Connecting Middle Grades Science and Mathematics with TI-Nspire™ and TI-Nspire™ Navigator™ – Day 2

T³ Professional Development Categories and Learning Objectives

There are three categories of T³ Professional Development, each with a unique set of learning objectives. This workshop is focused on technology integration, and its objectives are as follows:

Technology Integration

➤ Emphasis on learning to use TI technology, with broad "how-to" coverage highlighting a wide range of features

➤ Subject/content-focused training on appropriate usage of TI technology in the classroom

- I am comfortable with essential technology skills for exploring math and science content.
- I can design opportunities for students to use technology as a tool to deepen their understanding of mathematics and science.
- I can locate and download TI activities that align to my standards.
- I can describe the role technology should play in the successful implementation of my standards, and I can implement a vision of a classroom where students routinely use technology to engage in the practice and content standards.

Workshops focused on instructional practices and content knowledge have the following objectives:

Instructional Practices

➤ Emphasis on classroom practices with technology as a tool to enhance student learning

➤ Models CCSS, TEKS, and STEM tasks using in-depth discussions, reflective practices, and essential technology skills

- I can demonstrate the importance of teacher actions for students' engagement in the Practices, and I can take actions that will enable students to become mathematical and scientific practitioners.
- I can describe the role that technology should play in the successful implementation of my standards, and I can implement a vision of a classroom where students routinely use technology to engage in practice and content standards.
- I can design tasks for students to employ the Practices, using technology as a tool to deepen their understanding of mathematics and science.
- I can ask questions designed to make student thinking visible – to push them to think about connections, make comparisons, or probe their understanding.

Content Knowledge

➤ Emphasis on content with technology as support

➤ Addresses critical, tough-to-teach topics and new content standards for CCSS or TEKS

- I have a deeper understanding of the mathematics and science in my content area, and I am aware of the shifts in content that affect what I teach.
- I can design opportunities for students to use technology as a tool to deepen their understanding of mathematics and science.
- I can locate and download TI activities that align to my standards.
- I can describe the role technology should play in the successful implementation of my standards, and I can implement a vision of a classroom where students routinely use technology to engage in the practice and content standards.

I can…
Enter data into the built-in Lists & Spreadsheet application.
Add a page to an existing document.
Set up a plot in the built-in Data & Statistics application.
Plot a function.
Use a moveable line to approximate a pattern.
Locate a TI-Nspire™ activity on education.ti.com.
Download and open a TI-Nspire™ document.
Send a TI-Nspire™ document from a computer to a handheld.
Collect data using Events with Entry Mode in the built-in Vernier DataQuest™ application.
Recognize functional patterns in data.
Use the Documents Workspace in the TI-Nspire™ CX Navigator™ Teacher Software.
Recognize the application of different question types.

Entering and Graphing Data

TI PROFESSIONAL DEVELOPMENT

Activity Overview

This activity describes how to enter data into a Lists & Spreadsheet application and then generate a graph of the data using Quick Graph. Additionally, data are graphed on a separate page using the Data & Statistics application.

Part One – Preparing the Document

Step 1:

Press ⌂ on . Select **New Document** to open a new document.

Step 2:

Select **Add Lists & Spreadsheet**.

Note: To add a Lists & Spreadsheet page to an existing document, press ctrl doc▾ and select **Add Lists & Spreadsheet**. Alternatively, press ⌂ on and select ▦ using the Touchpad.

Part Two – Entering and Graphing One-Variable Data

Step 3:

In column A, press ▲ on the Touchpad to move to the cell at the top of column A.

Step 4:

Type the list name **height** next to the letter A. Press enter .

Step 5:

Press ▼ on the Touchpad and move down to cell A1. Enter the following 15 values for height. Pressing enter or ▼ will move the cursor to the next cell in the column.
{55, 50, 58, 47, 68, 52, 50, 55, 50, 58, 58, 62, 66, 58, 61}
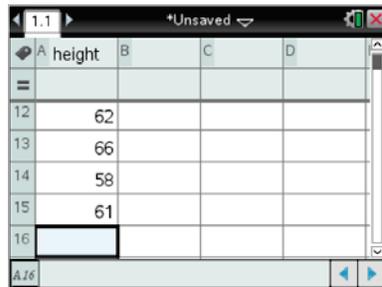
1

Entering and Graphing Data
TI PROFESSIONAL DEVELOPMENT

Step 6:

To graph the data, move the cursor to one of the data cells in column A. Select **Menu > Data > Quick Graph**.
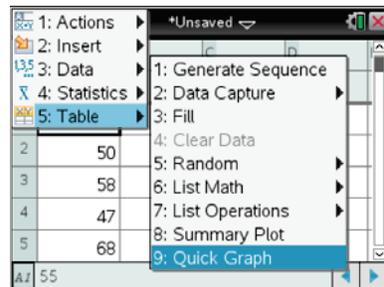
Note: The screen will automatically split vertically—the Lists & Spreadsheet application remains in the left work area while a Data & Statistics application is inserted in the right work area. A dot plot appears.
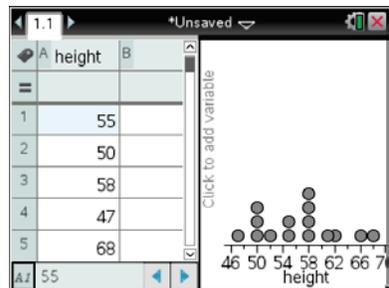
Step 7:

To change the graph to a box plot of the data, select **Menu > Plot Type > Box Plot**.

