M[®]s from your teacher.
2. Pour the M&Ms out onto a flat surface and count them. Enter the count on the spreadsheet on Page 1.4.
3. Place the M&M's back in the cup, shake, and pour all of them out again.
4. Remove the candies that landed M-side up, and count the remaining M&Ms (with no M showing).
5. Repeat steps 3 and 4 until no M&M's remain to put back into the cup.
6. Record each trial in the data table on Page 1.4.

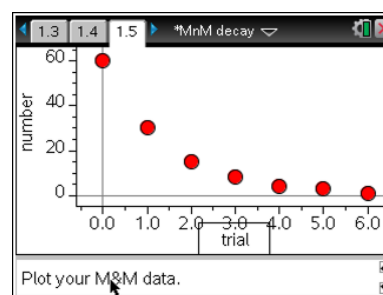
Note: Do not enter the trial where you have no M&M's left.

trial	number		
0			
1			
2			

Teacher Tip: You might want to demonstrate how to drag segments and how to join segments to form a vertex of an angle.

Move to page 1.5

7. Plot the *number* vs. the *trial* on the Data & Statistics page.



Move to pages 1.6 and 1.7.

8. What is your independent variable?

Answer: trials

9. What is the dependent variable?

Answer: number of candies



Teacher Tip: This is a good time to talk about radioactive particle decay and that the trials would represent the number of years it takes the particles to decay.

TI-Nspire Navigator Opportunity: *Quick Polls (Multiple Choice or Open Response)*
See Note 1 at the end of this lesson.

Move to page 1.9.

10. What observations can you make about the data? Is it linear? Non-linear?

Answer: Non-linear.

TI-Nspire Navigator Opportunity: *Live Presenter*
See Note 2 at the end of this lesson.

Teacher Tip: Bring out the basic curve of the line (exponential) while staying in middle school level. Ask questions to bring out understanding of components of the problem.

Move to pages 1.10 through 1.15.

11. What is the meaning of the y-intercept?

Answer: Starting population of M&M's.

12. What is the meaning of the x-intercept?

Answer: The amount of trials it takes for exponential decay to occur based on this example.

13. How many trials did it take to get to approximately half of your original amount? What does this represent?

Answer: one; half life



14. How did the number of sides impact the half life? Hypothesize how the half life would be impacted if there were three sides with only one side marked?

Answer: .two sides = $\frac{1}{2}$; 3 sides = $\frac{1}{3}$

15. Summarize your conclusions about the pattern of the relationship in this decay model.

Sample Answers: Decay is not linear; it has a half life.

Teacher Tip: Now that the students have established an understanding of a growth or decay curve, you can discuss the idea of initial state and the y-intercept.

Wrap Up

Upon completion of the discussion, the teacher should ensure that students are able to understand:

- The basic shape of the graph of the decay model is non-linear.
- What the y- and x-intercepts represent; and that decay models always have a half life.

TI-Nspire Navigator

Note 1

Question 9, Quick Polls (Multiple Choice or Open Response)

Draw a sketch of 4 different decay curves with different steepness of curve and the initial point crossing the y-axis marked. Ask the students:

1. What is the initial population for the first curve?
2. Which curve has the smallest growth factor?
3. Which graph decays the quickest?
4. Which graph has the greatest decay rate?

Note 2

Question 10, Live Presenter

Once students have generated a graph, it would be a good time to make one of the students Live Presenter to discuss the meaning of the curve that is generated with the class.



Radioactive Dating

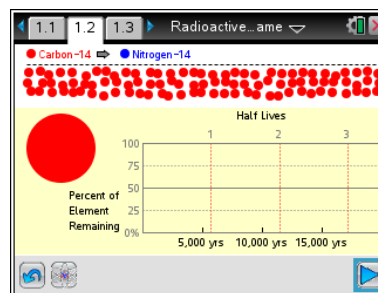
Middle Grades Student Activity

Name _____

Class _____

Open the TI-Nspire document *Radioactive_Dating.tns*.

In this simulation, you will discover how isotopes of different atoms change chemically (in a decomposition reaction) and give off radioactivity in the process. You will learn how the known rate at which certain isotopes decompose is used to estimate the age of a fossil. Then you will play a game to learn more about radioactive dating of fossils in an archeological site.



How can the number of particles in the nucleus (center) of an atom vary and yet still be the same element? Atoms of the same element can have different numbers of neutrons. They still have the same number of electrons and protons. These different possible versions of each element are called isotopes.


Carbon-14 is a radioactive isotope. It decomposes into another element and releases radioactivity in the process. This decomposition occurs at a known rate, so scientists can use the amount of the element/isotope remaining to determine how old something is. This known rate is called half-life, and here is how it works.

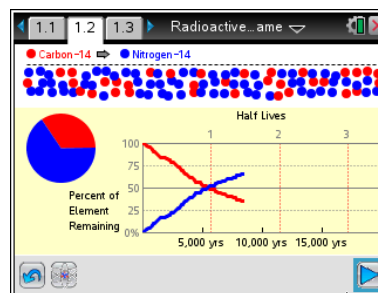
During the first 50% of its life, or during half-life 1, 50% of its atoms of an isotope will decompose. At 75% of its life, half-life 2, another 50% of the atoms that are left over from half-life 1 will decompose. Finally up to 100% of its life, half-life 3, another 50% of remaining atoms remaining from half-life 2 will decompose. Then a few will decompose slowly until all change into a different isotope.

Read the directions on page 1.1.

Move to page 1.2.

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

1. Run the simulation for Carbon-14. Observe how long it takes for Carbon-14 to decompose into Nitrogen-14. Then analyze the patterns you see. Press  to change from Carbon-14 to Uranium-238. Observe how long it takes for Uranium-238 to decompose into Lead-236.



Q1. How are the divisions of half-life along the top of the horizontal axis on the graph determined? What is the pattern in the placement of the vertical lines named Half Lives?



Radioactive Dating

Middle Grades Student Activity

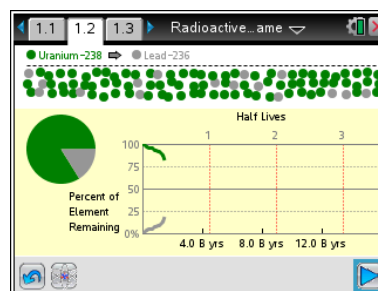
Name _____

Class _____

- Q2. What do you notice about the rate at which the substances decompose at the beginning of the process? What do you notice about this rate as time progresses?


2. Press  to change from Carbon-14 to Uranium-238. Run the simulation again.

- Q3. Why do you think the intersecting line for the decomposition of Uranium-238 into Lead-236 is not exactly at the 1st half-life line?

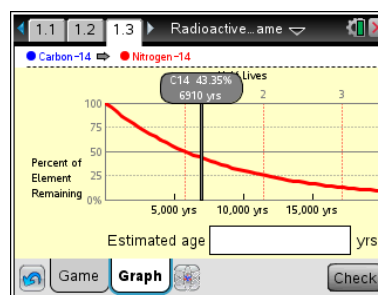


- Q4. What do you notice about the difference in decomposition rates between Carbon-14 and Uranium-238?
- Q5. For what objects might Carbon-14 be more useful than Uranium-238 in determining the age of substances? In other objects, why might Uranium-238 be more useful than Carbon-14?

Move to page 1.3 and press Graph.

3. Now look at graph that shows the percent of Carbon-14 and Uranium-238 remaining after a certain number of years. The percent is shown in the gray oval at the top of the vertical bar.
4. Grab () the gray bar. Observe how the percent remaining changes as the age increases from left to right.

Note: Press  to change from Carbon-14 to Uranium-238.



- Q6. How does the age of Carbon-14 differ from the age of Uranium-238 after they have both decomposed about 50% (the first half-life)? 50% of the first 50% (the second half-life) and 50% of the previous 50% (the third half-life)?
- Q7. What is similar about the decomposition of both elements? What is different?







Radioactive Dating

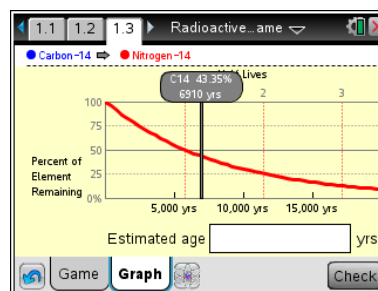
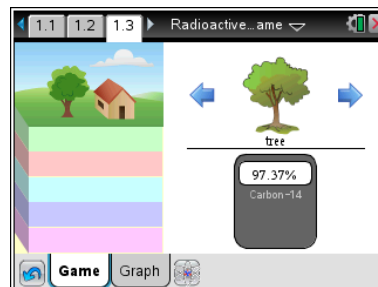
Middle Grades Student Activity

Name _____

Class _____

On page 1.3, press **Game**.

5. Play the Radioactive Dating game. Click on each of the different layers on and below Earth's surface. View objects and where they can be found. Or use the arrows  and  to move up and down the layers. (Note: Two objects are found at each level.) Then use the following directions to predict the age of each object using radioactive dating.
6. First, decide whether it is more useful to use Carbon-14 or Uranium-238. Then click  to change from one of these isotopes to another. (Hint: If an object does not have an isotope remaining, showing 0%, you must use the other isotope to obtain a range.)
7. Record the percentage of the isotope remaining for the object. Then click **Graph**.
8. Move the gray slider in both directions until the number in the oval is as close as possible the percentage you recorded in step 6 above. Write down the corresponding age of the object.
9. Enter the estimated age in the box provided. (Note: When entering ages in billions, you must write the number in numerals without commas, for example 240000000 for 240 billion years.)
10. Press  and the appearance of the green face means your answer is correct. The red face means your answer is incorrect.



Analysis Questions.

- Q8. Where do you suppose the younger layers of Earth's surface are located? Where are the older layers?
- Q9. In which layers would the younger fossils be found? The older fossils be found?
- Q10. Which isotope was more useful in analyzing younger fossils? Analyzing older fossils?
- Q11. Did the percent remaining seem to make a difference when choosing Carbon-14 or Uranium-238? If so, when was this the case?

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Radioactive Dating

MIDDLE GRADES SCIENCE NSPIRED

TEACHER NOTES

Science Objectives

- Students will learn that when isotopes of different atoms change chemically (in a decomposition reaction) and emit radioactivity in the process.
- Students will learn how the known rate at which isotopes decompose is used to estimate the age of a fossil.
- Students will discover that Carbon-14 is more useful for dating younger fossils and Uranium-238 is more useful older fossils.
- Students will learn that younger fossils are located in the upper layers under Earth's surface and older fossils in lower layers.

Vocabulary

- | | |
|---------------|----------------------|
| • isotopes | • radioactivity |
| • decompose | • radioactive dating |
| • Carbon-14 | • half-life |
| • Uranium-238 | • archeological site |

About the Lesson

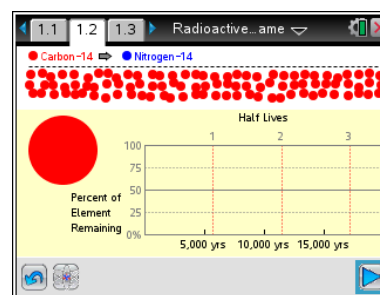
- This lesson involves students using TI-Nspire technology to simulate radioactive dating at an archeological site.
- As a result, students will:
 - Reinforce understanding of the atom and its parts.
 - Learn how the amount of radioactive emissions given off by certain isotopes as they decompose can help determine the age of fossils.
 - The decomposition rate of Carbon-14 is more useful for dating younger fossils and the decomposition rate of Uranium-238 is more useful for dating older fossils.
 - Recognize that younger fossils are in the upper layers under Earth's surface and older fossils are found in lower layers.

TI-Nspire™ Navigator™

- Send out the *Radioactive_Dating_Game.tns* file.
- Monitor student progress using Screen Capture.
- Use Live Presenter to allow students to show how they manipulate variables that effect results.

Activity Materials


- TI-Nspire™ Technology



TI-Nspire™ Technology Skills:

- Open a document
- Move between pages
- Move between tabs within a page

Tech Tips:

Make sure that students know how to reset, play, and pause the simulation using .

Lesson Materials:

Student Activity

- Radioactive_Dating_Student_MG.doc
- Radioactive_Dating_Student_MG.pdf
- Radioactive_Dating_Game.tns



Move to page 1.2.


1. On this page students run the simulation for Carbon-14. They should observe how long it takes for the isotopes Carbon-14 and Uranium-238 to decompose and then analyze the patterns they see.

- Q1. How are the divisions of half-life along the top of the horizontal axis of the graph determined? What is the pattern in the placement of the vertical lines named Half Lives?

Answer: The time it takes for each isotope to decompose is divided into approximately four equal parts. The last half-life is not shown in its entirety because the few atoms that decompose at the very end are not significant.

- Q2. What do you notice about the rate at which Carbon-14 and Uranium-238 decompose in the beginning of the process? What do you notice about this rate of decomposition as time progresses?

Answer: The isotopes decompose quickly at the beginning of the aging process and then more slowly as time progresses.



2. Students press  to change from Carbon-14 to Uranium-238 and run the simulation again.

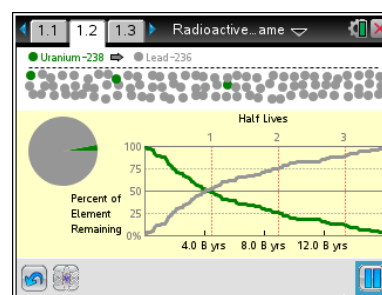
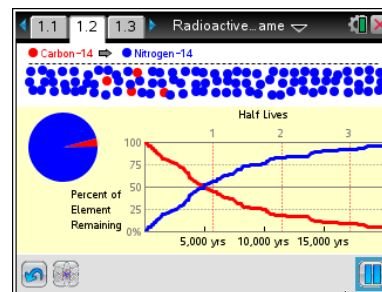
- Q3. Why do you think the intersecting line for the decomposition of Uranium-238 is not exactly at the 1st half-life line?

Answer: When dividing Uranium into four parts to mark each half-life, Uranium-238 is much more of an approximation than Carbon-14. This is because Uranium-238 decomposes so much more slowly and its range is much less spread out.

- Q4. What do you notice about the difference in decomposition rates between Carbon-14 and Uranium-238?

Answer: The decomposition rate of Carbon-14 is much faster than that of Uranium-238.

Press **ctrl**  and **ctrl**  to navigate through the lesson.





Radioactive Dating


MIDDLE GRADES SCIENCE NSPIRED

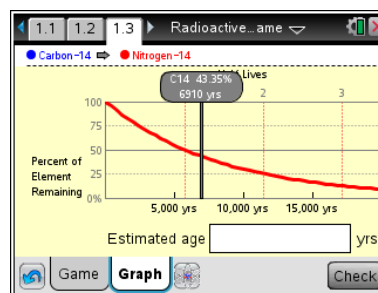
TEACHER NOTES


- Q5. In what cases might Carbon-14 be more useful than Uranium-238 in determining the age of substances? In other instances, why might Uranium-238 be more useful than Carbon-14?

Answer: Because the range of Carbon-14 is less spread out than Uranium-238, Carbon-14 might be more useful for younger fossils. Uranium-14 might be more useful for older fossils.

Move to page 1.3 and press Graph.

- Students should now look at a graph that shows the percent of Carbon-14 and Uranium-238 remaining after a given number of years.
- Students can grab and drag the gray bar  to see how percentage remaining changes as the age increases from left to right.



Tech Tip: When students press  this will grab the bar and they can drag it from left to right. They will eventually need to move this tool slowly to get as close as possible to the age value for each fossil shown on the **Game** page.



- Q6. How does the age of Carbon-14 differ from the age of Uranium-238 after they have both decomposed about 50% (the first half-life)? 50% of the first 50% (the second half-life) and 50% of the previous 50% (the third half-life)?

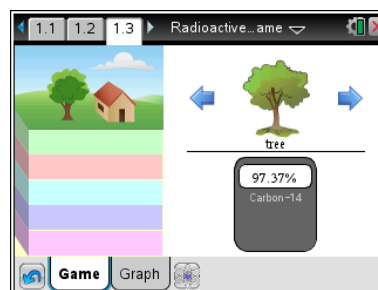
Answer: 1st half-life Carbon-14: 5,500 years and Uranium-238: 4.43 billion years;
 2nd half-life Carbon-14: 11,500 years and Uranium-238: 9 billion years;
 3rd half-life Carbon-14: 17,000 years and Uranium-238 13.4 billion years

- Q7. What is similar about the decomposition of both elements? What is different?

Answer: Carbon-14 and Uranium-238 decompose at approximately the same 50% rate for each half-life. Carbon-14 decomposes more quickly than Uranium-238.

On page 1.3, press Game.



- Students should play the Radioactive Dating game by first clicking on each of the different layers on and below Earth's surface. Students should view objects and where they can be found. Or they can use the arrows  and  to move up and down the layers on and under Earth's surface. (Note: Two objects are found at each level.) Point out to students that the depths and thicknesses of the layers are equally spaced for the purposes of

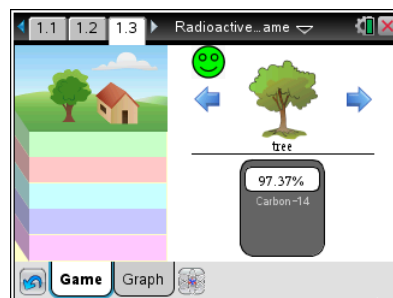
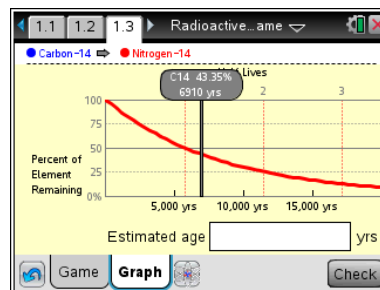




this game and do not represent the same number of years.

Students should then use the following directions to predict the age of each object using radioactive dating.

6. Students should first decide whether it is more useful to use Carbon-14 or Uranium-238. Then click  to change from one isotope to the other.
7. Students should record the percentage of the isotope remaining the object. Then they click Graph.
8. Students should move the gray bar in both directions until the number in the oval is as close as possible the percentage they recorded in step 6. They should write down the corresponding age of the object.
9. Enter the estimated age in the box provided. (Note: When entering ages in billions, you must write the number in numerals without commas, for example 240000000 for 240 billion years.)
10. When students press  they will know whether or not their answer is correct by the appearance of the green (correct) or red (incorrect) face.



Analysis Questions

- Q8. Where do you suppose the younger layers of Earth's surface are located? Where are older layers?

Answer: The younger layers of Earth's surface are the uppermost, while the older layers are the lowermost.

- Q9. In which layers would the younger fossils be found? The older fossils be found?

Answer: The younger fossils are found in the uppermost layers and the older in the lowermost layers. This is because the lower layers were laid down first and the upper layers were laid down more recently.

- Q10. Which isotope was more useful in analyzing younger fossils? Analyzing older fossils?

Answer: Carbon-14 is more useful in analyzing younger fossils and Uranium-238 is more useful for older fossils.



Radioactive Dating

TEACHER NOTES

MIDDLE GRADES SCIENCE NSPIRED

Q11. Did the percent remaining seem to make a difference when choosing Carbon-14 or Uranium-238? If so, when was this the case?

Answer: When analyzing older objects with Carbon-14, there was 0% of the isotope remaining. Therefore, using Uranium-238 was preferable to Carbon-14. For younger objects, Carbon-14 was preferable to Uranium-238 because the percentage remaining less than 100% and still showed a range.

TI-Nspire Navigator Opportunities

Allow students to volunteer to be the Live Presenter and demonstrate how to move the slider to show how percentage of decomposition is related to the age of a fossil. They should also demonstrate the steps to playing the game.

Wrap Up

When students are finished with the activity, collect students' worksheets.

Assessment

- Formative assessment will consist of questions embedded in the student worksheet. Analyze questions in the student worksheet with the students. Teacher can also collect scores that students earned in the game.
- Summative assessment will consist of questions/problems on the chapter test.

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Fahrenheit vs. Celsius

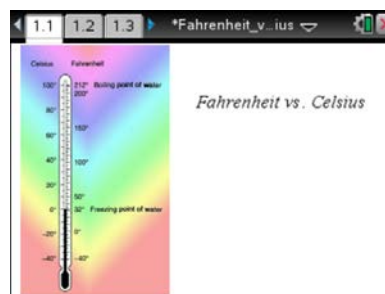
Student Activity

Name _____

Class _____

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

While nearly the entire world uses the Celsius (Centigrade) temperature scale, the United States continues to use the Fahrenheit scale. This activity will explore the relationship between the two temperature scales by gathering, graphing, and analyzing data.



Move to page 1.2.