Using the Touchpad, move the cursor over the box plot to view values for the minimum, first quartile, median, third quartile, and maximum.
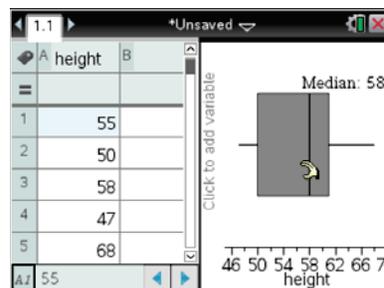
Step 8:

To change the graph to a histogram of the data, select **Menu > Plot Type > Histogram**.
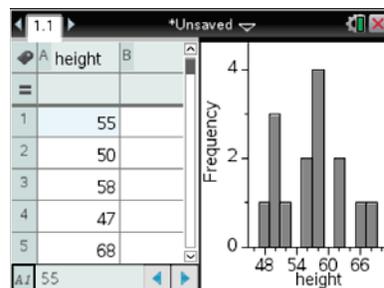
Part Three – Entering Two-Variable Data

Step 9:

Insert another Lists & Spreadsheet page by pressing [ctrl] [doc▾] and choosing **Add Lists & Spreadsheet**. Alternatively, you may press [⌂ on] and select ⊞ using the Touchpad.

Entering and Graphing Data
TI PROFESSIONAL DEVELOPMENT

Step 10:

In column A, move up to the top of the column. Type the list name **height**. Press enter. The list will automatically populate using the height data from page 1.1.

Note: Alternatively, move to the top of the column, press var, select **Link To:,** and select the list **height**.

Step 11:

In column B, move up to the top of the column. Enter the list name **armspan**. Press enter.

Step 12:

Press ▼ on the Touchpad and move down to cell B1. Enter the following values for armspan.

{53, 50, 56, 45, 67, 53, 49, 53, 51, 58, 59, 61, 64, 55, 61}

Part Four – Graphing a Scatter Plot Using Quick Graph

Step 13:

To make a scatter plot of (height, armspan), select both lists.

Place the cursor in a cell in the height column. Press ▲ to move to the top of the list until the entire list is highlighted.

Press and hold ⇧shift, and press ▶ to move to the right and highlight both lists. Release the ⇧shift key.

Step 14:

Select **Menu > Data > Quick Graph**.

The screen will automatically split vertically—the Lists & Spreadsheet application remains in the left work area while a Data & Statistics application is inserted in the right work area. A scatter plot appears.
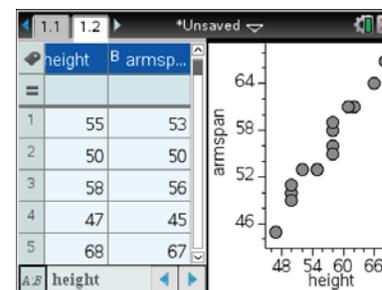
Note: The dark rectangle around the Data & Statistics application work area indicates that the application is active. To move from one work area to another, press ctrl tab or use the Touchpad to move to the desired application, and press 🖱 to select it.

Entering and Graphing Data
TI PROFESSIONAL DEVELOPMENT

Part Five – Graphing Data on a Separate Data & Statistics Page

Step 15:

Press [ctrl] [doc▾], and insert a Data & Statistics page.

Step 16:

Press [tab], and select **height** for the independent variable.

Alternatively, click on the "Click to add variable" message in the lower part of the screen, and select **height**.

Step 17:

Press [tab], and select **armspan** for the dependent variable.

Alternatively, click on the "Click to add variable" message on the left side of the screen, and select **armspan**.
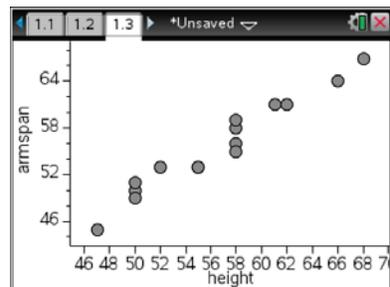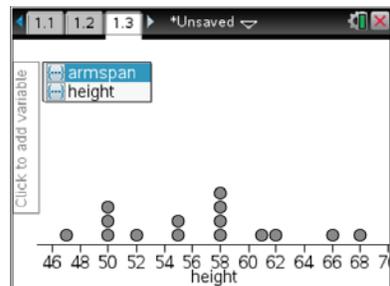
Part Six – Add a Movable Line and Adjust to Fit the Data

Step 18:

Select **Menu > Analyze > Add Movable Line.**
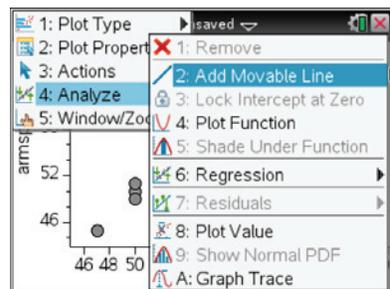
Step 19:

To translate the line, move the cursor to the line near the middle of the screen. When the translation symbol (✛) appears, press [ctrl] [🖰] to grab the line. Use the Touchpad to translate the line. When finished, release the line by pressing [🖰] or [esc].
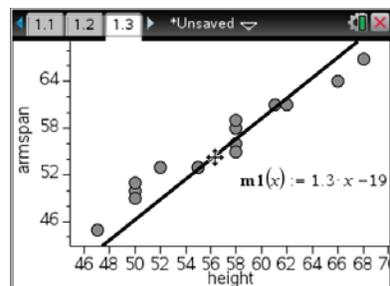
Step 20:

To rotate the line, move the cursor to the line near the edge of the screen. When the rotation symbol (↻) appears, press [ctrl] [🖰] to grab the line. Use the Touchpad to rotate the line. When finished, release the line by pressing [🖰] or [esc].
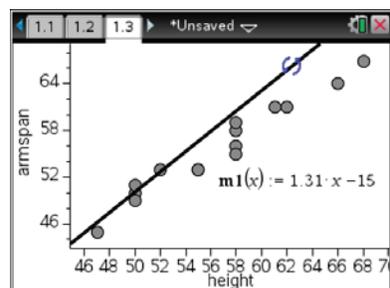
Will It Float or Sink?

Student Activity

Name _____

Class _____

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

Why do some things float and others sink? Have you ever wondered why ice floats in water? Have you wondered why a rock sinks in water, while polystyrene foam floats? What physical properties make some objects float and others sink? In this activity, you'll use a simulation to explore these questions.
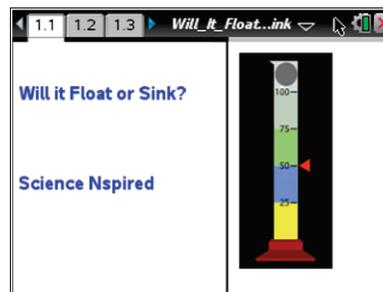
Density is a physical property that indicates whether an object will sink or float. Density is the ratio of an object's mass to its density.

$$Density = \frac{Mass}{Volume}$$

The units for density in this simulation are grams per milliliter, or g/mL. When an object floats on water, then the density of that object is less than that of water.
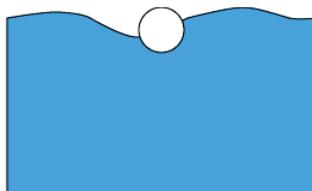
The same idea applies with liquids. If you were to combine oil and water, eventually the layer of oil would collect above the layer of water. This is because oil is less dense than water.

The simulation contains a virtual density column. Four beakers with different liquids (called solutions) of different densities are shown. Your task is to calculate the density of each of the four solutions. Then, based on the results, predict the order in which the layers will settle. Finally, you will predict where a solid object will float when dropped into the column.

Move to pages 1.2 – 1.3.

1. Move the cursor over a beaker, and you will see the mass and volume measures for a solution. Record this data in the table on the next page.
    a. IMPORTANT: If you select the beaker, the liquid will be "poured" into the cylinder, forcing you to reset.
    b. WARNING: When you press the Reset button, the values for mass and volume change to new values.
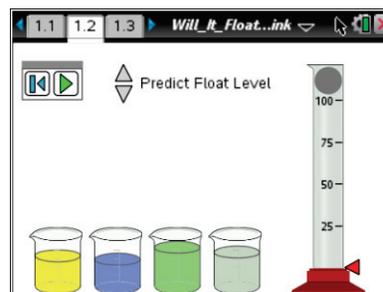
Will It Float or Sink?
Student Activity

Name _____

Class _____

Container 1	Container 2	Container 3	Container 4
Mass: _____ Volume: _____	Mass: _____ Volume: _____	Mass: _____ Volume: _____	Mass: _____ Volume: _____

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

Q1. What is the formula for calculating density? _____

Container 1	Container 2	Container 3	Container 4
Density: _____	Density: _____	Density: _____	Density: _____

3. Once you have calculated the densities, return to page 1.2 and click on the solution containers in the order in which they will settle in a graduated cylinder.

    If you select an incorrect order, you will "win a Goat". Reset 🔘 the page and try again.

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

    Mass: _____   Volume: _____

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

    Density of Solid Ball: _____

6. Use the arrows beside "Predict Level" to move the red arrow next to the graduated cylinder to show where you predict the ball will float in the column.

7. Select the play button ▶ to watch the ball fall through the density column. If you correctly predicted the location of the ball, you will receive a "Gold Star". If you did not predict the correct location of the ball, you will "win a Goat". Press the Reset button 🔘 and try again until you receive the Gold Star.

Will It Float or Sink?

Student Activity

Name _____

Class _____

Move to pages 2.1 – 2.5. Answer questions 2 – 6 below and/or on your handheld.