Answer the question on your TI-Nspire™ CX CAS handheld.

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

Move to page 1.3.

Answer the question on your TI-Nspire handheld.

Move to page 2.1.

1. Pour about 100 mL of tap water into a 250-mL beaker.
2. Connect the TI-Nspire™ Lab Cradle to the handheld.
3. Connect Vernier EasyTemp® USB temperature sensors to the TI-Nspire Lab Cradle (see the photo to the right).
4. In the Vernier DataQuest™ app for TI-Nspire, set up the data-collection mode by selecting **Menu > Experiment > Collection Mode > Events with Entry**.



5. Enter *Sample* as the Name, leave the *Units* field blank, and click OK.



Fahrenheit vs. Celsius

Student Activity

Name _____

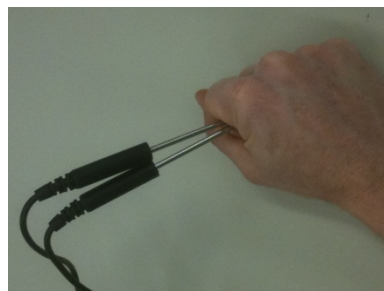
Class _____

6. Select **Menu > Experiment > Setup Sensors > Change Units** and select Fahrenheit for temperature sensor 2. Click OK.

7. Start data collection by pressing **Start**.

You will measure the temperature of one group member's hands in both Celsius and Fahrenheit.

8. The volunteer should pick up the two temperature sensors and simultaneously hold their tips in the palm of the same hand as shown to the right.



9. Watch the live temperature read out. When the temperature stops rising, click the **Keep** button.
10. You will be prompted to enter a number. Type 1 to number the first temperature measurement trial, and click OK. The two temperature measurements have been saved.
11. Place the two temperature sensors simultaneously in the tap water.
12. When the temperature stabilizes, click the **Keep** button, and type 2 for the second trial when prompted.
13. Add several ice cubes to the beaker of tap water. Stir using both probes. When the temperature stops decreasing, click the **Keep** button, and enter 3 when prompted.
14. Stop data collection.
15. Select **Menu > Graph > Y-axis Columns > Temperature 2 (°F)**.
16. Select **Menu > Graph > X-axis column > Temperature (°C)**.
17. Select **Menu > Analyze > Curve Fit > Linear**.
18. a. What is the slope of the line? _____
 b. What is the y-intercept? _____



Fahrenheit vs. Celsius

Student Activity

Name _____

Class _____

19. Explain the meanings of these values.

Move to page 3.1.

Answer the question on your TI-Nspire handheld.

What type of relationship exists between Celsius and Fahrenheit temperatures?

- ☐ Indirect
- ☐ Inverse
- ☐ Exponential
- ☐ Linear

Move to page 3.2.

Answer the question on your TI-Nspire handheld.

The slope of the Fahrenheit vs. Celsius graph represents the fact that _____ Fahrenheit degrees equals 1 Celsius degree.

- ☐ 32
- ☐ 5/9
- ☐ 1.8
- ☐ -32

Move to page 3.3.

Answer the question on your TI-Nspire handheld.

The y-intercept of the Fahrenheit vs. Celsius graph represents the _____ the freezing points between the Fahrenheit and Celsius temperature scales.

- ☐ difference in
- ☐ magnitude of
- ☐ ratio of
- ☐ product of



Extension

1. Select **Menu > Graph > Y-axis Columns > Temperature (°C)**.
2. Select **Menu > Graph > X-axis Column > Temperature 2 (°F)**.
3. Select **Menu > Analyze > Curve Fit > Linear**.
4. a. What is the slope of the line? _____
 b. What is the y-intercept? _____
5. Explain the meaning of these values.
6. Disconnect the temperature sensors.
7. Properly dispose of the water in the beaker.

Move to page 3.4.

Answer the question on your TI-Nspire handheld.

3.2	3.3	3.4	*Fahrenheit_v...ius
<p>The slope of the Celsius vs. Fahrenheit graph in the Extension is the _____ of the slope from the Fahrenheit vs. Celsius graph.</p>			
<input type="radio"/> product			
<input type="radio"/> equivalent			
<input type="radio"/> reciprocal			
<input type="radio"/> natural log			



Science Objectives

- Students will learn about linear relationships.
- Students will perform data collection and analysis.
- Students will graph data and draw conclusions based on the graph.
- Students will find linear regressions.

Vocabulary

- temperature scale
- Celsius
- Fahrenheit
- linear regression

About the Lesson

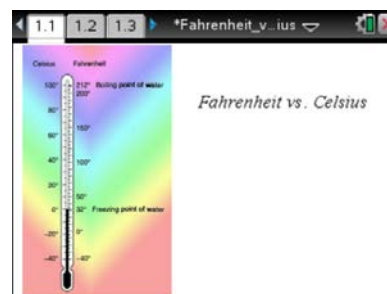
- This lesson involves gathering temperature data simultaneously with two probes—one measuring Fahrenheit and the other Celsius.
- As a result, students will...
 - Become familiar with TI-Nspire™ CX technology and the Vernier DataQuest™ application.
 - Use two temperature sensors to make measurements.
 - Use a graph to make conclusions about the experiment.

TI-Nspire™ Navigator™ System

- Send the TI-Nspire™ document to students.
- Use Class Capture to monitor student progress.
- Collect and grade the TI-Nspire document.

Activity Materials

- TI-Nspire™ Lab Cradle
- 2 Vernier EasyTemp® USB temperature sensors
- Two 250-mL beakers
- Tap water
- Ice cubes
- Paper towels



TI-Nspire™ Technology Skills:

- Open a document
- Move between pages
- Gather data using the Vernier DataQuest™ application
- Analyze data

Lesson Files:

Student Activity

- Fahrenheit_vs_Celsius_PD_Student.pdf
- Fahrenheit_vs_Celsius_PD_Student.doc

TI-Nspire document

- Fahrenheit_vs_Celsius_PD.tns



Discussion Points and Possible Answers

Tech Tip: Use Class Capture to monitor student progress.

Move to page 1.2.

Nearly the entire world uses the _____ temperature scale.

Answer: Celsius

Move to page 1.3.

The United States uses the _____ temperature scale.

Answer: Fahrenheit

Move to page 2.1.

1. Pour about 100 mL of tap water into a 250-mL beaker.
2. Connect the TI-Nspire Lab Cradle to the handheld.
3. Connect Vernier EasyTemp[®] USB temperature sensors to the TI-Nspire Lab Cradle (see the photo to the right).
4. In the Vernier DataQuest app for TI-Nspire, set up the data-collection mode by selecting **Menu > Experiment > Collection Mode > Events with Entry**.

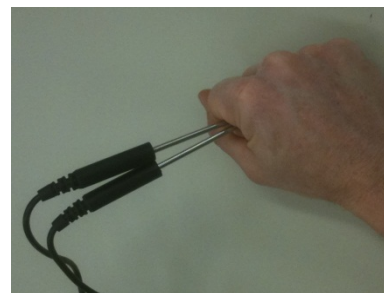


5. Enter *Sample* as the Name, leave the *Units* field blank, and click OK.
6. Select **Menu > Experiment > Setup Sensors > Change Units** and select Fahrenheit for temperature sensor 2. Click OK.
7. Start data collection by pressing **Start**.



You will measure the temperature of one group member's hands in both Celsius and Fahrenheit.

8. The volunteer should pick up the two temperature sensors and simultaneously hold their tips in the palm of the same hand as shown to the right.



9. Watch the live temperature read out. When the temperature stops rising, click the **Keep** button.
10. You will be prompted to enter a number. Type 1 to number the first temperature measurement trial, and click OK. The two temperature measurements have been saved.
11. Place the two temperature sensors simultaneously in the tap water.
12. When the temperature stabilizes, click the **Keep** button, and type 2 for the second trial when prompted.
13. Add several ice cubes to the beaker of tap water. Stir using both probes. When the temperature stops decreasing, click the **Keep** button, and enter 3 when prompted.
14. Stop data collection.
15. Select **Menu > Graph > Y-axis Columns > Temperature 2 (°F)**.
16. Select **Menu > Graph > X-axis column > Temperature (°C)**.
17. Select **Menu > Analyze > Curve Fit > Linear**.
18. a. What is the slope of the line? _____

Answer: 1.8

- b. What is the y-intercept? _____

Answer: 32°F



19. Explain the meanings of these values.

Answer: The slope indicates the fact that a Celsius degree is 1.8 times as great as a Fahrenheit degree. The y-intercept indicates that the freezing point on the Fahrenheit scale is 32 degrees above the Celsius freezing point.

Move to page 3.1.

What type of relationship exists between Celsius and Fahrenheit temperatures?

Answer: linear

Move to page 3.2.

The slope of the Fahrenheit vs. Celsius graph represents the fact that _____ Fahrenheit degrees equals 1 Celsius degree.

Answer: 1.8

Move to page 3.3.

The y-intercept of the Fahrenheit vs. Celsius graph represents the _____ the freezing points between the Fahrenheit and Celsius temperature scales.

Answer: difference of

What type of relationship exists between Celsius and Fahrenheit temperatures?

☒ Indirect

☐ Inverse

☐ Exponential

☒ Linear

The slope of the Fahrenheit vs. Celsius graph represents the fact that _____ Fahrenheit degrees equals 1 Celsius degree.

☐ 32

☐ 5/9

☒ 1.8

☐ -32

The y-intercept of the Fahrenheit vs. Celsius graph represents the _____ the freezing points between the Fahrenheit and Celsius temperature scales.

☒ difference in

☐ magnitude of

☐ ratio of

☐ product of

Extension

1. Select **Menu > Graph > Y-axis Columns > Temperature (°C)**.
2. Select **Menu > Graph > X-axis Column > Temperature 2 (°F)**.
3. Select **Menu > Analyze > Curve Fit > Linear**.
4. a. What is the slope of the line? _____

Answer: about 0.55



b. What is the y-intercept? _____

Answer: about -17.8°C

5. Explain the meaning of these values.

Answer: The slope indicates the fact that a Fahrenheit degree is about 0.55 times as great as a Celsius degree. The y-intercept indicates that the Celsius equivalent to 0°F is about -17.8° .

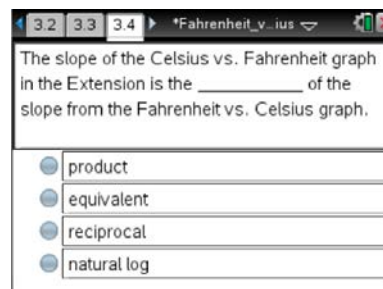
6. Disconnect the temperature sensors.

7. Properly dispose of the water in the beaker.

Move to page 3.4.

The slope of the Celsius vs. Fahrenheit graph in the Extension is the _____ of the slope from the Fahrenheit vs. Celsius graph.

Answer: reciprocal



Wrap Up

Upon completion of the discussion, the teacher should ensure that students are able to understand:

- How to connect to TI-Nspire Lab Cradle to the TI-Nspire CX CAS handheld
- How to connect sensors to the TI-Nspire Lab Cradle
- How to gather and analyze data
- The relationship between the Fahrenheit and Celsius temperature scales

Assessment

Students will complete the embedded multiple-choice questions in the TI-Nspire document. In addition, students will answer questions on the student activity sheet.

TI-Nspire Navigator

Note 1: Portfolio and Slide Show

Use the TI-Nspire Navigator to draw back, grade, and save the TI-Nspire document to the Portfolio. Use Slide Show to view student responses.

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Getting Started with the TI-Nspire™ Family of Teacher Software

TI PROFESSIONAL DEVELOPMENT

TEACHER NOTES

Activity Overview

In this activity, you will explore basic features of the TI-Nspire™ family of Teacher Software. You will explore the Welcome Screen, add pages with Calculator and Graphs applications, and explore the menus and submenus of each application. You will explore the five tabs within the Documents Toolbox, as well as the options available in the Documents toolbar and the Status bar.

Materials

- TI-Nspire™ Teacher Software

Step 1:

Open the Teacher Software. The Welcome Screen displays an icon for each of the eight applications: Calculator, Graphs, Geometry, Lists & Spreadsheet, Data & Statistics, Notes, Vernier DataQuest™, and Question. To see a brief description of each application, hover the cursor over each icon.



The Welcome Screen also allows you to view content, manage handhelds, transfer documents, and open documents. To see a description of each option, hover the cursor over each icon. To view the Welcome Screen at any time, go to **Help > Welcome Screen**.

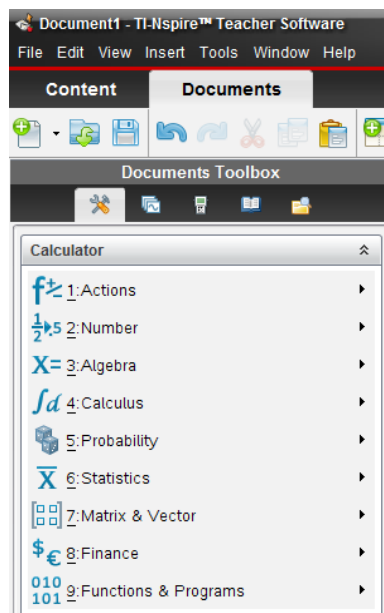
To create a new document with a Calculator application as the first page, click .

Step 2:

The Calculator application allows you to enter and evaluate mathematical expressions as well as create functions and programs.

In most cases, each application has a unique menu of commands and tools. To view the Calculator menu, go to the Documents Toolbox and select the **Document Tools** tab. Each item in the Calculator menu has a submenu. Explore the various menus and submenus by entering and evaluating your own expressions.

Note: To access the Calculator menu on the handheld, press .



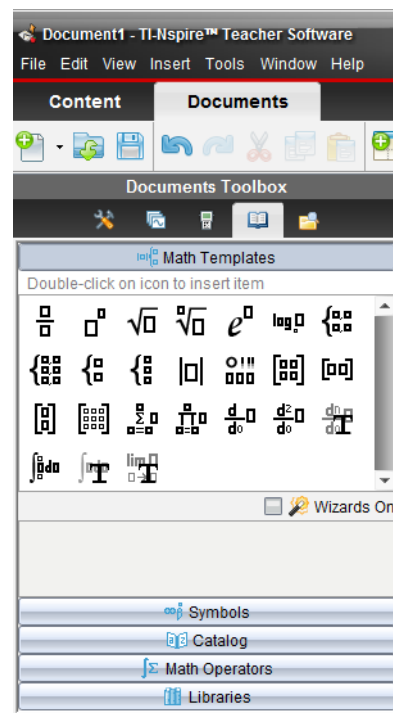


Step 3:

The **Utilities** tab contains Math Templates, Symbols, Catalog, Math Operators, and Libraries panes. Only one pane is displayed at a time, and the Math Templates pane is the default pane. Explore each of the other panes by clicking them.

To insert a Math Template into the Calculator application, double-click it. Explore various Math Templates by evaluating your own expressions involving fractions, exponents, square roots, logarithms, and absolute value expressions.

Note: When evaluating expressions, the Calculator application displays rational expressions by default. To display a decimal approximation on a PC, press **CTRL + Enter**. To display a decimal approximation on a Mac, press **Command + Enter**.

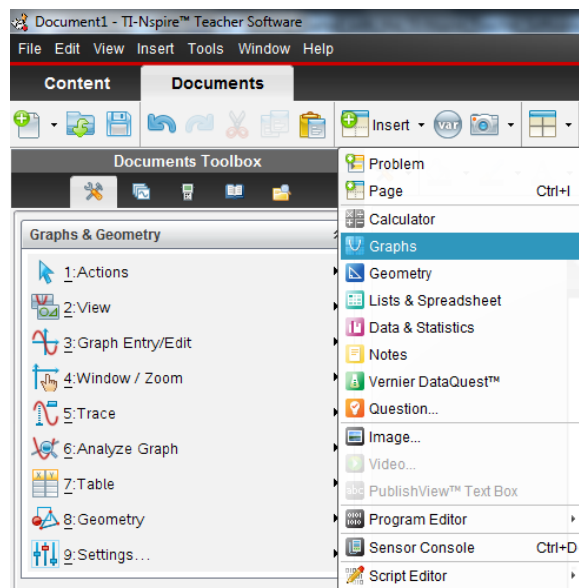


Step 4:

The **Insert** menu allows you to insert problems and pages, along with each of the eight applications. A problem can contain multiple pages, and variables that are linked within a problem are linked across pages.

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

The Graphs application allows you to graph and analyze relations and functions. Explore the various menus and submenus available in the Graphs application.






Getting Started with the TI-Nspire™ Family of Teacher Software


TI PROFESSIONAL DEVELOPMENT

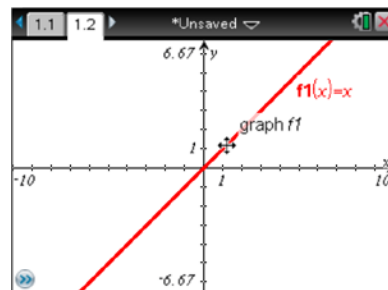
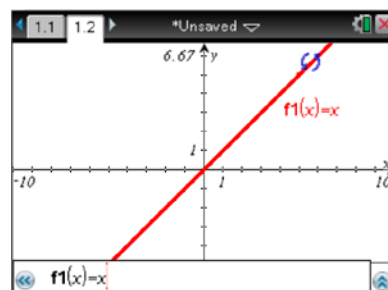
TEACHER NOTES

Step 5:

Graph the function $f(x) = x$ by typing x into the function entry line and pressing **Enter**.


Rotate the line by hovering the cursor over the upper-right corner of the graph. When the rotational cursor, , appears, rotate the line by clicking and dragging it.


Translate the line by hovering the cursor over the line near the origin. When the translational cursor, , appears, translate the line up and down by clicking and dragging it.

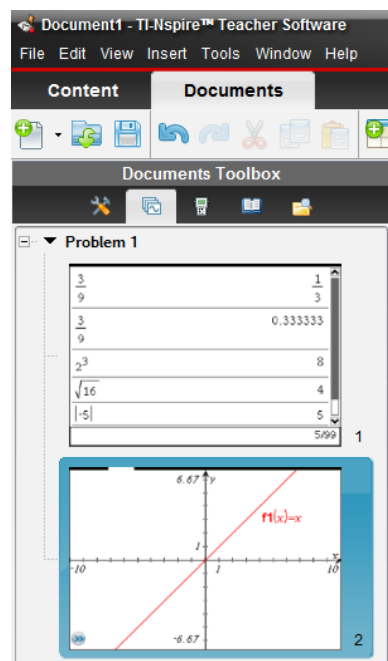


Step 6:

Since you have inserted a Calculator application and a Graphs application, your TI-Nspire™ document now has two pages. The Page Sorter view allows you to view thumbnail images of all pages in the current TI-Nspire document.

Access the Page Sorter by going to the Documents Toolbox and clicking the  **Page Sorter** tab. Pages can be rearranged by grabbing and moving them. Right-clicking allows for pages to be cut, copied, and pasted.


Note: To access Page Sorter in the handheld, press **ctrl** .
To right-click in the handheld, press **ctrl** **menu**.

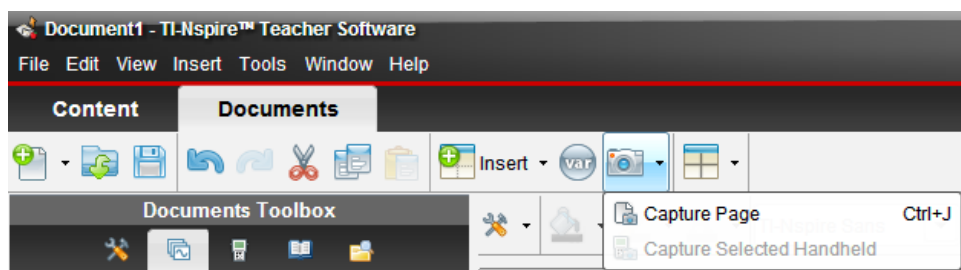





Step 7:

The Documents toolbar allows you to create, open, and save a TI-Nspire document. Commands such as Undo, Redo, Cut, Copy, and Paste are also available. Explore these options by hovering the cursor over each icon. Pages, problems, and applications can be inserted and variables can be stored.

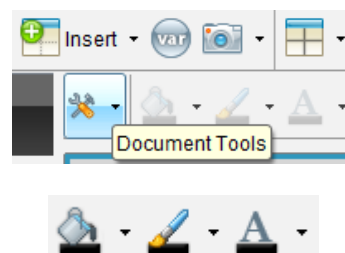
Take a Screen Capture of the current page by selecting  **Take Screen Capture > Capture Page**. This Screen Capture can be saved as an image.




Page layouts allow multiple applications to appear on one screen. Explore the various page layouts that are available by clicking  **Page Layout**.


The Document Tools menu contains tools and commands for the current application.

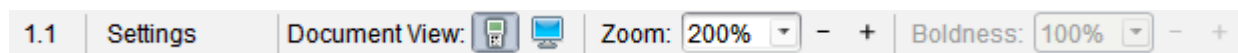
To change the fill color, line color, or text color, select an object and then select a color from the appropriate menu. To receive additional information about a given menu, hover the cursor over it. Not all color menus are available on all applications.



Step 8:

The Status Bar allows the user to access Settings, change the Document View from Handheld mode to Computer mode, and adjust the zoom of the SideScreen. Change the Document View to Computer mode by clicking  **Computer mode**.

Change the Document View back to Handheld mode by clicking  **Handheld mode**. Increase the zoom of the SideScreen to 200% by selecting 200% in the Zoom menu. The Boldness feature is enabled when using a PublishView™ document.





Getting Started with the TI-Nspire™ Family of Teacher Software

TI PROFESSIONAL DEVELOPMENT

TEACHER NOTES

Step 9:

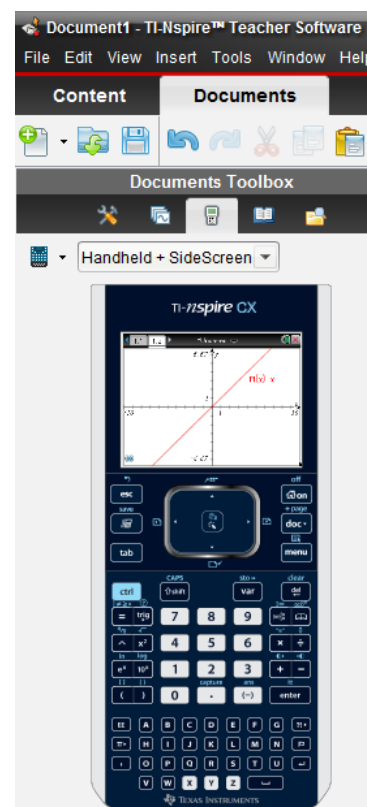
To access the TI-SmartView™ emulator for TI-Nspire, go to the Documents Toolbox and select the **TI-SmartView** tab.

TI-SmartView emulator has three available views: Handheld only, Keypad + SideScreen, and Handheld + Side Screen. Explore each of these views.

The TI-SmartView emulator has three available keypads:

- TI-Nspire™ CX
- TI-Nspire™ with Touchpad
- TI-Nspire™ with Clickpad

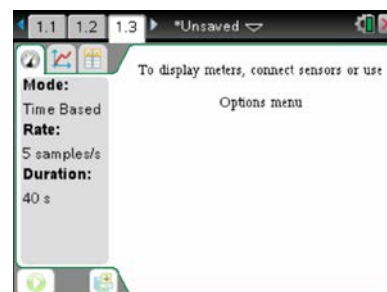
Each keypad has three available views: Normal, High Contrast, and Outline. Click the **Keypad** menu and explore each keypad and view.



Step 10:

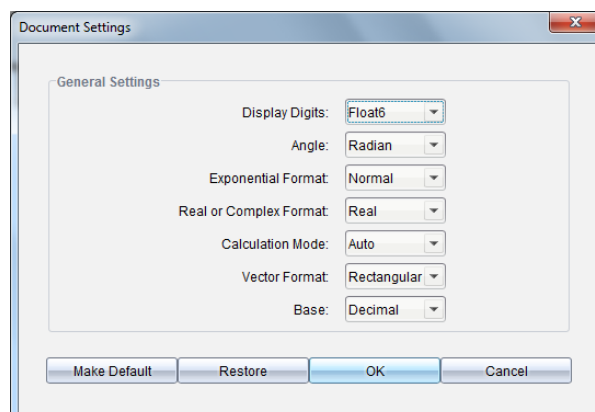
The Vernier DataQuest™ app can be used to collect, view, and analyze real-world data. Insert a page with the Vernier DataQuest app by selecting **Insert > Vernier DataQuest™**.

Though no data will be collected during this activity, the data meter will automatically launch when a Vernier sensor is connected to the computer's USB port.



Step 11:

View the Document Settings by going to **File > Settings > Document Settings**. The Document Settings also can be viewed by going to the Status Bar and double-clicking **Settings**.





Getting Started with the TI-Nspire™ Family of Teacher Software

TI PROFESSIONAL DEVELOPMENT

TEACHER NOTES

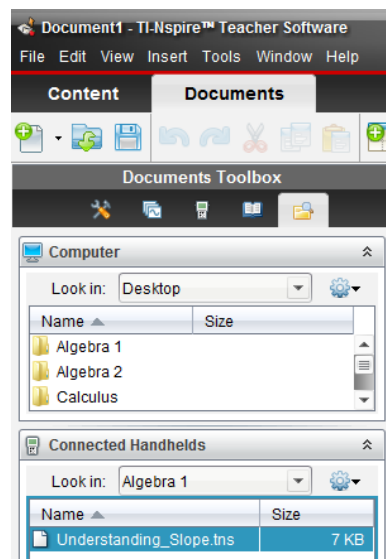
Note: To move across fields in the Document Settings window, press **tab**. To change the setting in a given field, press **▼**, select the desired setting, and press **tab** to move to the next field. To exit the window, press **enter**.

Step 12:

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

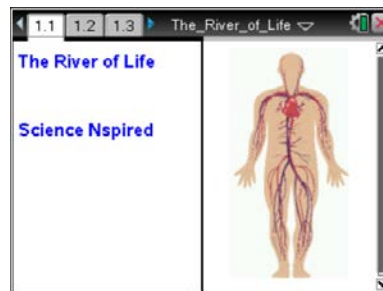
To transfer a TI-Nspire document from the computer to the connected handheld, locate the document in the Computer panel. Click, drag, and drop it into the desired handheld or folder in the Connected Handhelds panel.

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.



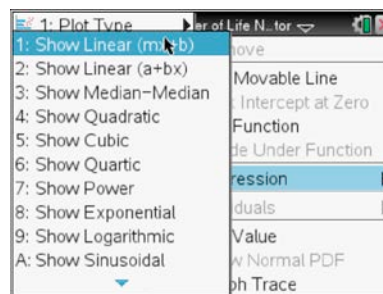


Blood is a body part that often gets overlooked because it is made, in large part, of liquid. This liquid portion of the blood is called the plasma, while the “solid” portion is made up of the blood cells. Later, you will have an opportunity to research what the different components of the blood do for you. For now, however, you will examine the relationship between the body weight and the blood volume of a human. Look at the data table below and discuss with a partner what you observe about the relationship between body weight and blood volume.



1. Open the TI-Nspire™ document *The_River_of_Life_MG.tns* or *The_River_of_Life_HS.tns*.
2. On Page 1.3, look for any trends in the data of human body weight (in pounds) and human blood volume (pints of blood).
3. Now, graph the data by inserting a Data & Statistics page. Press **ctrl** **doc** and select Data & Statistics.
4. Select **weight** as the y-value and **volume** as the x-value.
5. Answer the questions on Pages 1.6 and 1.7.
6. (Page 1.6) Estimate the weight (in pounds) of a woman who has 11.5 pints of blood in her body.
7. (Page 1.7) Estimate the number of pints of blood that would be in a 200-pound man.
8. Determine the equation of the line that represents the relationship between body weight and blood volume by analyzing the data. Press **Menu > Analyze > Regression > Show Linear**. Then answer the question on Page 1.10.

Press **ctrl** **right arrow** and **ctrl** **left arrow** to navigate through the lesson.



9. (Page 1.10) Which equation expresses the correct relationship for the graph?
 - a) volume (in pints) = 12lb/pt * weight (in pounds)
 - b) weight (in pounds) = 12lb/pt * volume (in pints)
 - c) volume (in pints) = 12pt/lb * weight (in pounds)
 - d) weight (in pounds) = 12pt/lb * volume (in pints)



10. On Page 1.11, perform a Graph Trace by selecting **Menu > Analyze > Graph Trace**. Move the cursor left and right to get a better estimate of the answers to the original questions and then answer them on Pages 1.13 and 1.14.
11. (Page 1.13) Estimate the weight (in pounds) of a woman who has 11.5 pints of blood in her body.
12. (Page 1.14) Estimate the number of pints of blood that would be in a 200-pound man.
13. Compare your answers from Pages 1.6 and 1.7 with Pages 1.13 and 1.14.
14. Read Page 1.16 and 1.18 to determine an even better method of determining body weight and blood volume. Answer the questions on Page 1.17 and 1.19.
15. (Page 1.17) Determine the weight (in pounds) of a woman who has 11.5 pints of blood in her body.
16. (Page 1.19) Determine the number of pints of blood that would be in a 200-pound man.
17. (Page 1.20) Your turn! How many pints of blood do you have in YOUR body?

The remaining questions are a bit more challenging. See how many of them you can get right!

18. (Page 1.22) How many pints of blood would there be in a person who had a weight of 75 kg? (Hint: there are about 2.2 pounds in one kilogram.)
19. (Page 1.23) If this weight/blood volume relationship were true for other animals, too, how many gallons of blood would there be in a horse that had a weight of 500 kg?
20. (Page 1.24) Estimate the weight of a person who has two gallons of blood in her body.
21. (Page 1.25) If you decided to donate blood at the blood bank, you would donate one pint. Using your own weight, calculate the percentage of your blood you would be donating.
22. (Page 1.26) If 52% of your blood is water, what is the volume of water (in pints) circulating in your blood vessels right now?



23. (Page 1.27) Red blood cells are by far the most numerous cells in the blood, averaging about 4.5×10^6 cells per microLiter (1000 microLiter = 1ml; 1000ml = 1L). How many microLiter are there in one Liter?

24. (Page 1.28) Using the information in the previous question, calculate the approximate number of red blood cells you have in your body right now.

25. (Page 1.29) White blood cells (WBCs) are another type of blood cell in your body. Human blood contains about 7.0×10^3 WBCs per microLiter. Calculate the approximate number of leukocytes (WBCs) you have in your body right now.

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Science Objectives

- Students will calculate the volume of blood in their own bodies.
- Students will analyze and quantify some of the components of their blood.

Math Objectives

- Students will use tabular data to accurately generate a scatter plot.
- Students will generate a linear regression model, use the function to perform calculations, and interpolate a value on the regression model.

Materials Needed

- TI-Nspire™ or TI-Nspire™ CAS handheld unit for each student

Vocabulary

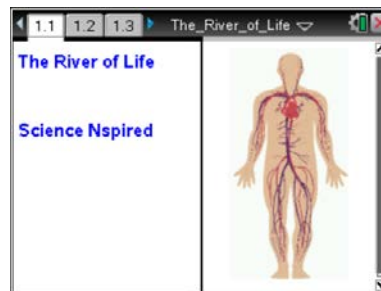
- plasma
- erythrocytes
- leukocytes
- milligram
- microliter

About the Lesson

- This lesson involves generating a linear regression model for human blood volume vs. body weight.
- As a result, students will:
 - Algebraically calculate their own blood volume.
 - Interpolate on the regression model to determine their blood volume.

TI-Nspire™ Navigator™ System

- Use Class Capture to monitor student progress.



TI-Nspire™ Technology Skills:

- Download a TI-Nspire™ document
- Open a document
- Move between pages
- Entering and graphing data using multiple applications
- Tracing, interpolating, predicting



Discussion Points and Possible Answers

1. Open the TI-Nspire™ document *The_River_of_Life_MG.tns* or *The_River_of_Life_HS.tns*.
2. On Page 1.3, look for any trends in the data of human body weight (in pounds) and human blood volume (pints of blood).
3. Now, graph the data by inserting a Data & Statistics page.
Press **ctrl** **doc** and select Data & Statistics.
4. Select **weight** as the x-value and **pint** as the y-value.
5. Answer the questions on Page 1.6 and 1.7.
6. (Page 1.6) Estimate the weight (in pounds) of a woman who has 11.5 pints of blood in her body.

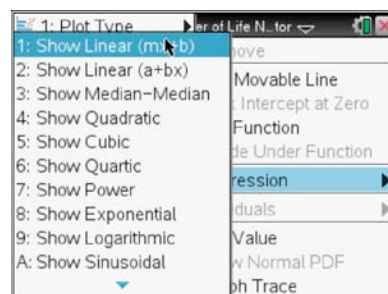
Press **ctrl** **▶** and **ctrl** **◀** to navigate through the lesson.

Answer: Answers will vary.

7. (Page 1.7) Estimate the number of pints of blood that would be in a 200-pound man.

Answer: Answers will vary.

8. Determine the equation of the line that represents the relationship between body weight and blood volume by analyzing the data. Press **Menu > Analyze > Regression > Show Linear**. Then answer the question on Page 1.10.



9. (Page 1.10) Which equation expresses the correct relationship for the graph?
 - a) volume (in pints) = 12lb/pt * weight (in pounds)
 - b) weight (in pounds) = 12lb/pt * volume (in pints)
 - c) volume (in pints) = 12pt/lb * weight (in pounds)
 - d) weight (in pounds) = 12pt/lb * volume (in pints)

Answer: b) weight (in pounds) = 12lb/pt * volume (in pints)



10. On Page 1.11, perform a Graph Trace by selecting **Menu > Analyze > Graph Trace**. Move the cursor left and right to get a better estimate of the answers to the original questions and then answer them on Pages 1.13 and 1.14.

11. (Page 1.13) Estimate the weight (in pounds) of a woman who has 11.5 pints of blood in her body.

Answer: Answers will vary.

12. (Page 1.14) Estimate the number of pints of blood that would be in a 200-pound man.

Answer: Answers will vary.

13. Compare your answers from Pages 1.6 and 1.7 with Pages 1.13 and 1.14.

14. Read Page 1.16 and 1.18 to determine an even better method of determining body weight and blood volume. Answer the questions on Page 1.17 and 1.19.

15. (Page 1.17) Determine the weight (in pounds) of a woman who has 11.5 pints of blood in her body.

Answer: 138 pounds

16. (Page 1.19) Determine the number of pints of blood that would be in a 200-pound man.

Answer: 16.7 pints

17. (Page 1.20) Your turn! How many pints of blood do you have in YOUR body?

Answer: Answers will vary.

The remaining questions are a bit more challenging. See how many of them you can get right!

18. (Page 1.22) How many pints of blood would there be in a person who had a weight of 75 kg? (Hint: there are about 2.2 pounds in one kilogram.)

Answer: 15.6 pints

19. (Page 1.23) If this weight/blood volume relationship were true for other animals, too, how many gallons of blood would there be in a horse that had a weight of 500 kg?

Answer: 11.4 gallons



20. (Page 1.24) Estimate the weight of a person who has two gallons of blood in her body.

Answer: 193 pounds

21. (Page 1.25) If you decided to donate blood at the blood bank, you would donate one pint. Using your own weight, calculate the percentage of your blood you would be donating.

Answer: Answers will vary. Lower percentage for heavier people.

22. (Page 1.26) If 52% of your blood is water, what is the volume of water (in pints) circulating in your blood vessels right now?

Answer: Answers will vary.

23. (Page 1.27) Red blood cells are by far the most numerous cells in the blood, averaging about 4.5×10^6 cells per microLiter (1000 microLiter = 1ml; 1000ml = 1L). How many microLiters are there in one Liter?

Answer: There are 1 million (1,000,000 or 1×10^6) microLiters in one Liter.

24. (Page 1.28) Using the information in the previous question, calculate the approximate number of red blood cells you have in your body right now.

Answer: Answers will vary

25. (Page 1.29) White blood cells (WBCs) are another type of blood cell in your body. Human blood contains about 7.0×10^3 WBCs per microLiter. Calculate the approximate number of leukocytes (WBCs) you have in your body right now.

Answer: Answers will vary

TI-Nspire Navigator Opportunity: Class Capture can be used to monitor student progress.



Sound and Waves

Student Activity

Name _____

Class _____

Open the TI-Nspire document *Sound_and_Waves.tns*.

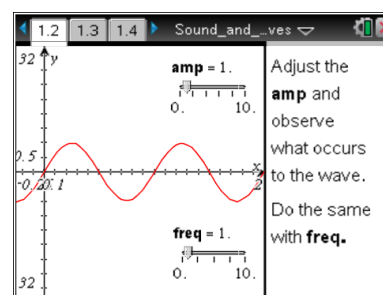
Sound is created by patterns of higher pressure, or compressions, and rarefactions, or lower pressure areas moving through the air. As these patterns form, they produce noise or notes. Specific notes, such as a C note form by a very specific pattern. In this activity you will explore ways to model these wave patterns and relate them to sound.



Move to page 1.2.

1. Explore the wave that is generated by changing the **amp** (amplitude) slider and observe the results. Change the **freq** (frequency) slider and observe the changes that occur. Note that for a sound wave, a peak in the graph represents a high pressure area, or compression, and a dip represents a lower pressure area, or rarefaction. For a water wave or wave in a rope, peaks and dips represent the actual motion of the rope or water surface in a given direction.

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



Move to pages 1.3–1.7. Answer the following questions here or in the .tns file.

- Q1. What happens to the wave as amplitude (**amp**) changes?
- Q2. What parts of the wave do not change when you adjust the amplitude?
- Q3. If the amplitude is set to 5, how is the “5” seen on the graph?
- Q4. What changes as frequency (**freq**) changes?
- Q5. If the frequency is 2, in units used for the graph, how is this number represented on the graph?



Sound and Waves

Student Activity

Name _____

Class _____

Move to pages 1.8 and 1.9 and use this information to answer the following questions.

Amplitude is the height of the wave from the line of symmetry or the middle of the wave.

Frequency is the number of waves per time.

Sound travels in waves with different frequencies and amplitudes.

Move to pages 1.10 and 1.11. Answer the following questions here or in the .tns file.

Q6. What property of sound does wave amplitude affect?

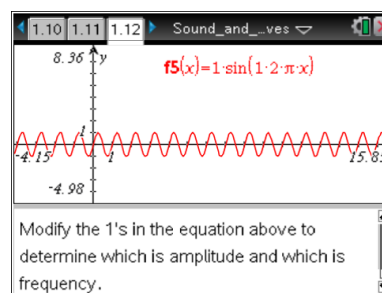
- | | |
|-----------|----------|
| A. speed | C. pitch |
| B. volume | D. beats |

Q7. What property of sound does wave frequency affect?

- | | |
|-----------|----------|
| A. speed | C. pitch |
| B. volume | D. beats |

Move to page 1.12.

2. Modify the 1's in the equation at the top of the screen to determine which is amplitude and which is frequency.



Move to pages 1.13 and 1.14. Answer the following questions here or in the .tns file.

Q8. In the equation $y = a \sin(b \cdot 2\pi \cdot x)$, what does a represent?

- | | |
|------------------|------------------|
| A. the amplitude | B. the frequency |
|------------------|------------------|

Q9. In the equation $y = a \sin(b \cdot 2\pi \cdot x)$, what does b represent?

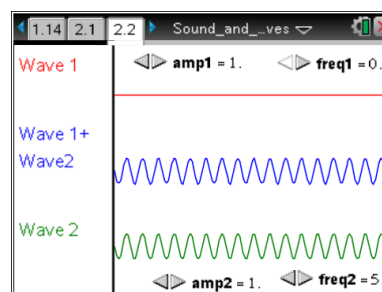
- | | |
|------------------|------------------|
| A. the amplitude | B. the frequency |
|------------------|------------------|

Move to pages 2.1 and 2.2.

Wave Addition

In this next problem, you will explore the addition of two waves.

3. On page 2.2 modify one variable at a time starting with frequency of wave 1 and answer the questions on the following pages.



Move to pages 2.3 and 2.4. Answer the following questions here or in the .tns file.

Q10. What happens to the sum wave when the frequency of wave 1 is changed?

Q11. If wave 1 is a sound wave, a higher frequency will cause _____.

- | | | |
|-----------------|-----------------------|----------------|
| A. higher pitch | B. no change in pitch | C. lower pitch |
|-----------------|-----------------------|----------------|



Sound and Waves

Student Activity

Name _____

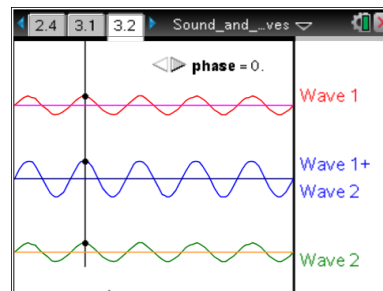
Class _____

Move to pages 3.1 and 3.2.

Wave Addition

In this next problem, you will explore the addition of two waves.

4. Adjust the phase for the top wave. The sum of wave 1 and wave 2 (bottom wave) appears as the middle wave.



Move to pages 3.3–3.5. Answer the following questions here or in the .tns file.