Q2.   When poured into the graduated cylinder, the densest liquid will _____.
   A. float on top
   B. be the middle layer
   C. be the bottom layer
   D. mix together

Q3.   As the solid becomes denser, it is most likely to _____.
   A. sink
   B. float
   C. rise to the top
   D. hang in the middle

Q4.   Density is _____.
   A. how heavy an object is
   B. the size of an object
   C. volume divided by mass
   D. how closely packed the matter is

Q5.   The density of glycerin is 1.26 g/mL. If the mass of glycerin doubles, increasing from 125 g to 250 g, the volume _____.
   A. doubles
   B. decreases by one-half
   C. is unchanged
   D. decreases by one-fourth

Q6.   The density of glycerin is 1.26 g/mL. If the mass of glycerin doubles, increasing from 125 g to 250 g, the density _____.
   A. doubles
   B. decreases by one-half
   C. is unchanged
   D. decreases by one-fourth

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Will It Float or Sink?

MIDDLE GRADES SCIENCE NSPIRED

Science Objectives

- Students will calculate the density in g/mL given the mass of a liquid and its volume.
- Students will sort layers of liquids of different densities.
- Students will predict where a solid object of a given density will float in a density column.

Vocabulary

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

About the Lesson

- While students may associate flotation with a solid and a liquid (for example, ice floating on water), this lesson allows students to visually see the relationship between density of liquid solutions and the relative position of an object in the solutions based on its density.
- As a result, students will:
  - Understand how solutions will separate based on their densities.
  - Predict where a solid object will float within the given solutions based on its given mass and volume.

Using TI-Nspire™ Navigator™

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

Activity Materials

- Compatible TI Technologies: 🔲 TI-Nspire™ CX Handhelds, 📱 TI-Nspire™ Apps for iPad®, 💻 TI-Nspire™ Software
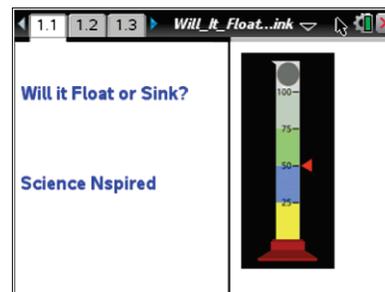
Tech Tips:

- This activity includes class captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/ calculators/pd/US/Online-Learning/Tutorials

Lesson Materials:
Student Activity
- Will_It_Float_or_Sink_ Student.doc
- Will_It_Float_or_Sink_ Student.pdf

TI-Nspire document
- Will_It_Float_or_Sink.tns

Will It Float or Sink?

MIDDLE GRADES SCIENCE NSPIRED

Discussion Points and Possible Answers

Have students read the background information on the student activity sheet. Review the concept of density with students.

$$Density = \frac{Mass}{Volume}$$

While students may normally associate flotation with a solid object floating in a liquid (e.g., ice floating in water), "flotation" also occurs with liquids.
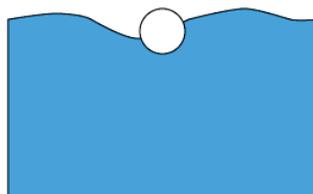
Move to pages 1.2 – 1.3.

1. Students should move the cursor above each beaker to see the mass and volume data. As the cursor hovers over each beaker, students should record the data in the table below.

   a. IMPORTANT: If students select a beaker, the liquid will be "poured" into the cylinder and they will have to reset the page to remove the liquid from the cylinder using ⏮. This also resets the data for all the liquids.
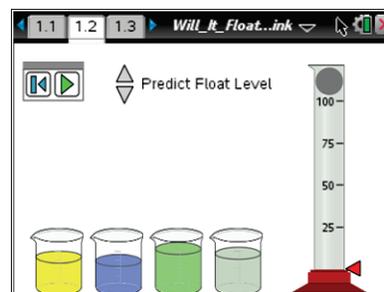
   b. Reinforce that when reset is pressed, the masses and volumes of ALL the liquids in the beakers change. They have to start over again.

Sample Data:

Container 1	Container 2	Container 3	Container 4
Mass: ___45.23 g___ Volume: ___30 mL___	Mass: ___25.28 g___ Volume: ___20. 5 mL___	Mass: ___85.12 g___ Volume: ___25 mL___	Mass: ___62.15 g___ Volume: ___35.5 mL___

2. Students should use the calculator page 1.3 or the Scratchpad to calculate the density of each solution.

   Guide students to use dimensional analysis if they cannot remember the formula for density. The units of g/mL are units of mass divided by volume.

Will It Float or Sink?

MIDDLE GRADES SCIENCE NSPIRED

Q1.   What is the formula for calculating density? _____

Answer: $density = \dfrac{mass}{volume}$

> **Tech Tip:** Students can press ⬛ to use Scratchpad instead of moving between pages 1.2 and 1.3 to perform calculations.
>
> **iPad Tip:** Use page 1.3 to do calculation. The iPad does not have Scratchpad.

Sample Answers:

Container 1	Container 2	Container 3	Container 4
Density: __1.51 g/mL_	Density: __1.23 g/mL_	Density: __3.40 g/mL_	Density: __1.75 g/mL_

3.   Once they have calculated all the densities, they should arrange them in order from greatest to least. Next the student should go back to page 1.2 and click on the solutions in the order they would be poured into the graduated cylinder—most dense first and least dense last.

   If the student is not successful, he/she will "win a Goat" and have to reset the page to start over.