Q12. What effect does a phase shift have on the summation wave?

Q13. The phase change will _____.

- | | |
|----------------------|----------------------------|
| A. change the pitch | C. change the speed |
| B. change the volume | D. have no change to sound |

Q14. What does it mean to be in phase?

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Science Objectives

- Students will construct an understanding of frequency, amplitude, and phase shift.
- Students will develop the understanding of the sine function and how it relates to sound waves.
- Students will simulate the addition of two waves and observe that this addition forms sound dampening and beats.



Vocabulary

- | | |
|---------------|---------------|
| • amplitude | • notes |
| • beats | • phase shift |
| • dampening | • sound |
| • frequency | • waves |
| • compression | |

TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Grab and drag a point

About the Lesson

- In this lesson students change characteristics of a sine wave to discover the frequency, amplitude, and phase shift. They will also use these properties to see the effect of adding two waves to form dampening and beats.
- As a result students will be able to:
 - Define, describe, and use the different characteristics of waves (frequency, amplitude, phase shift)
 - Recognize and explain the result of adding two waves together.
 - Explain the effect phase shift has on the sum wave.
 - Recognize and explain the effect frequency and phase shift have on the sum wave.

Tech Tips:

- Make sure the font size on your TI-Nspire handhelds is set to Medium.
- You can hide the function entry line by pressing **ctrl** **G**.

Lesson Files:

Student Activity

- Sound_and_Waves_Student.doc
- Sound_and_Waves_Student.pdf

TI-Nspire document

- Sound_and_Waves.tns

TI-Nspire™ Navigator™ System

- Send out the *Sound_and_Waves.tns* file.
- Monitor student progress using Screen Capture.
- Use Live Presenter to spotlight student answers.
- Enter items as appropriate for use of TI-Nspire Navigator.

Activity Materials


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

Visit

<http://www.sciencenspired.com/>
for lesson updates and tech tip videos.

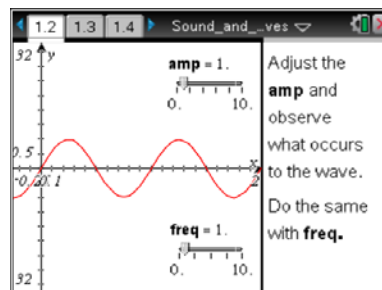


Discussion Points and Possible Answers

Tech Tip: To move a slider, place the cursor over the slider and press and hold the  button. The hand will close to allow students to drag the slider and see the effect on the graph.

Move to page 1.2.

- Students should move the amplitude (**amp**) and the frequency (**freq**) and observe the effect of these movements on the graph.



TI-Nspire Navigator Opportunities

At the beginning of the lesson, you can use Live Presenter to ensure that students understand how to adjust the slider. If students are having difficulty grabbing the bar to drag, ask them to give each other tips on how to grab the correct location.

Move to pages 1.3–1.7.

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

- Q1. What happens to the wave when amplitude (**amp**) is changed?

Answer: Changes occur in: 1. the height of the wave (representing the strength of wave compressions); and 2. the distance from the crest to the line of symmetry.

- Q2. What parts of the wave do not change when you adjust the amplitude?

Answer: The distance between x values where the wave has peaks (and valleys) does not change.

- Q3. If the amplitude is set to 5, how is the “5” seen on the graph?

Answer: An amplitude of 5 is the perpendicular distance from the line of symmetry to the peak or the valley.



Q4. What changes as frequency (**freq**) changes?

Answer: Changes occur in: 1. the distance between each peak, valley, or x-intercept; and 2. the distance between waves.

Q5. If the frequency is 2, in units used for the graph, how is this number represented on the graph?

Answer: The unit 2 is the number of waves that occur within one unit of time or one second.

Move to pages 1.8 and 1.9.

Students should use this information to answer the questions.

Amplitude is the height of the wave from the line of symmetry or the middle of the wave.

Frequency is the number of waves per unit of time.

Sound travels in waves with different frequencies and amplitudes.

Move to pages 1.10 and 1.11.

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

Q6. What property of sound does wave amplitude affect?

Answer: B. volume

Q7. What property of sound does wave frequency affect?

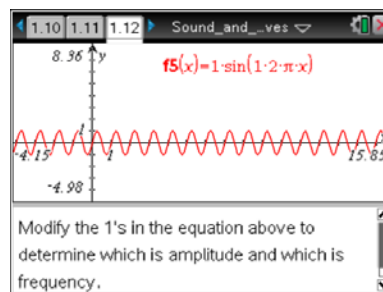
Answer: C. pitch.

TI-Nspire Navigator Opportunities

A Quick Poll could be used to have students input the answer to the above questions or to “vote” on a given answer if the class is split on which is the correct answer.

Move to page 1.12.

- Students will modify the 1's in the equation at the top of page 1.12 to determine which changes amplitude and which changes frequency. They can change the values by clicking in the text box, adjusting the value, and pressing **enter**.





Tech Tip: For students to change the equation they need to click on the equation once to select it and then a second time to get into editing mode. Once the equation is in edit mode, they can scroll left and right to the value they want to change. Have them place the cursor to the right of the value, press back space to delete the value, and then enter their new value.

Move to pages 1.13 and 1.14.

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

Q8. In the equation $y = a \sin(b \cdot 2\pi \cdot x)$, what does a represent?

Answer: A. the amplitude

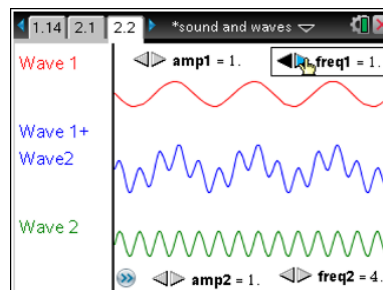
Q9. In the equation $y = a \sin(b \cdot 2\pi \cdot x)$, what does b represent?

Answer: B. the frequency

Move to pages 2.1 and 2.2.

Wave Addition

3. On page 2.2 students will modify one variable at a time starting with frequency of wave 1. They should change **freq1** and observe the effect it has on wave 1 + wave2.



Tech Tip: On the handheld there are numerous calculations going on in the background so the students need to be patient while the wave is changing.

Move to pages 2.3 and 2.4.

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

Q10. What happens to the sum wave when the frequency of wave 1 is changed?

Answer: The sum wave changes shape, generating different patterns.

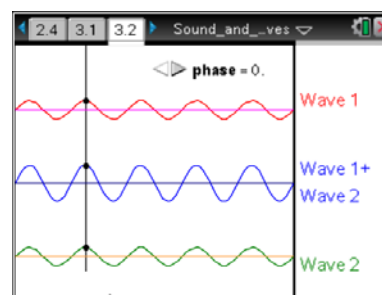
Q11. If wave 1 is a sound wave, a higher frequency will cause _____.

Answer: A. higher pitch

Move to pages 3.1 and 3.2.

Phase Shift

4. Students will change the phase by clicking on the slider. As they shift the wave, they should observe that the sum wave dampens or amplifies.



Move to pages 3.3–3.5.

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

Q12. What effect does a phase shift have on the summation wave?

Answer: When the two waves are in phase, the sum wave is amplified. When they are out of phase, they cancel one another

Q13. The phase change will _____.

Answer: B. change the volume

Q14. What does it mean to be in phase?

Answer: The peaks of both waves happen at the same time creating an amplified wave.

TI-Nspire Navigator Opportunities

You can send this activity out to the students using TI-Nspire Navigator. Throughout the activity you can send them quick polls to determine how their understanding is developing.

Wrap Up

Create a discussion about waves and the characteristics. Talk to the students about the relationship these waves have to sound waves. Discuss the following features of waves (frequency, amplitude, phase, addition with frequency change, addition with phase shift, dampening and amplification.)

Assessment

- Give the students two waves with different frequencies and have them make a rough drawing of what they would expect the graph to look like.
- Give them a second set of waves with equal frequencies but with a phase shift– the peak of one wave should be over the trough the other. Ask students to sketch the resultant wave.

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Activity Overview:

In this activity, you will navigate through a TI-Nspire™ document, answer questions, manipulate a graphic, and input values into a spreadsheet.

Part One—Opening the Document

Step 1:

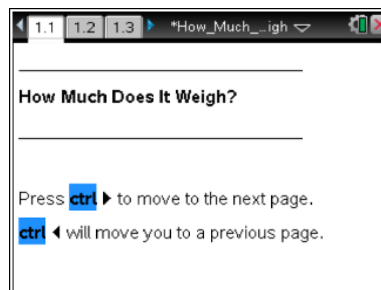
Press and select **My Documents**.

Step 2:

Locate *How_Much_Does_It_Weigh.tns* and press to open it. If asked whether or not you want to save the current document, choose No (unless you want to save it).

Step 3:

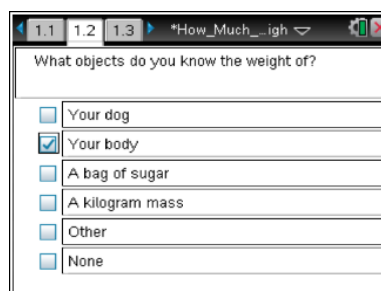
Once the document opens, press to move to page 1.2.



Part Two—Selecting an Answer

Step 4:

To answer the question, press the down arrow on the bottom of the Touchpad to move to the desired response.



Step 5:

Press to select a response. On questions with multiple responses allowed, you deselect the answer by pressing a second time or select **Menu > Clear Answers**.

Another option for selecting an answer is to swipe your finger across the Touchpad to move the cursor, and click to make a selection.


Step 6:

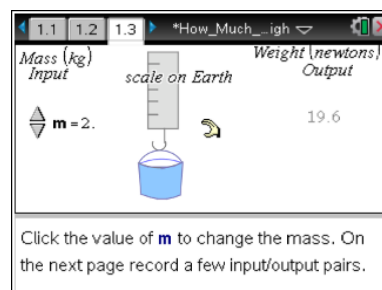
After choosing all desired responses, press to move to page 1.3.




Part Three—Changing the Input for the Mass

Step 7:

Move the cursor to the up and down arrows under the text *Mass (kg) Input*. Click , and use the up and down arrows on the Touchpad to change the values.





Step 8:

Also try clicking the number next to $m =$ and manually change the value. Use the arrows to get to the end, press  to backspace over the previous value, and enter a new value.

Step 9:

Press  to evaluate this value.

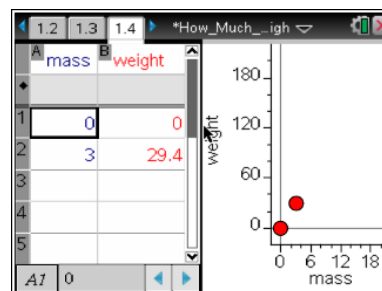
Step 10:

Press   to move to the next page. A scatter plot of force/weight versus mass has been set up.


Part Four—Editing the Spreadsheet

Step 11:

Record the input and output values in the spreadsheet on page 1.4, using the arrows to move to the desired cell.





Step 12:

Press the number on the keypad, and press .

What science concepts can be explored with this activity?

What questions can we ask to highlight the math concepts?

Step 13:

Press   to move to pages 1.5–1.8 to answer the open-response and multiple-choice questions. In this question document, multiple responses not allowed.



Energy of a Roller Coaster

Student Activity

Name _____


Class _____

Open the TI-Nspire document *Energy_of_a_Roller_Coaster.tns*.


What gives a roller coaster its high speed? How does it complete the track without an engine? A roller coaster is a great example of energy transformation. Roller coaster designers must keep energy considerations at the forefront of their designs in order to create exciting, workable rides. In this activity you will explore some of the basic energy ideas behind roller coasters.

When a force is applied to an object and the object moves in the direction of the force, the force does work on the object. Work is defined as the product of the displacement of the object, Δx , and the component of the force in the direction of the displacement, F_x . Gravitational potential energy (PE) can be described as stored energy an object possesses due to its height above a reference point. It is calculated by multiplying the weight of the object, mg , by its height above the reference, h . Kinetic energy (KE) is the energy an object possesses due to its motion. This is calculated by the formula $KE = \frac{1}{2}mv^2$. Work, potential energy, and kinetic energy are all measured in Joules (J).

Move to pages 1.2 and 1.3.

1. Read the information on page 1.2. After reading the directions on page 1.3, press  to close the pop-up box.
2. On this page you will find a block on a surface. You may grab the block by the point in the middle and lift it above the surface. The force required to lift the block and the height of the block above the surface is displayed on the screen. The product of these numbers is the work done on the block. As the block is lifted, a bar graph measures its gravitational potential energy. Another bar graph measures the kinetic energy of the block.





Answer questions 1–3 here as you work through the simulation before moving to page 2.1.



- Q1. Grab the block with the cursor and lift it above the surface. Then use the spaces below to record the lifting force and the height to which you lift the block. Use these numbers to calculate the work you do on the block. Observe what happens to the gravitational potential energy as you lift the block. Click the play button , and observe the gravitational potential and kinetic energies of the block as it falls.

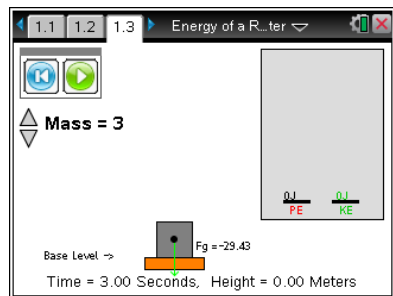
 A. $F =$ _____ N

 B. $h =$ _____ m

 C. $W = F \cdot h =$ _____ J


Press   and   to navigate through the lesson.

To grab a point with the cursor, move the cursor over the object until it becomes a hand, and then press and hold  until the hand closes. Use the touchpad to move the object. Press  to release the object.





Energy of a Roller Coaster

Student Activity

Name _____

Class _____

- Q2. Describe what happens to the gravitational potential energy of the block as you lift it. Compare the potential energy at the highest point to the work done in lifting the block.
- Q3. Describe what happens with the gravitational potential and kinetic energies as the block falls. What do you observe about the sum of the two energies as the block falls? Compare the kinetic energy of the block when it reaches the surface to the gravitational potential energy when you released it.

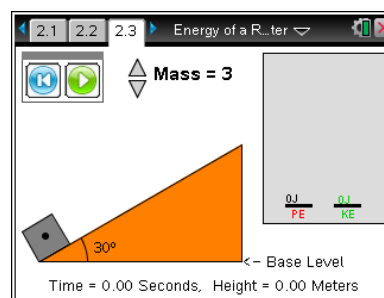
Move to pages 2.1–2.2.

3. Read the information on pages 2.1 and 2.2. After reading the directions on page 2.3, press to close the pop-up box.

Roller coasters are not lifted straight up, and they do not fall freely. Instead, they move up and down hills. In this activity, you will see a block with a mass of 3 kg at the bottom of an incline.

First you will note of the **force** required to pull the block and the

distance it is pulled. The product of **force** and **distance** is equal to the work done on the block. You will then observe the **potential energy** of the block at the top of the incline. Finally, you will see the **potential** and **kinetic** energies of the block as it slides down the incline.



Move to page 2.3.

4. On this page, a 3-kg block starts at the bottom of a frictionless hill. Grab the point in the middle of the block near the corner of the incline and move it up to pull the block up the incline. The force required to pull the block and the distance pulled are displayed on the screen. As the block is pulled up the hill, a bar graph measures its potential energy. As the block slides down the hill, another bar graph measures its kinetic energy.

Answer questions 4–6 here before moving to page 2.4.

- Q4. Drag the block to the top of the incline, and record the distance and the force required to pull the block to this location. The work done on the block is the product of these two numbers. Observe the potential energy as the block is pulled up the hill. Click the play button , and observe the potential and kinetic energies of the block as it slides down the incline.

A. $F = \underline{\hspace{2cm}} \text{ N}$

B. $d = \underline{\hspace{2cm}} \text{ m}$

C. $W = F \cdot d = \underline{\hspace{2cm}} \text{ J}$

Name

Class _____



Energy of a Roller Coaster

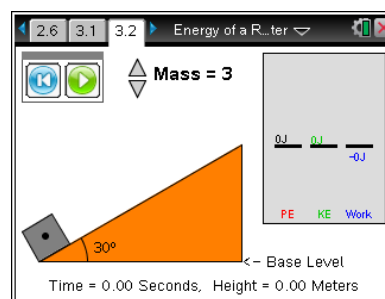
Student Activity

Name _____

Class _____

Move to pages 3.1 and 3.2.

- Read the information on page 3.1. After reading the directions on page 3.2, press to close the pop-up box.
- Click the play button on page 3.2, and observe the work and energy bar graphs as the block slides.



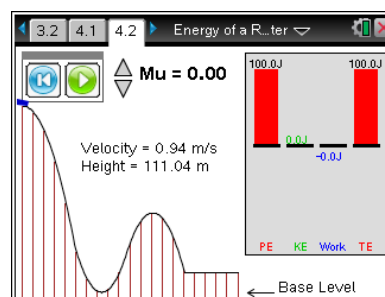
A more realistic picture of the block on a hill includes friction resisting the motion of the block. On an actual roller coaster, friction and air resistance oppose the motion. Forces that oppose motion do negative work on the object. This **work** is **negative** because the direction of the friction force is opposite to the direction of motion. This simulation includes a friction force acting on a 3-kg block as the block slides down a 30° incline.

Answer questions 10 and 11 here before moving to page 4.1.

- Q10. Note the gravitational potential energy of the block at the top of the hill. Click the play button, and observe the work and energy bar graphs as the block slides. Describe the changes you observe in the gravitational potential energy and the kinetic energy of the block as it slides. Compare the kinetic energy at the bottom of the hill to the gravitational potential energy at the top.
- Q11. How much work was done by the friction force? What effect did this appear to have on the energy of the block?

Move to pages 4.1 and 4.2.

Page 4.2 simulates a roller coaster car moving along a track. The height and velocity of the car are displayed. On the right side of the screen are bar graphs for potential energy, kinetic energy, total mechanical energy, and work done by friction. The total mechanical energy is the sum of the potential and kinetic energies.



- After reading the directions press to close the pop-up box. The roller coaster car is already at the top of the track. Clicking the play button will release the car. Clicking the reset button will place the car back at the top of the roller coaster. You may change the friction, μ , by clicking the up and down arrows (\blacktriangle or \blacktriangledown) for Mu.



Energy of a Roller Coaster

Student Activity

Name _____

Class _____

Answer questions 12–21 here before moving to page 4.3.

Q12. Set the value of μ to zero. Press the down arrow \blacktriangledown a couple times after it shows $\mu = 0.00$. Start the car and allow it to move through the track. Observe the bar graphs as the car moves along the track. Describe the changes you observe in the potential energy, kinetic energy, and total energy. Comment on how the three energy measurements appear to relate to each other.

Q13. Reset the car and set the value of μ to zero. Stop the car at the bottom of the first hill. Record the values of the PE, KE, TE, height (h), and velocity (v). Repeat these steps, this time stopping at the top of the second hill. Repeat the steps again, this time stopping at the bottom of the second hill.

top of the 1st hill PE = _____ J KE = _____ J TE _____ J h = _____ m v = _____ m/s

bottom of 1st hill PE = _____ J KE = _____ J TE _____ J h = _____ m v = _____ m/s

top of the 2nd hill PE = _____ J KE = _____ J TE _____ J h = _____ m v = _____ m/s

bottom of 2nd hill PE = _____ J KE = _____ J TE _____ J h = _____ m v = _____ m/s

Q14. Calculate the ratio of the potential energy at the top of the first hill to the gravitational potential energy at the top of the second hill. Now calculate the ratio of the height of the first hill to the height of the second hill. What do you observe about the two ratios? What does this tell you about the relationship between gravitational potential energy and height?

Q15. Calculate the ratio of the kinetic energy at the bottom of the first hill to the kinetic energy at the top of the second hill. Now calculate the ratio of the speed at the bottom of the first hill to the speed at the top of the second hill. What do you observe when you compare these two ratios? What can you infer about the relationship between the kinetic energy of the roller coaster and its speed?

Q16. At the bottom of the second hill, what percentage of the roller coaster's total energy is in the form of potential energy? What percentage is in the form of kinetic energy? What percentage of the maximum speed of the roller coaster is its speed at the bottom of the second hill?



Energy of a Roller Coaster

Student Activity

Name _____

Class _____

- Q17. Move the roller coaster back to the beginning of the track. Change the coefficient of friction to $\mu = 0.1$ so that friction will act on the roller coaster and do negative work as it moves along the track. Click on the play button and observe the bar graphs as the car moves along the track. A new bar graph measures the work done by the friction force. What happens to the total mechanical energy of the car as it moves along the track?
- Q18. You have probably heard a statement similar to “Energy is neither created nor destroyed, but it may change forms.” With this in mind, how can you explain what is happening to the total mechanical energy of the car? What effect is friction having on the car? (Hint: Think about what happens when you rub your hands together rapidly.)
- Q19. Friction and air resistance are classified as non-conservative forces. In contrast, the force of gravity is classified as a conservative force. Explain what this means in the context of this simulation and your observations above. (Hint: In physics, a quantity is conserved if it remains constant as other quantities change.)
- Q20. Compare the speed of the car at the bottom of the first hill in this simulation to the speed of the car at the bottom of the first hill when there was no friction. What difference do you observe? Is this consistent with your observations above?
- Q21. With friction opposing the motion, could a roller coaster make it to the top of a hill, which has the same height as the starting hill? Explain your answer.



Energy of a Roller Coaster

Student Activity

Name _____

Class _____

Move to pages 4.3–4.6. Answer questions 22–25 here and/or in the .tns file.

Q22. A roller coaster achieves maximum speed (ignore friction) _____.

- | | |
|--|--|
| A. at the bottom of any hill | C. anywhere on the track which is not at the top of a hill |
| B. at the lowest position of the track | D. part way down the first hill |

Q23. To increase the maximum speed of a roller coaster, a designer should _____.

- | | |
|---------------------------|-------------------------------|
| A. make the track shorter | C. have fewer hills |
| B. make the track longer | D. make the first hill taller |

Q24. In the absence of friction, the greatest height a roller coaster can achieve _____.

- | | |
|--------------------------------------|---|
| A. is higher than the first hill | C. is equal to the height of the first hill |
| B. is much lower than the first hill | D. is determined by the most recent hill it has passed over |

Q25. A roller coaster will stop _____.

- | | |
|---|--|
| A. when its potential energy is equal to its total energy | C. at the top of any hill regardless of its height |
| B. only if it crashes into something | D. when it runs out of gas |

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Science Objectives

- Students will explore the relationship between work and energy.
- Students will explore energy transformations related to the motion of a roller coaster with and without friction.

Vocabulary

- conservative vs. non-conservative forces
- gravitational potential energy
- kinetic energy
- total mechanical energy
- work

About the Lesson

- This lesson begins with an exploration of the relationships between work, potential energy, and kinetic energy using. The simulation uses a block that is either lifted and dropped or is pulled up an incline and allowed to slide back down. These concepts are then applied to a simulation of a roller coaster car moving along a track.
- As a result, students will:
 - Observe that an external force doing positive work increases the mechanical energy of an object, while friction causes a decrease in mechanical energy.
 - Describe how energy transforms between potential and kinetic forms, and, in the absence of friction, the total mechanical energy remains constant.
 - Relate the concepts of work and energy to the design and motion of a roller coaster.

TI-Nspire™ Navigator™

- Send out the *Energy_of_a_Roller_Coaster.tns* file.
- Monitor student progress using Screen Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- *Energy_of_a_Roller_Coaster.tns* document
- TI-Nspire™ Technology
- *Energy_of_a_Roller_Coaster_Student* Activity Handout





TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Use a minimized slider
- Grab a point with the cursor

Tech Tips:

Make sure that students understand how to use the Play/Pause and Reset buttons to control the animation on the simulation page.

To grab a point with the cursor, move the cursor over the point until it becomes a hand, and then press and hold  until the hand closes. Use the touchpad to move the object. Press  to release the object.

Lesson Materials:

Student Activity

- *Energy_of_a_Roller_Coaster_Student.doc*
- *Energy_of_a_Roller_Coaster_Student.pdf*

TI-Nspire document

- *Energy_of_a_Roller_Coaster.tns*




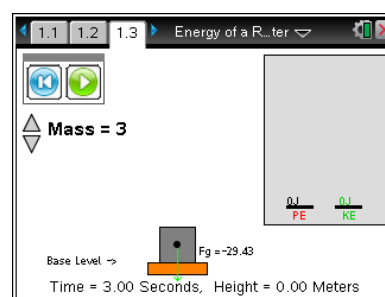
Discussion Points and Possible Answers

Allow students to read the background information on the student activity sheet.

This file is divided into four problems. The first problem simulates a block that students lift and drop. Students calculate the work done and compare it to the energy acquired by the block. The second problem explores these same ideas with a block on an incline. The third problem introduces friction between the block and the incline. The fourth problem simulates a roller coaster car moving along a track with and without friction. Students should follow the handout and answer the questions as they manipulate the simulations. A few summary questions are included in the .tns file.

Move to pages 1.2 and 1.3.

1. Have students read the instructions and background materials on page 1.2 before moving on to the simulation. After reading the directions on page 1.3, press  to close the pop-up box.
2. Students should grab the block by the point in the middle and lift it above the surface. The instructions and questions in the student handout guide them through the exploration.



Students should answer questions 1–3 on their activity sheets as they work through the simulation.

- Q1. Grab the block with the cursor and lift it above the surface. Then use the spaces below to record the lifting force and the height to which you lift the block. Use these numbers to calculate the work you do on the block. Observe what happens to the gravitational potential energy as you lift the block. Click the play button, and observe the gravitational potential and kinetic energies of the block as it falls.

Sample Answers: A. $F = 29.43$ N, B. $h = 1.23$ m, C. $W = F \cdot h = 36.2$ J

- Q2. Describe what happens to the gravitational potential energy of the block as you lift it. Compare the potential energy at the highest point to the work done in lifting the block.

Sample Answer: The potential energy of the block increases as it is lifted. The amount of potential energy gained is equal to the amount of work done on the block.



Energy of a Roller Coaster

SCIENCE NSPIRED

TEACHER NOTES

- Q3. Describe what happens with the gravitational potential and kinetic energies as the block falls. What do you observe about the sum of the two energies as the block falls? Compare the kinetic energy of the block when it reaches the surface to the potential energy when you released it.

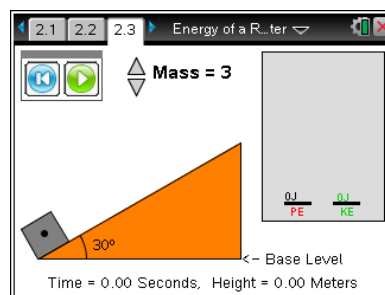
Sample Answer: The kinetic energy increases as the potential energy decreases during the fall. The sum of the two energies remains constant. At the surface, all of the initial potential energy has been transformed into kinetic energy.

Move to pages 2.1–2.2.

3. Read the information on pages 2.1 and 2.2. After reading the directions on page 2.3, press  to close the pop-up box.

Move to page 2.3.

4. On this page students should grab the point in the middle of the block near the corner of the incline and move it up to pull the 3-kg block up the incline. The incline is frictionless. Students should observe that the gain in gravitational potential energy is still equal to the work done in pulling the block to the top. The applied force is equal to the component of the block's weight, which is parallel to the incline.



Students should answer questions 4-6 below before moving to page 2.4.

- Q4. Drag the block to the top of the incline, and record the distance and the force required to pull the block to this location. The work done on the block is the product of these two numbers. Observe the gravitational potential energy as the block is pulled up the hill. Click the play button, and observe the potential and kinetic energies of the block as it slides down the incline.

Sample Answer: A. $F = 20$ N, B. $d = 8.42$ m, C. $W = F \cdot d = 168.4$ J

- Q5. The block has a mass of 3 kg, and the hill is a 30° incline. Demonstrate how the height of the block at the top of the hill can be calculated. Use this height to calculate the gravitational potential energy at the top of the hill. Compare your calculation of potential energy to the work calculated in the previous question.

Sample Answer: $h = d \cdot \sin \theta = 8.42 \text{ m} \cdot \sin 30^\circ = 4.21 \text{ m}$

$PE = mgh = 3 \text{ kg} \cdot 9.8 \text{ N} \cdot 4.21 \text{ m} = 123.774 \text{ J}$. This is the same as the work done on the block.



- Q6. Describe what happens with the potential and kinetic energies as the block slides down the hill. What do you observe about the sum of the two energies as the block slides? Compare the kinetic energy of the block when it reaches the surface to the gravitational potential energy when you released it.

Sample Answer: The kinetic energy increases as the potential energy decreases when the block slides down the incline. The sum of the two energies remains constant. All of the initial potential energy is transformed into kinetic energy.

Move to pages 2.4–2.6.

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

- Q7. The gravitational potential energy of an ideal roller coaster at its highest point is equal to the work required to get it to the top of the hill.

Answer: A. True

- Q8. Choose the correct statement(s) about kinetic energy (KE) and potential energy (PE) based on your observations of the block on the frictionless incline. (There is more than one correct statement.)


Answers:

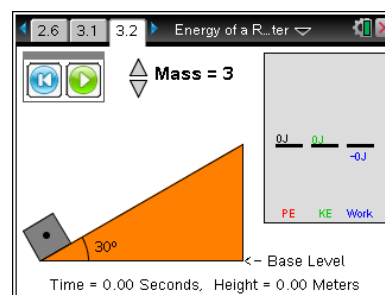
- B. As the block slides down the hill, its KE increases at the same rate as its PE decreases.
- C. As the block slides, the sum of its KE and PE remains constant.
- D. The greater the height of the block when it is released, the more KE it will have when it reaches the bottom.

- Q9. On an actual roller coaster, how does it gain its initial gravitational potential energy?

Sample Answer: A chain pulls the roller coaster to the top of the first hill and does work on it.

Move to pages 3.1 and 3.2.

5. Students should read the information on page 3.1. After reading the directions on page 3.2, press  to close the pop-up box.
6. Click the play button on page 3.2, and observe the work and energy bar graphs as the block slides.





This simulation includes a friction force acting on a 3-kg block as the block slides down a 30° incline. The friction force does negative work on the block as it slides down the incline. Students should observe that this decreases the mechanical energy of the block.

Students should answer questions 10 and 11 on the activity sheet before moving to page 4.1.

- Q10. Note the potential energy of the block at the top of the hill. Click the play button, and observe the work and energy bar graphs as the block slides. Describe the changes you observe in the potential energy and the kinetic energy of the block as it slides. Compare the kinetic energy at the bottom of the hill to the potential energy at the top.

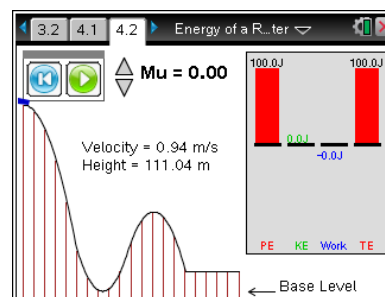
Sample Answer: The potential energy decreases and the kinetic energy increases as the block slides down the incline, but the kinetic energy of the block at the bottom is less than the potential energy of the block at the top. Some energy is missing.






- Q11. How much work was done by the friction force? What effect did this appear to have on the energy of the block?

Sample Answer: The amount of work done by friction is equal to the missing energy. Friction appears to take energy away from the block.

Move to pages 4.1 and 4.2.

Page 4.1 simulates a roller coaster car moving along a track. The height and velocity of the car are displayed. On the right side of the screen are bar graphs for potential energy, kinetic energy, total mechanical energy, and work done by friction. The total mechanical energy is the sum of the potential and kinetic energies.



7. After reading the directions students press  to close the pop-up box. The roller coaster car is already at the top of the track. Students can click the play button  will release the car. Clicking the reset button  will place the car back at the top of the roller coaster. They may change the friction, μ , by clicking the up and down arrows ( or ) for μ .
- Students should note the increase in velocity as the coaster moves up and down hills. A graph shows the corresponding changes in potential, kinetic, and total energy.



Students should answer questions 12-21 on the activity sheet before moving to page 4.3.

- Q12. Set the value of Mu to zero. Press the down arrow ▼ a couple times after it shows Mu = 0.00. Start the car and allow it to move through the track. Observe the bar graphs as the car moves along the track. Describe the changes you observe in the potential energy, kinetic energy, and total energy. Comment on how the three energy measurements appear to relate to each other.

Sample Answer: The potential energy decreases as the car moves down a hill and increases as it moves up a hill. The kinetic energy increases as the car moves down a hill and decreases as it moves up a hill. The total energy stays constant. The energy transforms back and forth between potential and kinetic.

- Q13. Reset the car and set the value of Mu to zero. Stop the car at the bottom of the first hill. Record the values of the PE, KE, TE, height (h), and velocity (v). Repeat these steps, this time stopping at the top of the second hill. Repeat the steps again, this time stopping at the bottom of the second hill.

Sample Answers:

top of the 1 st hill	PE = <u>100</u> J	KE = <u>0</u> J	TE <u>100</u> J	h = <u>111</u> m	v = <u>0.94</u> m/s
bottom of 1 st hill	PE = <u>0</u> J	KE = <u>100</u> J	TE <u>100</u> J	h = <u>0</u> m	v = <u>46.68</u> m/s
top of the 2 nd hill	PE = <u>42.7</u> J	KE = <u>57.3</u> J	TE <u>100</u> J	h = <u>47.4</u> m	v = <u>35.23</u> m/s
bottom of 2 nd hill	PE = <u>10.8</u> J	KE = <u>89.2</u> J	TE <u>100</u> J	h = <u>12.03</u> m	v = <u>44.08</u> m/s

- Q14. Calculate the ratio of the gravitational potential energy at the top of the first hill to the gravitational potential energy at the top of the second hill. Now calculate the ratio of the height of the first hill to the height of the second hill. What do you observe about the two ratios? What does this tell you about the relationship between potential energy and height?

Sample Answers: $\frac{PE_1}{PE_2} = \frac{100}{42.7} = 2.34$; $\frac{h_1}{h_2} = \frac{111}{47.4} = 2.34$

The two ratios are the same. The potential energy of the car is directly proportional to the height of the track.



- Q15. Calculate the ratio of the kinetic energy at the bottom of the first hill to the kinetic energy at the top of the second hill. Now calculate the ratio of the speed at the bottom of the first hill to the speed at the top of the second hill. What do you observe when you compare these two ratios? What can you infer about the relationship between the kinetic energy of the roller coaster and its speed?

Sample Answers: $\frac{KE_1}{KE_2} = \frac{100}{89.2} = 1.12$; $\frac{v_1}{v_2} = \frac{46.68}{44.08} = 1.05$

The two ratios are not the same. The ratio of the kinetic energies is larger than the ratio of the speeds. This implies that kinetic energy and speed are not directly proportional. The kinetic energy is actually proportional to the square of the speed. As a result, doubling the kinetic energy of the car does not double its speed.

- Q16. At the bottom of the second hill, what percentage of the roller coaster's total energy is in the form of potential energy? What percentage is in the form of kinetic energy? What percentage of the maximum speed of the roller coaster is its speed at the bottom of the second hill?

Sample Answers: $\frac{PE}{TE} = \frac{10.8}{100} = 10.8\%$; $\frac{KE}{TE} = \frac{89.2}{100} = 89.2\%$; $\frac{v_2}{v_1} = \frac{44.08}{46.68} = 94\%$

- Q17. Move the roller coaster back to the beginning of the track. Change the coefficient of friction to $\mu = 0.1$ so that friction will act on the roller coaster and do negative work as it moves along the track. Click on the play button and observe the bar graphs as the car moves along the track. A new bar graph measures the work done by the friction force. What happens to the total mechanical energy of the car as it moves along the track?

Sample Answer: The total mechanical energy of the roller coaster decreases steadily.

- Q18. You have probably heard a statement similar to "Energy is neither created nor destroyed, but it may change forms." With this in mind, how can you explain what is happening to the total mechanical energy of the car? What effect is friction having on the car? (Hint: Think about what happens when you rub your hands together rapidly.)

Answer: As friction does negative work, the mechanical energy decreases. The work done by friction transforms mechanical energy into heat, a non-mechanical form of energy. As a result, the temperature of the track and the wheels increases.



- Q19. Friction and air resistance are classified as non-conservative forces. In contrast, the force of gravity is classified as a conservative force. Explain what this means in the context of this simulation and your observations above. (Hint: In physics, a quantity is conserved if it remains constant as other quantities change.)

Sample Answer: When gravity does work on an object, its total mechanical energy is not changed even though energy is transformed between potential and kinetic. This means mechanical energy is conserved. When friction and air resistance do work, however, the mechanical energy of an object decreases as it is transformed into thermal energy. As a result, mechanical energy is not conserved.

- Q20. Compare the speed of the car at the bottom of the first hill in this simulation to the speed of the car at the bottom of the first hill when there was no friction. What difference do you observe? Is this consistent with your observations above?

Sample Answer: The speed is 30.4 m/s with friction and 34.3 m/s without friction. The speed is less when friction is present. This means that not all of the initial gravitational potential energy has been transformed into kinetic energy. Some has been turned into thermal energy.

- Q21. With friction opposing the motion, could a roller coaster make it to the top of a hill, which has the same height as the starting hill? Explain your answer.

Sample Answer: A roller coaster could not get back to its starting height. Since work done by friction decreases mechanical energy, the roller coaster would stop at a lower height. Designers must make subsequent hills smaller than the first hill.

Move to pages 4.3–4.6.

Have students answer questions 22-25 on the handheld, the activity sheet, or both.

- Q22. A roller coaster achieves maximum speed (ignore friction) _____.

Answer: B. at the lowest position of the track

- Q23. To increase the maximum speed of a roller coaster, a designer should _____.

Answer: D. make the first hill taller



Q24. In the absence of friction, the greatest height a roller coaster can achieve _____.

Answer: C. is equal to the height of the first hill

Q25. A roller coaster will stop _____.

Answer: A. when its potential energy is equal to its total energy

TI-Nspire Navigator Opportunities

Take screenshots of the entire class to show the car along various parts of the track. Discuss with students the variation in the velocity and height. Throughout the activity, discuss the simulations with students using Slide Show. At the end of the lab, collect the .tns files and save to Portfolio.

Wrap Up

When students are finished with the activity, retrieve the .tns file using TI-Nspire Navigator and collect the student handouts. Save grades to Portfolio. Discuss activity questions using Slide Show.

Assessment

- Formative assessment will consist of questions embedded in the .tns file and student responses on the handout. The questions will be graded when the .tns file is retrieved. The Slide Show will be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test.

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Science Objectives

- Students will set up a data collection experiment.
- Students will predict the shape of motion graphs.
- Students will determine and interpret the slope of v vs. t graph as acceleration.
- Students will calculate the angle slope of an incline.
- Students will consider differences in rolling and sliding acceleration.

Math Objectives

- Students will consider the implications of differently shaped graphs.
- Students will find the equation and slope of a line.
- Students will give meaning to slope and intercept, including units.
- Students will use basic trigonometry to calculate the slope angle of an incline and components of a vector.

Vocabulary

- velocity
- acceleration
- incline slope
- frictionless
- vector component

Materials & Advance Preparation

- CBR 2™
- Table that can be tilted (or long, wide board)
- Several blocks to tilt table
- Tape measure (10' or 3 m minimum)
- Ball (soccer, volley, basket, and so on)

About the Lesson

- This lesson involves collecting motion data as a ball rolls down and incline.
- As a result, students will:
 - Set up data collection equipment and technology.
 - Calculate the slope of their table from measurements.
 - Predict what the graphs of d vs. t , v vs. t , and a vs. t should look like.
 - Find the acceleration of the rolling ball after viewing each graph of collected data.
 - Use their measured table slope in a vector diagram to determine the theoretical acceleration of a frictionless sliding object, and compare this value to their measured acceleration.



TI-Nspire™ Technology Skills:

- Open a document
- Set up a data collection experiment and collect data with a CBR 2™
- Analyze data
- Use Scratchpad
- Show hidden point and drag to make a dynamic diagram

Tech Tips:

- If students accidentally create extra pages, they can be deleted in Page View. Press **ctrl** ▲, move to the unwanted page, and press **del**.

Lesson Materials:

TI-Nspire document

- Rolling_Rates.tns



TI-Nspire™ Navigator™ System

- Send the TI-Nspire document to class.
- Observe progress through C Capture
- Send out a Quick Poll to initiate discussion and clarify a concept.
- Use Collect from Class and Review Workspace features to check student work.
- Use Live Presenter to engage students and assess understanding of concepts.

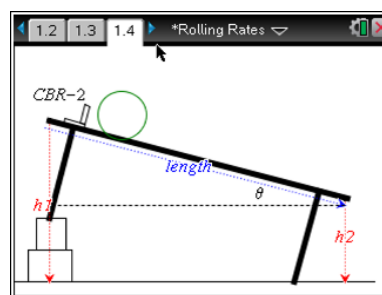
Discussion Points and Possible Answers

Tech Tip: The CBR 2 sends out a cone of ultrasound to measure distances by timing echoes. If the face of the CBR 2 is pointed too low, it might be affected by the surface.

Move to page 1.4.