4.   The student will then hover over the solid ball to reveal the mass and volume.

   Sample Data:

   Mass: _____18.11 g_____   Volume: _____5.00 mL_____

5.   Students can then return to page 1.3 or use Scratchpad to calculate the solid ball's density.

   Sample Calculation:

   Density of Solid Ball: _____3.63 g/mL_____

6.   Students then predict on page 1.2 where the solid will settle in the column. Be sure students understand which buttons are "predict" and which are "reset/play."

Will It Float or Sink?

MIDDLE GRADES SCIENCE NSPIRED

7. Students select the play button ▶ to test their predictions. If the prediction is incorrect, the student will have to reset the simulation and try again until they get a Gold Star.

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

TI-Nspire Navigator Opportunities

Use Class Capture to monitor for "Goats" and "Gold Stars" as students progress through the simulation.

Move to pages 2.1 – 2.5.

Have students answer questions 2 – 6 on the handheld, the activity sheet, or both.

Q2.   When poured into a graduated cylinder, the densest liquid will _____.

   Answer: C. be the bottom layer

Q3.   As the solid becomes denser, it is more likely to _____.

   Answer: A. sink

Q4.   Density is _____.

   Answer: D. how closely packed the matter is

Q5.   The density of glycerin is 1.26 g/mL. If the mass of glycerin doubles, increasing from 125 g to 250 g, the **volume** of the glycerin _____.

   Answer: A. doubles

Q6.   The density of glycerin is 1.26 g/mL. If the mass of glycerin doubles, increasing from 125 g to 250 g, the **density** of the glycerin _____.

   Answer: C. is unchanged

Will It Float or Sink?

MIDDLE GRADES SCIENCE NSPIRED

TI-Nspire Navigator Opportunities

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

Wrap Up

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

Assessment

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

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 education.ti.com

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Kidney Stones, Gravity and the ISS
Student Activity ⬛💻👆

Name _____

Class _____

Open the TI-Nspire™ document
Kidney_Stones_Gravity_and_the_ISS.tns.

NASA's operating budget has been reduced, and to save money NASA has outsourced their Astronaut Health Maintenance (AheM) to your company, HumaDyne. NASA requires a health assessment report for their astronauts on each body system before they can start their next mission.

Your department in HumaDyne deals exclusively with the excretory system; specifically you are to assess each astronaut's risk of developing kidney stones. However, your company is also reducing their budget so you only have a conductivity probe. Using this probe, you will determine the conductivity of each astronaut's sample, assess their risk from the data, and submit a report from your department.

Move to pages 1.3 – 1.5.

Background Information: Exposure to microgravity, such as on the International Space Station and other spacecraft, can cause negative physiological changes in humans both during and after a mission. For example, during a flight, the amounts of dissolved calcium, phosphates, and sodium in urine increases while the volume of urine itself decreases. These conditions lead to a higher risk of developing several kinds of kidney stones. The chemical composition of urine changes after the mission as well. These changes also result in a higher risk of developing kidney stones in addition to uric acid.

Q1. Explain how prolonged exposure to microgravity can impact a person's health.

Q2. Which of the following statements is an accurate reason as to why astronauts are at a high risk of developing kidney stones? Select all that apply.

   a. Astronauts typically have a lower volume of urine than a person on Earth.
   b. Lower levels of sodium are found in the astronaut's urine.
   c. Higher levels of calcium are found in the astronaut's urine.

Kidney Stones, Gravity and the ISS
Student Activity

Name _____

Class _____

Move to pages 1.6 – 1.7.

On page 1.7 you will see a Vernier DataQuest™ page. The page has been set up for you to collect data using Events with Entry mode and will average your data over a 10 second period. Make sure your conductivity probe is set to the 0-20,000 us/cm setting. Your teacher has already prepared 4 astronaut samples for you to measure, each labeled 1, 2, 3 and 4. Using Events with Entry mode, find the conductivity of each of the astronaut's urine sample. Record the data in the following chart:

	Astronaut 1	Astronaut 2	Astronaut 3	Astronaut 4
Conductivity (µs/cm)				

Move to pages 1.8 – 2.1.

We know the conductivity of the astronauts, however we still do not know how much calcium is in their urine. We are going to attempt to recreate the calcium mixture and measure the conductivity. Your teacher has already created a "stock solution" of pure calcium. 1mL of the stock solution represents 10mg of calcium. Start off by measuring 100mL of distilled water and place it into a clean beaker. Pour 100mL of distilled water into the clean beaker.

Move to page 2.2.

Plug in your conductivity probe, making sure the lever is still set to the 0-20,000 us/cm setting. Place your conductivity probe into the distilled water. Your TI-Nspire™ CX handheld should already be set up to collect data using Events with Entry, however if it is not change this setting now. Press Play to begin data collection.

Measure 1 mL of the stock solution using a pipet or some sort of dropper. Place 1 mL of the yellow stock solution into the beaker filled with 100 mL of distilled water. Slowly stir and take a snapshot of the data. A box will pop up asking you to enter a value. Type in 10, representing the 10 mg of calcium found in the 1 mL of stock solution. Continue adding in 1 mL of stock solution at a time, using events with entry. Repeat until you have reached 30 mL or 300 mg of calcium.

Record your data on the following page.

     education.ti.com

Kidney Stones, Gravity and the ISS
Student Activity

Name _____

Class _____

mL of Calcium Standard added	Total amount of calcium (mg)	Conductivity (µs/cm)	mL of Calcium Standard added	Total amount of calcium (mg)	Conductivity (µs/cm)
1	10		16	160	
2	20		17	170	
3	30		18	180	
4	40		19	190	
5	50		20	200	
6	60		21	210	
7	70		22	220	
8	80		23	230	
9	90		24	240	
10	100		25	250	
11	110		26	260	
12	120		27	270	
13	130		28	280	
14	140		29	290	
15	150		30	300	

3

Kidney Stones, Gravity and the ISS
Student Activity

Name _____

Class _____

Move to page 2.3.

This table indicates the approximant risk of an astronaut developing kidney stones based on a 100 mL urine sample. An astronaut found to have less than 100 mg of calcium in his/her urine is less likely to develop kidney stones. Using this information, and the information we know about our astronauts, we will be able to determine the diagnosis. Match the conductivity of the astronauts to the conductivity on page 2.2 to determine the amount of calcium and the risk for each astronaut.

The table below indicates the risk of kidney problems in correlation to the amount of calcium concentration per 100 mL.

Amount of Calcium	Risk of Developing Kidney Stones
<100 mg	Low
100-250 mg	Average
>250 mg	Increased

Use your information from page 2.2 to determine the astronauts calcium concentration based on your conductivity measurements.

Astronaut	Conductivity (µs/cm) *(from top of page 2 of student worksheet)*	Amount of Calcium (mg) *(Found using data on page 3, matching calcium to conductivity)*	Risk
1			
2			
3			
4			

Kidney Stones, Gravity and the ISS

Student Activity

Name _____

Class _____

Move to pages 2.4 -3.5.

Q3a. Astronaut #1 had a _____ risk.

    a. Low
    b. Average
    c. Increased

Q3b. Astronaut #1 had this many mg of calcium in his/her urine.

Q4a. Astronaut #2 had a _____ risk.

    a. Low
    b. Average
    c. Increased

Q4b. Astronaut #2 had this many mg of calcium in his/her urine.

Q5a. Astronaut #3 had a _____ risk.

    a. Low
    b. Average
    c. Increased

Q5b. Astronaut #3 had this many mg of calcium in his/her urine.

Q6a. Astronaut #4 had a _____ risk.

    a. Low
    b. Average
    c. Increased

Kidney Stones, Gravity and the ISS

Student Activity

Name _____

Class _____

Q6b. Astronaut #4 had this many mg of calcium in his/her urine.

Q7. What is gravity?

Q8. How do bones and calcium levels change for someone in prolonged microgravity environments?

Q9. How could the effects of microgravity be reduced or countered onboard the ISS?

Q10. If 89% of Earth's gravity reaches the space station, how is it possible for the ISS to remain in orbit? Draw a diagram to explain your thinking.

Q11. If 89% of Earth's gravity reaches the ISS, why do the astronauts still experience weightlessness?

Kidney Stones, Gravity and the ISS

TI PROFESSIONAL DEVELOPMENT

Science Objectives

- Students will assess the risk of kidney stone development in four astronauts from the ISS through an analysis of their urinary calcium concentration.
- Students will relate concepts of gravity to the impact it has on astronauts onboard the ISS (International Space Station).

Vocabulary

- kidney stone
- gravity
- inertia
- weightlessness
- microgravity
- concentration

About the Lesson

- This lesson involves using a conductivity probe and the Vernier DataQuest™ app to create a conductivity vs. concentration curve to determine the amount of calcium in an astronaut's urine.
- As a result, students will:
    - Use Events with Entry to create a concentration vs. conductivity curve.
    - Diagnose an astronaut's risk of developing kidney stones when exposed to prolonged period of microgravity.
    - Gain a better understanding of the effect of gravity on both the human body and objects in NEO (Near Earth Orbit).

TI-Nspire™ Navigator™

- Use the TI-Nspire™ Navigator™ System to…
    - Send and receive TI-Nspire™ documents.
    - Get immediate, impactful feedback on the progress of your lesson through formative assessment.
    - Display student work and data using Class Capture.

Activity Materials

Compatible TI Technologies : TI-Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software

Tech Tips:

- This activity includes screen captures from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire Apps. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:
Student Activity
- Kideny_Stones_Gravity_and_the_ISS_Student.pdf
- Kideny_Stones_Gravity_and_the_ISS_Student.doc

TI-Nspire document
- Kideny_Stones_Gravity_and_the_ISS_Student.tns

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Kidney Stones, Gravity and the ISS

TI PROFESSIONAL DEVELOPMENT

TEACHER NOTES

Pre-Lab Set Up

The teacher will create a "stock" 1 molar salt water solution. (Salt water will be used to simulate the calcium concentration in the urine- this does NOT have to be disclosed to students). To do this the teacher will pre-make a 1 molar NaCl solution by dissolving 58.44g of NaCl (table salt) with 1000 mL of distilled water to *simulate* the calcium. Then, place a few drops of yellow food coloring to add to the appearance. This will be known as the teacher's "stock solution." Place this solution to the side, as this will be used to create all of the sample astronaut's urine.