Ensure the table is blocked in a stable position with room to move about. Scratchpad can be opened by pressing . The slope angle of the table is found by the formula:

$$\theta = \sin^{-1}((h_1 - h_2)/\text{length})$$



Tech Tip: To set the TI-Nspire handhelds to degree mode, press and select **Settings > Settings > General > Angle > Degree** and press .

TI-Nspire Navigator Opportunity: Quick Polls (Open Response) and Live Presenter
See Note 1 at the end of this lesson.

Move to page 1.5.

Questions are contained in the TI-Nspire document.

1. When I let the ball roll and collect data, I expect the shape of the position vs. time graph to be:

Answer: quadratic curving up



Move to page 1.6.

2. I expect the shape of the velocity vs. time graph to be:

Answer: linear with positive slope

Move to page 1.7.

3. I expect the graph of acceleration vs. time to be:



Answer: linear with zero slope

TI-Nspire Navigator Opportunity: *Collect from Class*

See Note 2 at the end of this lesson.

Tech Tip: If planning to collect information from students through TI-Nspire Navigator, a good tip is to have students press **ctrl** ▲ after finishing a set of questions. When Screen Capture is turned on with auto refresh, black circles will indicate which students have finished the questions.

Move to page 1.8.

Students might need to run more than one trial. To store data from a good run, just click the Store button  then click the Start button  again to perform another trial. To discard data from a poor run, just click Start and the system will overwrite the data.

Have students look at all three graphs: position, velocity and acceleration. Discuss why the graphs are not perfect. Reasons can be related to how and when they let go of the ball and the time that the ball reached the end of the table. Bumpy rolling will also affect quality of data. Acceleration is typically the most variable, thus we use the v vs. t graph to get a better average value for acceleration.

Move to page 1.9.

Tech Tip: If a new DataQuest™ page does not appear, or the device does not seem to recognize the CBL 2, insert a new page and/or select **Menu > Experiment > New Experiment**.



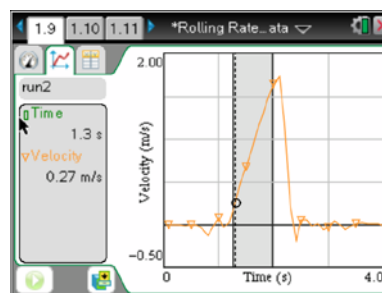
Move to page 1.10.

The three different graphs will have different ideal shapes: position should curve up, velocity should be linear with positive slope, and acceleration should be horizontal with some positive value.

In practice, the acceleration will likely be very rough as the ball may not roll smoothly nor reflect the pulse uniformly. There might also be some poor data, especially as the ball starts rolling and as it gets to the end of the table. A discussion of these issues is valuable for understanding how data and mathematics relate to the real world.

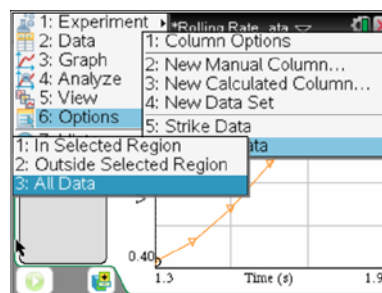
Move to page 1.11.

Selecting the data range is a little tricky at first. Practice and demo for the students.



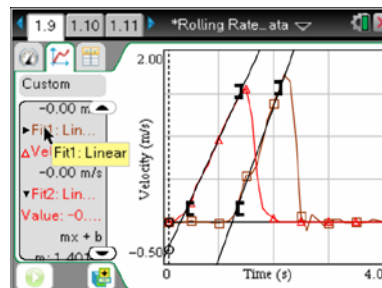
Move to page 1.12.

Struck data can be restored through the menu. It is not counted in any analysis calculations.



Move to page 1.13.

Several different trials can be analyzed. Scroll down the Graph Details box, and click on the results desired.



Move to page 1.14.

4. What are the units of the slope of a velocity vs. time graph?

Answer: m/s^2



Move to page 1.15.

5. What does the slope of a velocity vs. time graph represent?

Answer: rate change of velocity, which is acceleration

Move to page 1.16.

6. What was the acceleration of the ball rolling down the incline in your experiment?

Sample Answers: Answers will vary depending on the slope of the table. Insist on the students including units! m/s^2

Move to page 1.17.

7. When you put a line on your velocity vs. time graph, the equation of the line was in the form of: $m1(x) = mx + b$ where m and b are numbers related to your data. What does the value for b represent (based on the match of the line to the data)?

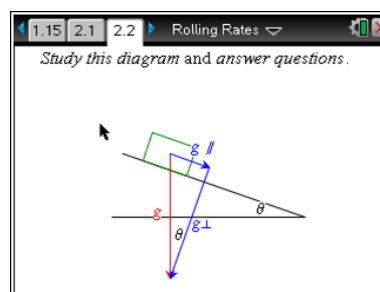
Answer: The value b , often called the y -intercept, represents the speed of the ball at time 0, or the initial speed of the ball when you started collecting data.

Teacher Tip: The initial speed might show as a negative value because the ball might have started rolling after data collection started. Use this as an example of the dangers of extrapolating blindly.

Teacher Tip: This is a good time to compare results around the class and discuss differences.

Move to page 2.2.



Remind the students that this represents a frictionless situation. Get the students involved in a discussion by asking questions like: What should happen to the block? Why? What causes the ball to roll down the slope? How are these two cases similar? What direction does gravity act? What direction do the block and the ball move?



TI-Nspire Navigator Opportunity: Live Presenter

See Note 3 at the end of this lesson.



Tech Tip: The diagram on Page 2.2 has a hidden point that makes the diagram dynamic. The issue of why a block slides (or a ball rolls) faster on a steeper slope can be illustrated showing the increase of $g_{//}$ as the slope increases. To do this, select **Menu > Actions > Hide/Show**. Move the cursor over the shadowed point labeled A, then press  and . Drag point A to change the slope and watch the changes in vector $g_{//}$.

Move to page 2.3.

8. What might the vector “g” in the diagram represent?

Answer: It could represent the weight of the block, or more appropriately in this context, the acceleration due to gravity.

Move to page 2.4.

9. If we consider acceleration of the block being caused by gravity, what is the value of vector “g”?

Answer: 9.8 m/s^2 in the vertically downward direction.

Move to page 2.5.

10. Which vector component causes the block to slide down the incline?

Answer: $g_{//}$

Move to page 2.6.

11. Knowing your slope angle, what is the acceleration of a frictionless block down the incline?

Sample Answer: Answers vary depending on the slope. $g_{//} = g \sin\theta$ Insist on including units.

Move to page 2.7.

12. Compare the observed acceleration of the ball (Page 1.15) to the theoretical acceleration of a frictionless block (Page 2.6). The ball's acceleration was:

Answer: less than a frictionless block



TI-Nspire Navigator Opportunity: *Collect from Class*

See Note 4 at the end of this lesson.

Move to page 2.8.

13. How can you explain your answer to Q12 on the previous page?

Answer: A rolling ball also undergoes angular acceleration and gains rotational kinetic energy. Some of the work done by gravity goes into making the ball rotate, thus it has less translational kinetic energy or linear speed.

Here is an opportunity for students to ask or discuss a wide variety of questions about the mathematics of the motion graphs and equations and about concepts of motion.

TI-Nspire Navigator Opportunity: *Collect from Class*

See Note 5 at the end of this lesson.

Tech Tip: If planning to delete a file from the student handhelds, make sure the students close the document before you initiate the final Collect from Class. Otherwise the document will still be open on the handheld and an unaware student might save it on the handheld so that the document, with the answers, would be available for the next user.

Wrap Up

This activity provides students with a real situation in which to explore the meaning of motion graphs, evaluate data, compare results with other groups, and relate the situation to theory. The concepts of motion—velocity, acceleration, sliding, and rotation—are observed and discussed. Connections to mathematics can be made.

Assessment

Informal, formative assessment can occur throughout this activity. Teacher-led question and answer at various points (TI-Nspire Navigator-enabled, if available) can serve as a check on student understanding and an opportunity for students to think and formulate conceptual answers. Questions in the TI-Nspire document can be reviewed (or collected with TI-Nspire Navigator, placed into student Portfolio, and de-briefed as a class in Slide Show).



TI-Nspire Navigator

Note 1

Question 1, *Quick Polls (Open Response) and Live Presenter*: If you have TI-Nspire Navigator, send out an Open Response Quick Poll and ask, “Which trigonometric function is used to find the slope angle of the table?” Also, you can make a student a Live Presenter in Screen Capture by selecting that student’s screen capture image and clicking on Make Presenter. Ask the rest of the students to coach the Presenter to answer your questions by clicking or moving the cursor so everyone can see what you are asking about. For example: “Click on the hypotenuse of the triangle we will use to determine the slope angle of the table.”

Note 2

Question 3, *Collect from Class*: This might be a good time to review student answers by using Collect from Class, Save to Portfolio, and Open in Class Analysis. Use the Slide Show to discuss any student misconceptions. You can review, re-teach, or proceed based on the results. Without TI-Nspire Navigator, it is still a good time to discuss the expected shapes of the graphs and the reasons why.

Note 3

Page 2.2, *Live Presenter*: This is another opportunity to engage the class and check understanding if you make a student a Live Presenter in Screen Capture. Ask the rest of the students to coach the Presenter to answer your questions by clicking or moving the cursor so everyone can see what you are asking about. For example: “Which vector is the cause of the block sliding down the slope?”

Note 4

Question 12, *Collect from Class*: This is another good time to review student answers from the TI-Nspire document by using the TI-Nspire Navigator Review Workspace features. Without TI-Nspire Navigator, it is still a good time to discuss the expected shapes of the graphs and the reasons why.

Note 5

Page 2.9, *Collect from Class*: You might want to do a final Collect from Class and delete the TI-Nspire document by checking the “Delete from handheld after collecting” box. This will ensure that the next users will have a fresh document when you send it out next time. However, you also might want to leave the document so that students can do further work on it at a later time.



This activity promotes the following **Common Core State Standards Mathematical Practices**:

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically

And the following **Constructivist 5-E's Processes**:

- Engagement
- Exploration
- Explanation
- Elaboration

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That's the Way the Ball Bounces: Height and Time for a Bouncing Ball

Picture a bouncing ball. Between impacts with the floor, the ball rises and slows, then descends and speeds up. For any particular bounce, if the ball's height is plotted as a function of time, the resulting graph has a parabolic shape. In other words, the relationship between height and time for a single bounce of a ball is quadratic. This relationship is expressed mathematically as

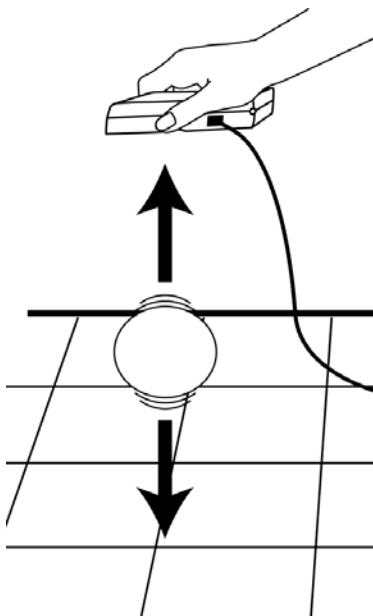
$$y = ax^2 + bx + c$$

where y represents the ball's height at any given time x . Another form of a quadratic equation is

$$y = a(x - h)^2 + k$$

where h is the x -coordinate of the vertex, k is the y -coordinate of the vertex, and a is a parameter. This way of writing a quadratic is called the *vertex form*.

In this activity, you will record the motion of a bouncing ball using a Motion Detector. You will then analyze the collected data and model the variations in the ball's height as a function of time during one bounce using both the general and vertex forms of the quadratic equation.









OBJECTIVES

- Record height versus time data for a bouncing ball.
- Model a single bounce using both the general and vertex forms of the parabola.

DataQuest 10**MATERIALS**

TI-Nspire handheld **or**
 computer and TI-Nspire software
 CBR 2 **or** Go!Motion **or**
 Motion Detector and data-collection interface
 ball (racquetball or basketball size)

PROCEDURE

1. If your Motion Detector has a switch, set it to Normal. Connect the Motion Detector to the data-collection interface. Connect the interface to the TI-Nspire handheld or computer. (If you are using a CBR 2 or Go!Motion, you do not need a data-collection interface.)
2. Position the Motion Detector about 1.5 m above the floor, so that the disc is pointing straight downward.
3. Choose New Experiment from the  Experiment menu. For this experiment, the default data-collection parameters for a Motion Detector will be used (Rate: 20 samples per second; Duration: 5 seconds). The number of points collected should be 101.
4. DataQuest needs to be set up so positions above the floor will be read as positive Position. That is, the Motion Detector will read distance above the floor. Choose Set Up Sensors ► Zero from the  Experiment menu. Then choose Set Up Sensors ► Reverse from the  Experiment menu.
5. Click the Graph View tab (). Choose Show Graph ► Graph 1 from the  Graph menu. Only the Position vs. Time Graph will be displayed.
6. Practice dropping the ball so that it bounces straight up and down beneath the Motion Detector. Minimize the ball's sideways travel. Dropping the ball from about waist high works well. The ball must never get closer than 15 cm from the detector. Be sure to pull your hands away from the ball after you drop it so the Motion Detector does not detect your hands.
7. Start data collection (.
8. When data collection is complete, a graph of position versus time will be displayed. Examine the graph; it should contain a series of parabolic regions. Check with your teacher if you are not sure whether you need to repeat the data collection. To repeat data collection, repeat Step 7.





DATA TABLE



Vertex	
x-coordinate	y-coordinate

	Values calculated from vertex form	Values from regression
<i>a</i>		
<i>b</i>		
<i>c</i>		

ANALYSIS

- Select the data corresponding to the ball's position between two bounces.
 - Select just one parabolic portion of the data.
 - Choose Strike Data ► Outside Selected Region from the  Data menu. DataQuest will remove data outside the region you just marked. A new graph showing only the parabolic portion of the data will be displayed. Choose Autoscale Now from the  Graph menu.
- Click any data point and use ► and ◀ to trace across the graph to determine the *x*- and *y*-coordinates of the vertex of the parabola (in this case, the maximum point on the curve). Record them in the first data table.


Answer Analysis Question 1.

- Now fit the vertex form of a quadratic model $y = a(x - h)^2 + k$ to your data. Since you have values for the parameters *h* and *k* of your model, you can try plotting the model using a guess for the *a* parameter. First, enter your model equation for graphing.
 - Insert a Graphs page.
 - Insert the Sensor Console in order to input the graph from DataQuest. Verify that your data appears and then close the Sensor Console.
 - Choose Zoom – Data from the  Window/Zoom menu to view all of your data.
 - Choose Function from the  Graph Type menu.
 - Enter your model equation into the Entry Line replacing *h* and *k* with the values you determined earlier. Enter 1 as the initial value for the parameter *a*.

$$f1(x) = a*(x-h)^2+k$$
 - Experiment with the movable parabola to find the best value for *a*, *h* and *k* by grasping the parabola to translate and dragging the 'arms' to change its curvature and direction.

When you have found the best value for the parameter *a*, use your optimized value for *a* and the values of *h* and *k* you determined earlier to complete the vertex form of the equation. Record the equation as your answer to Analysis Question 2.

DataQuest 10

4. It is also possible to express any quadratic function in the standard form of $y = ax^2 + bx + c$, where the coefficient a is the same as the coefficient you just found for the vertex form, and b and c are other parameters related to the h and k you already know. To determine the coefficients b and c , expand the vertex form of your equation and collect like terms. Record the corresponding values of a , b , and c in the middle column of the second data table, rounded to the nearest tenth.
5. Another way to determine the parameters is to use DataQuest to perform a quadratic regression on your data to determine the best-fitting parabola to your data.
 - a. Return to your DataQuest page.
 - b. Choose Curve Fit ► Quadratic from the  Analyze menu.
 - c. Record the a , b and c parameters, in the third column of the second data table.
 - d. Select OK. Then, answer Analysis Questions 3–5.

ANALYSIS QUESTIONS

1. In this activity, the ball bounced straight up and down beneath the detector, yet the plot you see might seem to depict a ball that is moving sideways as it bounces up and down. Explain why the graph looks the way it does.
2. Record the vertex form of the parabola from Analysis Step 3.
3. Are the values of a , b , and c in the quadratic regression equation consistent with the values you determined in Analysis Step 4?
4. Describe how the parameter a affects the graph of $y = a(x - h)^2 + k$. Specifically, how does the magnitude of a and the sign of a change the graph?
5. Suppose you had chosen the parabolic section for the bounce just to the right of the one you actually used in this activity. Describe how the parameters h and k would change, if at all, if this different parabolic section were to be fit with the equation $y = a(x - h)^2 + k$.

EXTENSION

How does the value of a vary from one bounce to the next? Collect another run of data, and determine a new value of the parameter a using any method you like. Explain why the values of a are in close agreement for both bounces. What does a measure?

CALCULUS EXTENSION

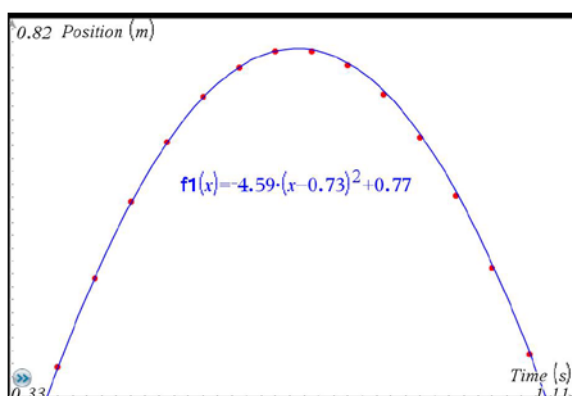
Take the second derivative of the modeling equation. What is the physical significance of this value?

TEACHER INFORMATION

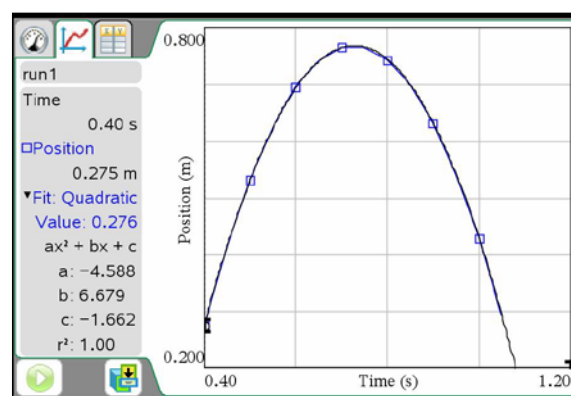
That's the Way the Ball Bounces: Height and Time for a Bouncing Ball

1. The student pages with complete instructions for data collection using DataQuest (TI-Nspire Technology), EasyData (TI-83/84 Plus calculators), DataMate (other TI calculators), or Logger *Pro* software can be found on the CD that accompanies this book. See *Appendix A* for more information.
2. The four different Motion Detectors that can be used when collecting data are: Vernier Motion Detector, CBR, CBR 2, or Go! Motion.
3. A basketball works well for this activity. Avoid using a soft or felt-covered ball such as a tennis ball as the surface prevents good detection by the Motion Detector.
4. The Motion Detector cord must not get between the ball and the detector during data collection.
5. The activity is best done by a group of three students: one to hold the detector, another to release the ball, and a third to operate the calculator.
6. Hold the ball from the sides, and release it by quickly moving hands outward and out of the detection cone of the Motion Detector.

SAMPLE RESULTS



Sample data with model of parabola



Sample data with quadratic fit

Activity 10**DATA TABLE**

Vertex	
x-coordinate	y-coordinate
0.725	0.765

Parameters	Values calculated from vertex form	Values from regression
a	- 4.59	- 4.59
b	6.7	6.68
c	- 1.68	- 1.66

ANSWERS TO ANALYSIS QUESTIONS

1. The graph we are using is vertical distance *vs.* time, not vertical distance *vs.* horizontal distance. That is, the horizontal axis is not horizontal distance, so the appearance of the graph has nothing to do with a side-ways moving ball.
2. Vertex model equation: $y = -4.59(x - 0.73)^2 + 0.77$.
3. The parameters of the standard form quadratic as determined by calculator regression and by the vertex fit are similar.
4. The magnitude of a determines how sharply curved the parabola is, while the sign of a determines whether the parabola is open upward (positive a) or downward (negative a).
5. Since the vertex of the new parabola would be to the right of the one originally used, the time value h would be larger. The y-coordinate of the vertex would be smaller than before, as the ball doesn't bounce as high each time.

Lab Write

[illegible]

Note that sample biology, chemistry, and physics lab reports are also provided.

File Edit View Insert Tools Window Help

New TI-Nspire Document Ctrl+N


New PublishView Document Ctrl+Shift+N

Open Document... Ctrl+O

Problem
Sheet Ctrl+
Calculator

As needed, add additional pages by selecting **Insert > Sheet**.