The teacher will pre-make 4 sample astronaut urine samples for each group. To do this:

1. Start with 100 mL of distilled water in a beaker.
2. Using the below chart, create an astronaut with a low risk, average risk and increased risk. To create an astronaut with a low risk, place 0-9 mL of the stock solution into the 100mL sample beaker.
3. Create a total of 4 astronauts, each with a different amount of calcium. Label the cups so the students know which astronaut is which.
4. Crete an answer key, indicating how many drops of the "stock solution" you used to create each astronauts urine sample.

mL of teacher stock	Calcium amounts	Possible formation of kidney stones	*Please note that 5mL of stock solution equals 50mg of calcium. You will have to multiply the concentration of teacher stock solution by 10 to get the calcium amount.*
0-9	<100 mg calcium	Low Risk	
10-25	100-250 mg calcium	Average Risk	
25+	250+ mg of calcium	Increased Risk	

Each group will need the following materials in addition to the TI-Nspire™ document and student worksheet:
*   4 astronaut urine samples, premade by the teacher and labeled 1-4
*   access to 30 mL of the stock solution
*   a graduated cylinder, beaker and pipet/dropper
*   100 mL of distilled water
*   Conductivity probe with EZ Link

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Kidney Stones, Gravity and the ISS

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Discussion Points and Possible Answers

> **Tech Tip:** Have the students plug in the conductivity probe when they get on page 1.7. This will cause the handheld to not make a new page, and all of the pre-determined settings will remain in place.

Move to pages 1.4 – 1.5.

After reading the introductory materials on pages 1.1 – 1.3, students will answer the following two questions:

Q1. Explain how prolonged exposure to microgravity can impact a person's health.

Sample Answer: As an astronaut remains in space, they lose muscle mass and bone density.

Q2. Which of the following statements is an accurate reason as to why astronauts are at a high risk of developing kidney stones? Select all that apply.

   a. Astronauts typically have a lower volume of urine than a person on Earth.
   b. Lower levels of sodium are found in the astronaut's urine.
   c. Higher levels of calcium are found in the astronaut's urine.

Answer: a and c
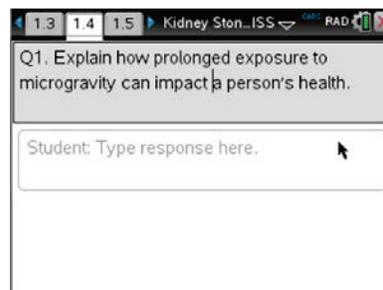
Move to page 1.7.

Students are to plug in the conductivity probe when they get to this page. Make sure the conductivity probe is set to the 0-20,000 us/cm setting, which can be adjusted by manipulating the silver lever on the side of the probe. Students should have their page set up to record data using events with entry, along with having the handheld defaulted to averaging the data over 10 seconds. The *x*-axis is labeled *astro.* for astronaut. The students will press the play button to begin data collection. They will place the conductivity probe into sample 1 and take a snapshot. The handheld will then average the data over a 10 second period. Students should then call this sample 1. They will repeat the process for all 4 astronauts. Once completed the students will hit the stop button. Students will record their data on their student worksheet on the top of page 2.

Kidney Stones, Gravity and the ISS

TI PROFESSIONAL DEVELOPMENT

TEACHER NOTES

TI-Nspire Navigator Opportunity: *Class Capture*
See Note 1 at the end of this lesson.

Move to page 2.2.

Students are to follow the same procedure as they did earlier making sure their device is set up on the same setting, events with entry is set to go, and the data will be average over 10 seconds.

This time, however, the students will be using 30 mL of the stock solution you provided them, along with 100 mL of distilled water in an attempt to recreate the astronaut urine samples.

Students are to place the conductivity probe into the 100 mL of distilled water. Next, they will slowly drop in 1 mL of the stock solution using a pipet/dropper. Students will then stir their mixture and press the snapshot icon to record their data. It will ask them to enter a value, which the students will call 10. 10 represents the 10 mg of calcium located in the 1 mL of teacher stock solution. Students will continue using events with entry as they add in 1 mL of the stock solution at a time, until they reach 30 mL of stock solution, also known as 300 mg of calcium.

mL of teacher stock added to 100mL distilled water	Total amount of calcium concentration in mg	Expected conductivity (us/cm)*	mL of teacher stock added to 100mL distilled water	Total amount of calcium concentration in mg	Expected conductivity (us/cm)*
1	10	1200	16	160	19000
2	20	2300	17	170	20000
3	30	3400	18	180	21000
4	40	4500	19	190	22000
5	50	5400	20	200	22500
6	60	6300	21	210	23000
7	70	7500	22	220	24500
8	80	8300	23	230	25000
9	90	9100	24	240	25500
10	100	10900	25	250	26000
11	110	11600	26	260	26400
12	120	12500	27	270	26900
13	130	14500	28	280	27300
14	140	16000	29	290	27900
15	150	17000	30	300	28400

Kidney Stones, Gravity and the ISS

TI PROFESSIONAL DEVELOPMENT

The expected conductivity is an estimate. These numbers will vary depending on the accuracy of the conductivity probe and the accuracy of the teacher stock solution. Even if yours are not exact, it will not change the results that your students will get. All of the numbers will be relative!