<Name of problem>

Insert ▾ Var  ▾

Problem

Sheet Ctrl+I

Calculator

education.tj.com



Creating a Lab Report

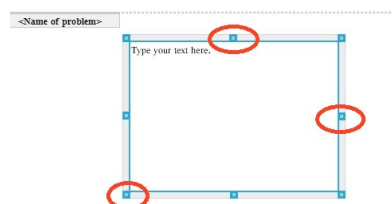
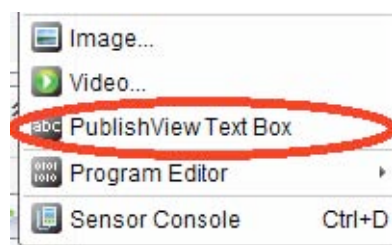
SCIENCE NSPIRED: SKILLS OF SCIENCE

Name _____

Class _____

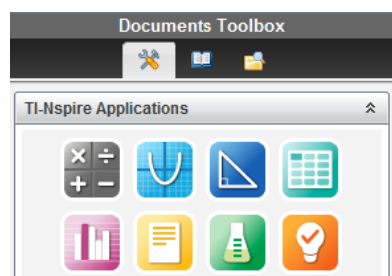
Insert and Resize a Text Box

To insert a text box, click **Insert > PublishView Text Box**. After the text box is inserted, you can resize the box to meet your needs. If you would like to use that same-size text box again, you can select, copy, and paste the text box and move it to a new location.



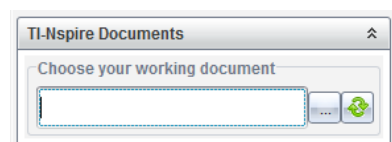
Insert and Resize a TI-Nspire Application

From the Document Toolbox, you can grab and drag a particular application into the PublishView document. You can also select the desired application from the **Insert** drop-down menu.



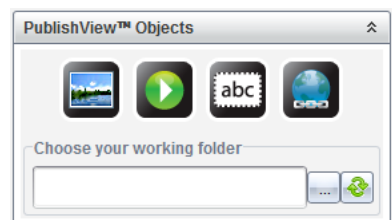
Insert Pages from a .tns File

You can easily drag and drop pages from a TI-Nspire document by choosing it from the TI-Nspire Documents section in the Document Toolbox. Once you select the file name, you will see all pages of the .tns file appear and can simply drag and drop the needed pages into your PublishView document.



Insert Other PublishView Objects

In addition to .tns pages, you can also insert images, videos, and hyperlinks by dragging the tool from the PublishView Objects box in the Document Toolbox to the PublishView document. Then, you will need to specify the file and/or location of the materials you wish to link to.





Creating a Lab Report

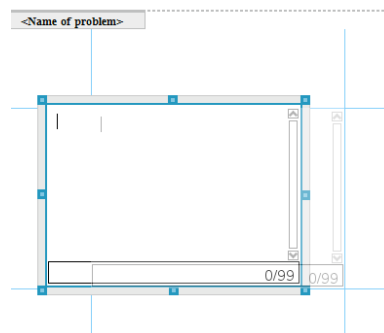
SCIENCE NSPIRED: SKILLS OF SCIENCE

Name _____

Class _____

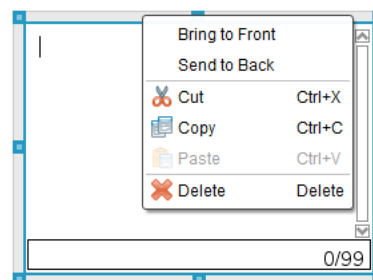
Move Objects in a PublishView document

Once an item has been placed in a PublishView document, it can easily be moved and placed as needed. Just hover near the exterior of the object until you see the small cross-hair arrows appear. Then, click the border of the object and drag it to the desired location.



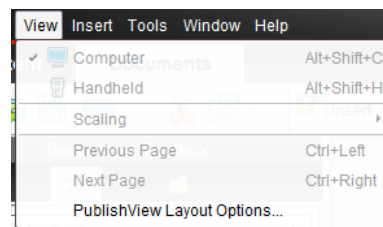
Move Objects Forward or Backward

Since objects can overlap in a PublishView document, you can select the priority given to a particular object. By right-clicking on an object, you can specify to **Bring to Front** or **Send to Back**.



Formatting Document

Once you become familiar with using the various objects in a PublishView document, you may want to explore further to format the documents to be more appealing. One such formatting option is to show the borders around objects or to remove them. This option can be found under **File > PublishView Layout Options**. Then, just explore from there!



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About the Lesson

- This lesson shows how students can use PublishView™ to create lab reports using the computer software. (Note that PublishView™ .tnsp documents cannot be created or viewed on the handheld).
- Students can create documents that include formatted text, embedded TI-Nspire™ applications, images, hyperlinks, links to videos, and embedded videos in a format that is suitable for printing on a standard piece of paper, for publishing to a web site or blog, or for use as an interactive worksheet.
- Students can create reports or projects containing data playback, curve fits, pictures, and video—all on the same sheet.
- Students can print and turn in assignments on a standard piece of paper.


Activity Materials

- *Lab_Report_Template.tnsp* document
- *Biology_Lab_Report_Sample.tnsp* document
- *Chemistry_Lab_Report_Sample.tnsp* document
- *Physics_Lab_Report_Sample.tnsp* document
- TI-Nspire™ Computer Software Technology

TI-Nspire™ Technology Skills:

- Create a new PublishView document
- Insert new Sheets, new Problems, Text Boxes, Video, or Images.

Tech Tips:

- To insert an active page from the .tns file, students should copy/paste (or drag/drop) the page.
- To insert a screen image of a page (not active), students should use the Screen Capture  feature.

Lesson Files:

Student Activity

- Lab_Report_Template_Student.doc
- Lab_Report_Template_Student.pdf

TI-Nspire documents

- Biology_Lab_Report_Sample.tnsp
- Chemistry_Lab_Report_Sample.tnsp
- Physics_Lab_Report_Sample.tnsp
- Lab_Report_Template.tnsp



Discussion

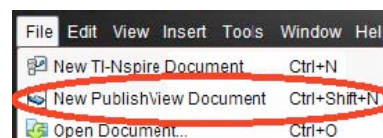
After students have completed a lab, they can take their data, graphs, analysis, and text and create a lab document. They can email or post their finished lab analysis or write ups to the instructor for grading. Students can add Calculators, Graphs, Data Table (spreadsheets), Data and Statistics, Notes, and even a Data Mate application to their document.

Students can also add images, videos, and hyperlinks to their document to help support their conclusions or create a new problem.

Below are various actions that students may want to consider when creating or customizing lab reports. Note that sample biology, chemistry, and physics lab reports are also provided to students.

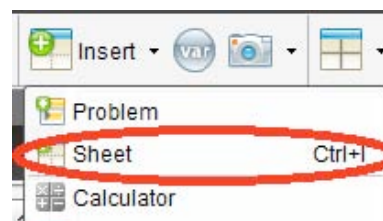
Creating a New PublishView Document

To have students create a lab report on the computer, they could either use the template provided or create a new PublishView document. Ensure students select the “PublishView” option from **File > New PublishView Document**.



Insert a New Sheet

As needed, students can add additional pages by selecting **Insert > Sheet**.



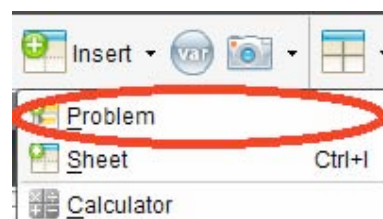
Customize Sections

Students can change the name of different sections of the document by clicking inside the < > and changing **<Name of problem>**.



Add a New Problem

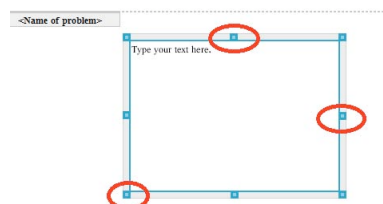
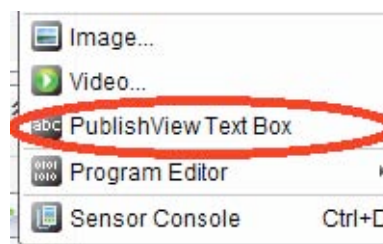
If students would like to separate parts of their lab report, they can insert a new “Problem” and name it as a new section.





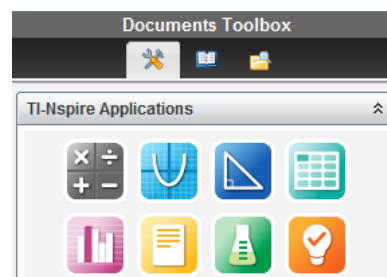
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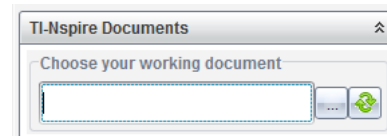
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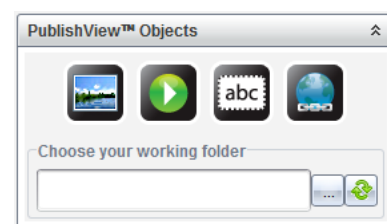
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Insert Other PublishView Objects

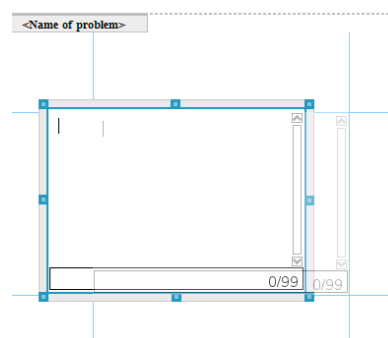
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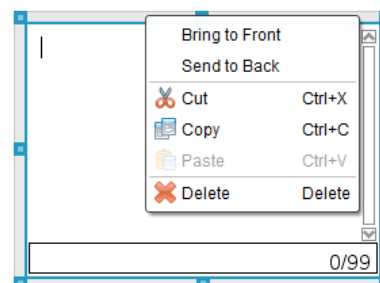
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Move Objects Forward or Backward

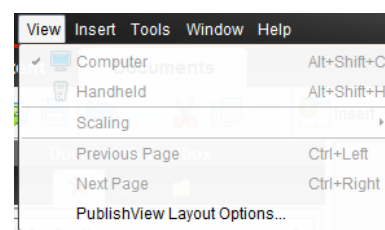
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Encourage students to explore from there!



Wrap Up

Students can email or post to sites like Blackboard or Moodle where the teacher can open and grade the lab report.



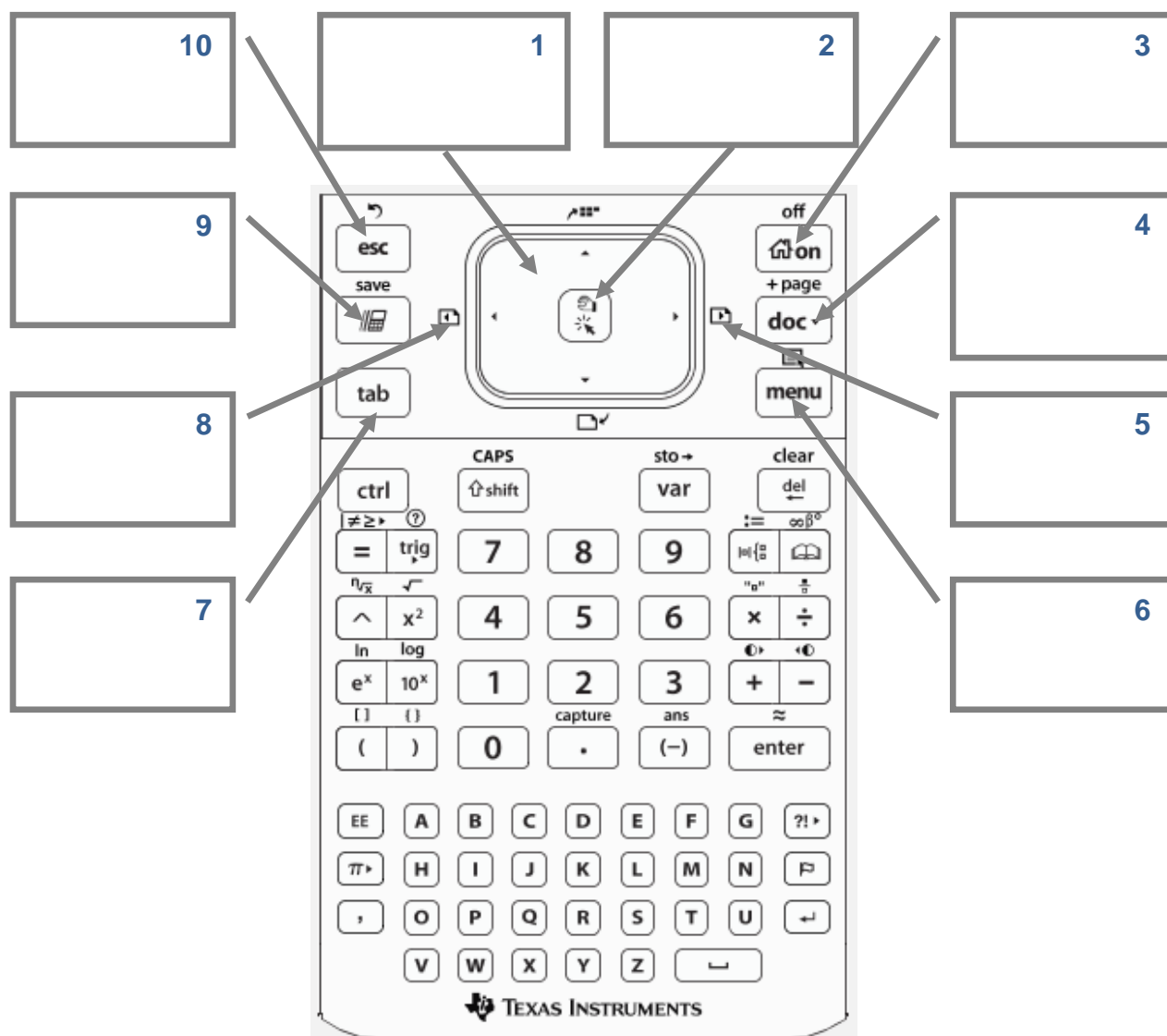
TI-Nspire™ CX Family Overview

TI PROFESSIONAL DEVELOPMENT

STUDENT ACTIVITY

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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Introduction to Data Collection

TI PROFESSIONAL DEVELOPMENT

TEACHER NOTES

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.

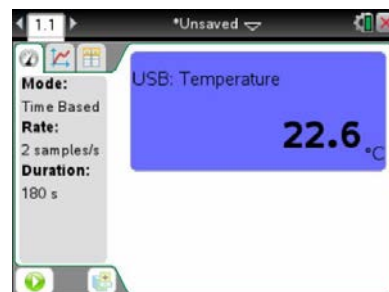


Step 2:

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:**

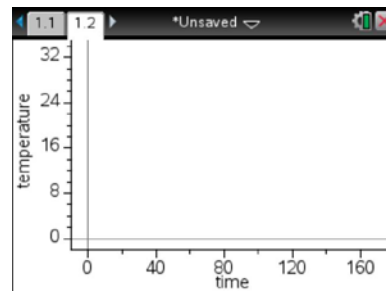
Let the temperature return to room temperature. Note your measure of the temperature of the room and compare it with others around you.

- 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 .

**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:

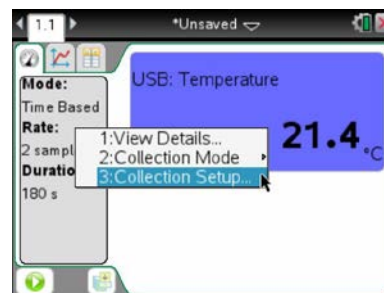
To save the results from the first experiment, place this “run” in the File Cabinet . Press **[tab]** until the File Cabinet is highlighted and press **[enter]**.

- What changes do you notice on the screen?

Step 11:

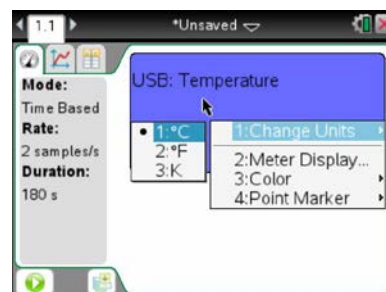
Now design an experiment that will cool the temperature probe.

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.



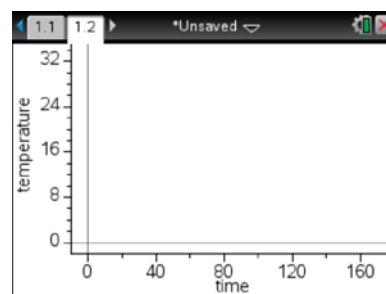



Note that these options are also under the **menu**. Based on what you learned in the heating experiment, adjust the settings as needed for your cooling experiment.

**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.

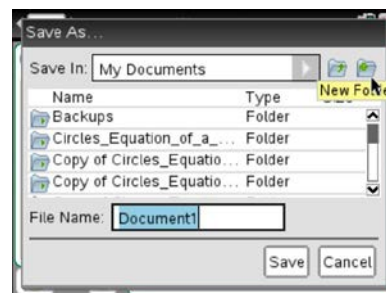
Step 14:

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. Create a new folder if you want.



Interactive Math and Science Classrooms...

I.C.E.R

Interaction
Communication
Engagement
Reasoning & Sense-Making

5Es Learning Cycle for Science

Engagement
Exploration
Explanation
Elaboration
Evaluation

CCSS

Mathematical Practices

Make sense of problems & persevere in
solving them

Reason abstractly & quantitatively

Construct viable arguments & critique
others' reasoning

Model with mathematics

Use appropriate tools strategically

Attend to precision

Look for & make use of structure

Look for & express regularity in
repeated reasoning

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Activity Overview


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

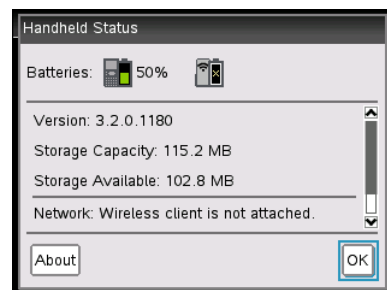
Materials

- TI-Nspire™ Teacher Software and USB connection cable


Viewing handheld status

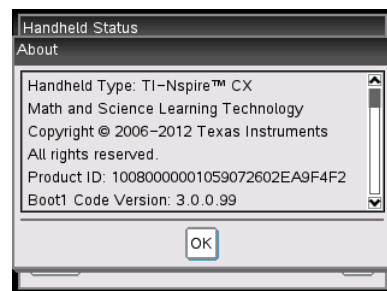
The Handheld Status screen displays the battery status, (OS) version, available space, the network (if any), and your student login name and whether you are logged in

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



Viewing handheld details on the About screen

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 .



Updating the handheld OS

You can update the OS on your TI-Nspire™ handheld using your computer and TI-Nspire™ Teacher Software or by transferring the OS from one handheld to another. OS upgrade operations 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. In this situation, documents may be affected by OS restoration. It is a good practice to back up your important documents and folders before installing an updated operating system.

Important OS download information

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*; and 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.



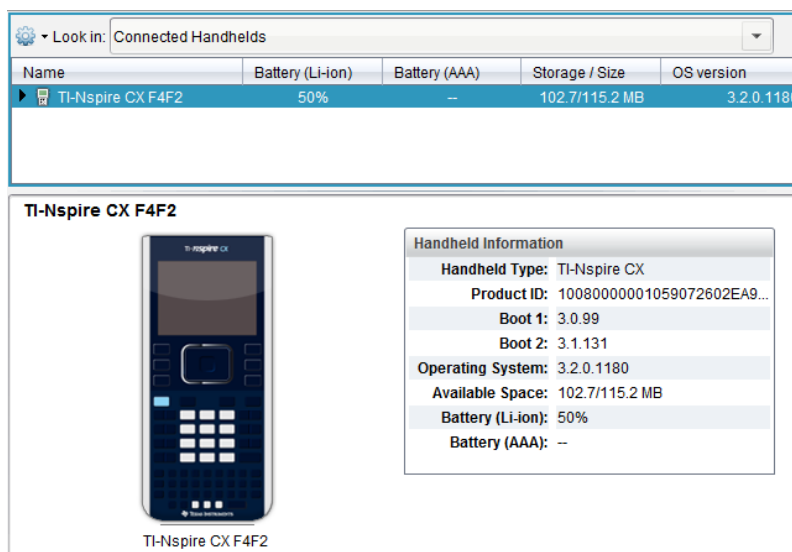
Finding operating system upgrades

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.

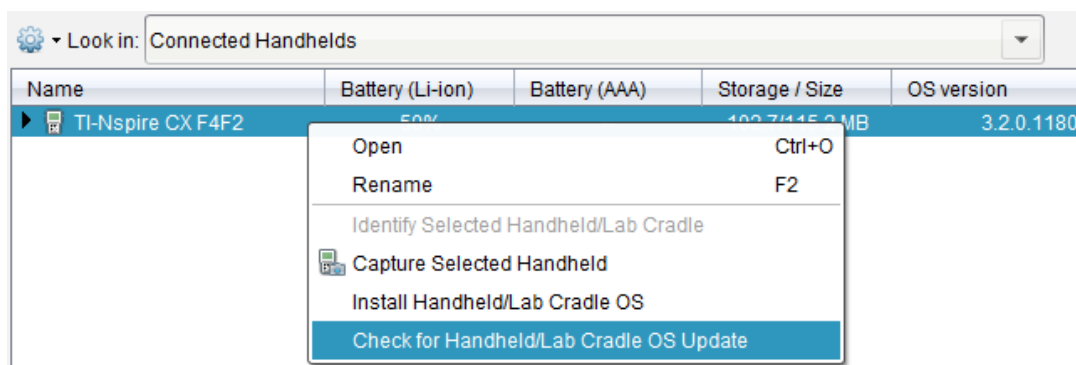
Using TI-Nspire Teacher Software to update the handheld OS

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. Click **Yes**.



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.

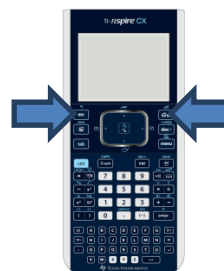
Materials

- 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.

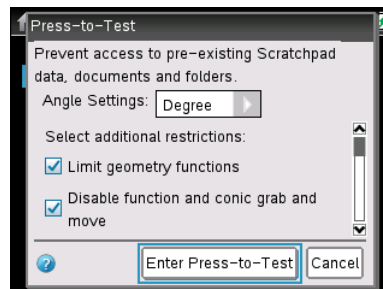
Note: To enable Press-to-Test on TI-Nspire™ with Clickpad, press and hold **esc**, **on**, and **off on**.



Step 2:

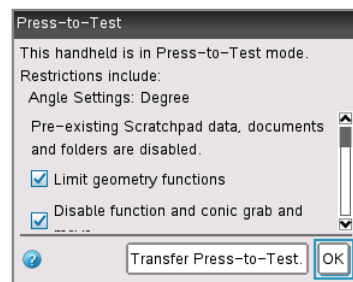
By default, Press-to-Test disables 3D graphing and pre-existing Scratchpad data, documents, and folders. The angle settings can be changed by pressing **►**, selecting the appropriate setting, and pressing **►** or **enter**.

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:

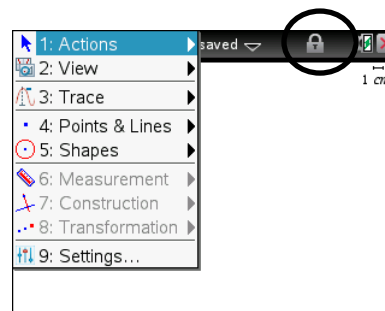
When in Press-to-Test mode, the LED at the top of the handheld begins blinking. Green indicates that all restrictions are selected (default), while yellow indicates that one or more restrictions are unselected. During the initial reboot, the LED alternates between red and, depending on the restrictions,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



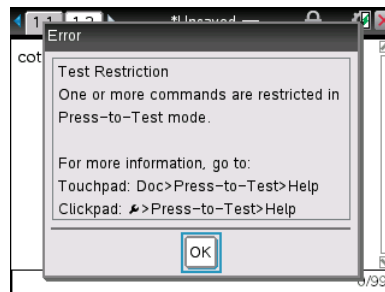
**Step 5:**

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.

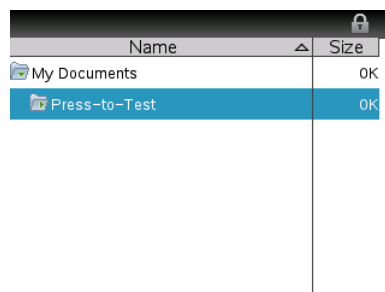
Note: The lock icon at the top of the screen indicates that the handheld is in Press-to-Test mode.

**Step 6:**

Add a Calculator application by selecting **doc** > **Insert** > **Calculator**. Type **cot($\pi/2$)** 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.

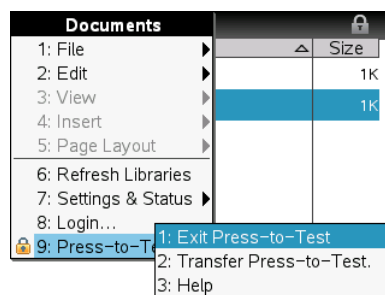
**Step 7:**

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.

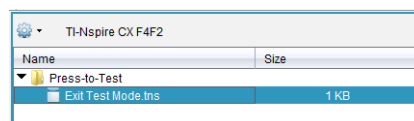
Press-to-Test can also be exited with the TI-Nspire™ Navigator™ Teacher Software. Once a class has been started, students can select **doc** > **Press-to-Test** > **Exit Press-to-Test**.

**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**.





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:

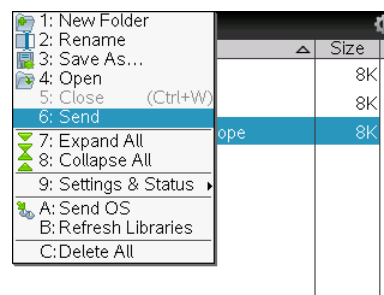
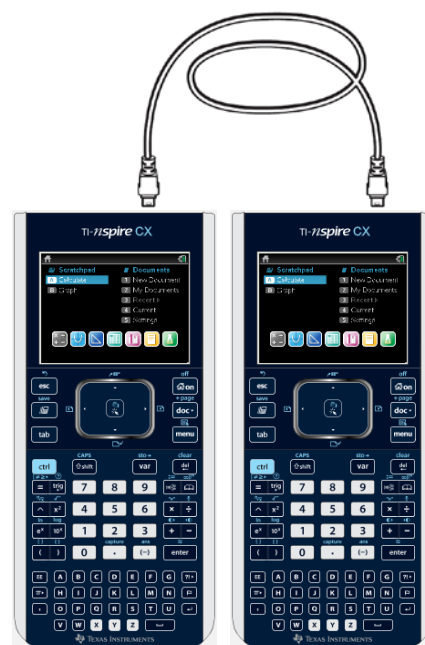
Open **My Documents** on the sending handheld.

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

TEACHER NOTES

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:

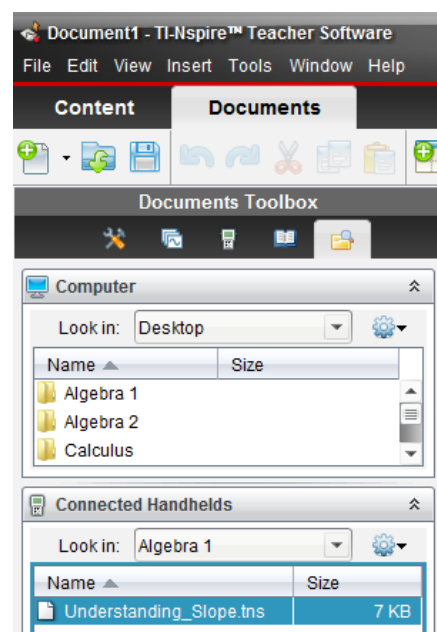
Open the Teacher Software. Go to the Documents Workspace by clicking the **Documents** tab.

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

TEACHER NOTES

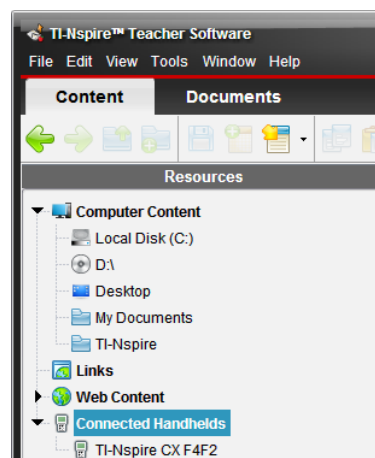
Transferring Documents in the Content Workspace

Step 6:

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

Step 7:

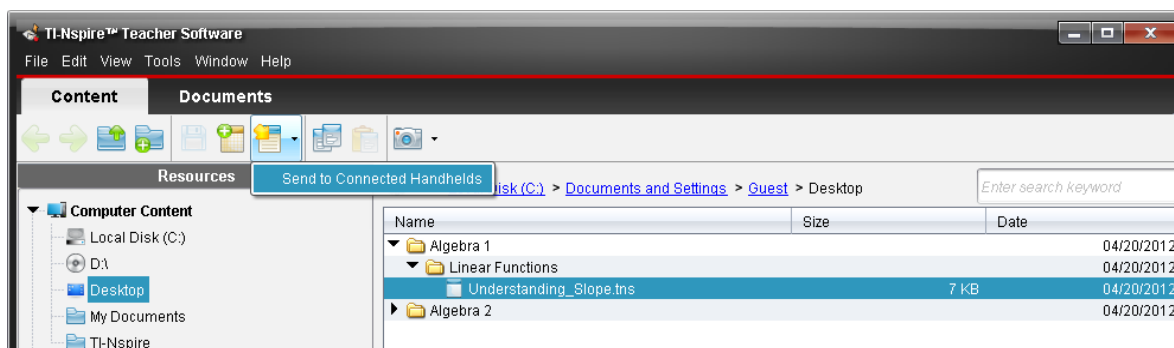
The connected handheld appears in the Content window, along with battery, storage, and OS information. To view the documents on a connected handheld, right-click it and select Open.



Look in: Connected Handhelds				
Name	Battery (Li-ion)	Battery (AAA)	Storage / Size	OS version
TI-Nspire CX F4F2	50%	—	102.8/115.2 MB	3.2.0.1180

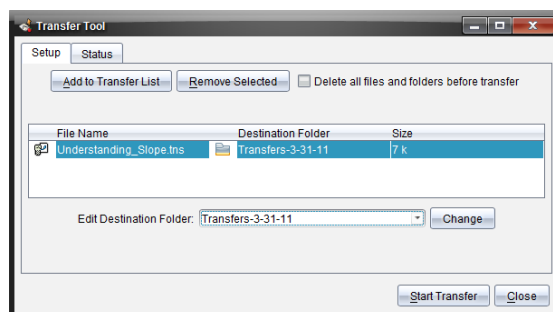
Step 8:

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

TEACHER NOTES

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:

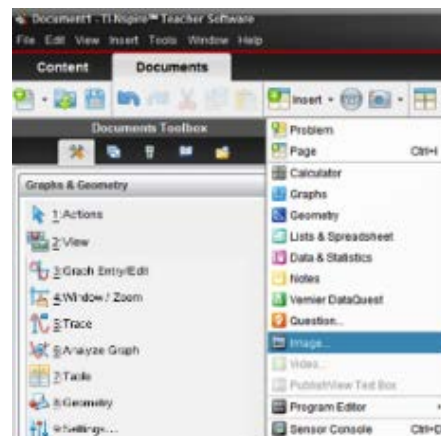
Open the Teacher Software. If the Welcome Screen appears when the software is opened, click to create a new document with a Graphs application as its first page. Otherwise, insert a Graphs application by selecting **Insert > Graphs**.

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

Step 2:

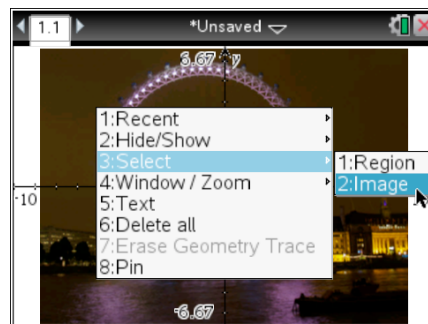
Insert an image into the Graphs application by selecting **Insert > Image**. A selection of images is preloaded in the **My Documents > TI-Nspire > Images** folder. Select **Ferris Wheel.jpg** and click Open.

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** . 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**.













Activity Overview

The following keypad shortcuts can be used to perform common functions on the TI-Nspire™ CX family of handhelds. Many shortcuts can also be performed in the TI-Nspire™ family of Teacher Software, as well as by selecting options from various menus and submenus.





















Getting Help

Open Hints ctrl 


Editing Text

Cut	ctrl 
Copy	ctrl 
Paste	ctrl 
Undo	ctrl  or ctrl 
Redo	ctrl  or  
Toggle approximate and exact results	ctrl 
Change key to include appropriate accent	

Inserting Characters and Symbols in a Document

Display character/symbol palette	ctrl 
Underscore	ctrl 
Display math template palette	
Backslash	 
Manual data capture point	ctrl 
Clear	ctrl 
Caps lock	ctrl 
Store	ctrl 
Square brackets	ctrl 
Curly brackets	ctrl 
Display Trig symbol palette	
Equals symbol	
Display pi symbols palette (π , i , θ , and so on)	
Display equality/inequality palette ($>$, $<$, \neq , \geq , \leq , $ $)	ctrl 
Display marks and letter symbols palette ($?$, $!$, $\$$, $'$, $"$, $:$, $;$, $_$, \backslash)	
Square root	ctrl 
log	ctrl 
ln	ctrl 
ans	ctrl 

Managing Documents

Open document menu	doc ▾
Open document	ctrl O
Close document	ctrl W
Create new document	ctrl N
Insert new page	ctrl I
Select application	ctrl K
Save current document	ctrl S or ctrl 

Navigation

Top of page	ctrl 7
End of page	ctrl 1
Page up	ctrl 9
Page down	ctrl 3
Up a level in the hierarchy	ctrl ▲
Down a level in the hierarchy	ctrl ▼
Context menu for selection	menu
Extends selection in direction of arrow	⇧shift any arrow




Navigating in Documents

Displays previous page	ctrl ◀
Displays next page	ctrl ▶
Displays Page Sorter	ctrl ▲
Exits Page Sorter	ctrl ▼
Switch between applications on a split page	ctrl tab
Moves focus backward within a page	⇧shift tab













Wizards and Templates

Add a column to a matrix after the current column	⇧shift ↵
Add a row to a matrix after the current row	↵
Integration template	⇧shift +
Derivative template	⇧shift -
Math template palette	 a b c or ctrl a b c
Fraction template	ctrl ÷

Modifying the Display

Increase contrast	ctrl 
Decrease contrast	ctrl 
Power off	ctrl  on

Using Application-Specific Shortcuts

Select all in Notes or Program Editor	ctrl 
Check syntax and store (in Program Editor)	ctrl 
Insert Data Collection console	ctrl 
Find (in Program Editor)	ctrl 
Hide/Show Entry Line (in Graphs or Geometry)	ctrl 
Go To (in Lists & Spreadsheet, Program Editor)	
Find and Replace (in Program Editor)	ctrl 
Insert Math Box (in Notes)	ctrl 
Open the Scratchpad	
Recalculate (in Lists & Spreadsheet)	ctrl 
Add Function Table (in Lists & Spreadsheet, Graphs, and Geometry)	ctrl 
Group/ungroup	ctrl  / ctrl 

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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 either **Math Nspired** or **Science Nspired**. These pages can also be accessed directly at mathnspired.com and sciencenspired.com. Select a subject on the left and view the available units.

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:

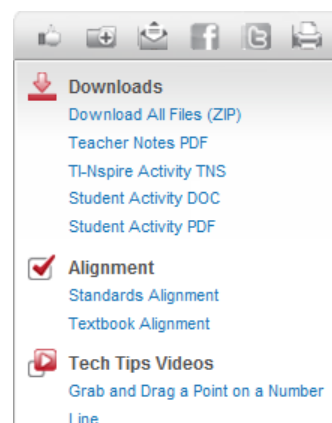
Icon	Type	Description
	Bell Ringer	Bell ringers are short lessons designed to help transition quickly into class after the bell rings.
	Action Consequence Simulation	Interactive, engaging lessons allow students to perform actions on a mathematical object or scientific simulation, observe consequences, 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.



Step 3:

Select an activity from the list. The activity page shows math objectives, relevant vocabulary, and additional information about the lesson. 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**.

Standards Search

Search for lessons that align to these curriculum and assessment standards.

Standards Search

Standards

Grade

Search

Textbook Search

Search for lessons that align to select textbooks from these publishers.

Textbook Search

Textbook

Grade

Search

Step 6:

Go to **Downloads & Activities > TI Math**. This page 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. The activity page contains an overview, a video preview, activity files, and alignments for standards and textbooks.

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.

2.71828

T3 Ticket Outta Here

What went well today?

What caused you difficulty?

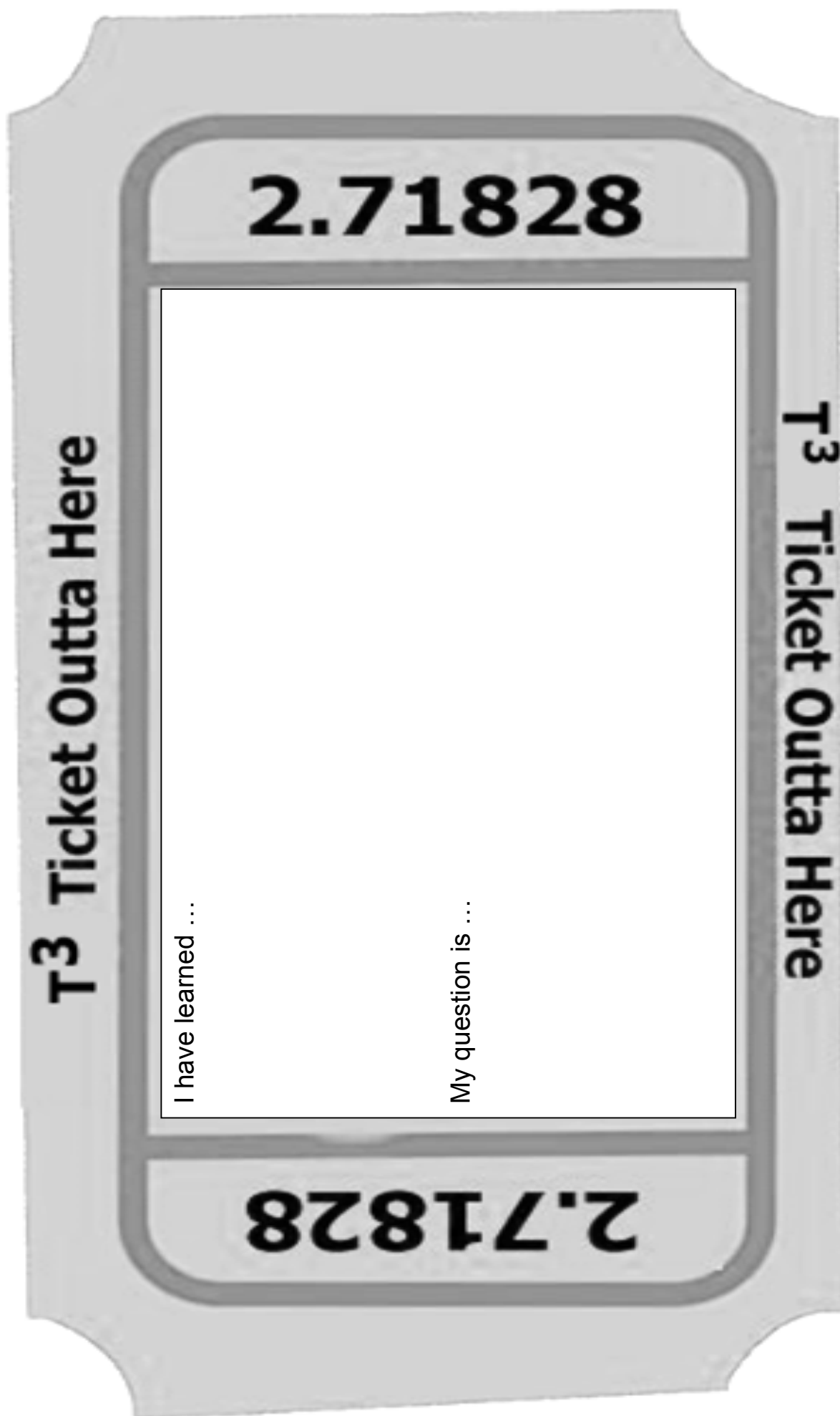
More of ?

Less of ?

2.71828

T3 Ticket Outta Here

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2.71828

T3 Ticket Outta Here

I have learned ...

My question is ...

My next steps are ...

2.71828

T3 Ticket Outta Here

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