**The above chart does NOT get disclosed to the students, this is for the teacher's eyes only! Students will record their data on the student worksheet, page 3.

Move to page 2.3

The table to the right is visible on page 2.3. Students will use this table to determine the level of risk each astronaut has of developing kidney stones. For example, if an astronaut is found to have 90 mg of calcium in their urine (9 drops of the stock solution), we would say they are at a low risk of developing kidney stones.

Remember, this is determined by matching the conductivity of the known astronaut samples to the conductivity vs. concentration curve created by the students on page 2.2 of the TI-Nspire™ document. Using this information, the students will fill the data table out on the bottom of page 4 of their student worksheet.

Move to pages 2.4 – 3.5.

Q3a. Astronaut #1 had a _____ risk.

> **Sample Answer:** Answers will vary based on the teacher created mixture. If the teacher used less than 10 drops in the urine sample, it will be a low risk, if the teacher used 11-24 drops of stock solution in the astronaut sample it will be an average risk, and lastly if the teacher used 25-30 mL of stock solution in the astronaut sample it will be an increased risk.

Q3b. Astronaut #1 had this many mg of calcium in his/her urine.

> **Sample Answer:** Answers will vary based on the stock solution described in question a above.

Kidney Stones, Gravity and the ISS   **TEACHER NOTES**

TI PROFESSIONAL DEVELOPMENT

Q4a. Astronaut #2 had a _____ risk.

Sample Answer: Answers will vary based on the teacher created mixture. If the teacher used less than 10 drops in the urine sample, it will be a low risk, if the teacher used 11-24 drops of stock solution in the astronaut sample it will be an average risk, and lastly if the teacher used 25-30 mL of stock solution in the astronaut sample it will be an increased risk.

Q4b. Astronaut #2 had this many mg of calcium in his/her urine.

Sample Answer: Answers will vary based on the stock solution described in question a above.

Q5a. Astronaut #3 had a _____ risk.

Sample Answer: Answers will vary based on the teacher created mixture. If the teacher used less than 10 drops in the urine sample, it will be a low risk, if the teacher used 11-24 drops of stock solution in the astronaut sample it will be an average risk, and lastly if the teacher used 25-30 mL of stock solution in the astronaut sample it will be an increased risk.

Q5b. Astronaut #3 had this many mg of calcium in his/her urine.

Sample Answer: Answers will vary based on the stock solution described in question a above.

Q6a. Astronaut #4 had a _____ risk.

Sample Answer: Answers will vary based on the teacher created mixture. If the teacher used less than 10 drops in the urine sample, it will be a low risk, if the teacher used 11-24 drops of stock solution in the astronaut sample it will be an average risk, and lastly if the teacher used 25-30 mL of stock solution in the astronaut sample it will be an increased risk.

Q6b. Astronaut #4 had this many mg of calcium in his/her urine.

Sample Answer: Answers will vary based on the stock solution described in question a above.

Q7. What is gravity?

Sample Answer: The force of attraction between all masses in the universe.

Q8. How do bones and calcium levels change for someone in prolonged microgravity environments?

Sample Answer: Bone plays an important role as a structure that supports the body and stores calcium. It retains fracture resistance by remodeling through a balance of bone resorption and formation. In a microgravity environment, because of reduced loading stimuli, there is increased bone resorption and no change in or possibly decreased bone formation, leading to bone mass loss at a rate of about ten times that of osteoporosis. The proximal femoral bone loses 1.5 percent of its mass per month, or roughly 10 percent over a six-month stay in space, with the recovery after returning to Earth taking at least three or four years. The calcium balance (the difference between intake and excretion), which is about zero on Earth, decreases to about -250 mg/day during flight, a value that increases the risk of kidney stones.

* Bone resorption is the process by which osteoclasts break down bone and release the minerals, resulting in a transfer of calcium from bone fluid to the blood.

Q9. How could the effects of microgravity be reduced or countered onboard the ISS?

Sample Answer: Crew members engage in physical exercise for two and a half hours a day, six times a week (fifteen hours a week) while in orbit to avoid these issues. Nevertheless, the risks of these problems occurring cannot be completely eliminated through physical exercise alone.

Q10. If 89% of Earth's gravity reaches the space station, how is it possible for the ISS to remain in orbit? Draw a diagram to explain your thinking.

Sample Answer: Earth's gravity pulls objects downward toward the surface. Gravity pulls on the space station, too. As a result, it is constantly falling toward Earth's surface. It also is moving at a very fast speed - 17,500 miles per hour. It moves at a speed that matches the way Earth's surface curves. If a person throws a baseball, gravity will cause it to curve down. It will hit the ground fairly quickly. An orbiting spacecraft moves at the right speed so the curve of its fall matches the curve of Earth. Because of this, the spacecraft keeps falling toward the ground but never hits it. As a result, they fall around the planet. The moon stays in orbit around Earth for this same reason. The moon also is falling around Earth.

Kidney Stones, Gravity and the ISS

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TEACHER NOTES

Q11. If 89% of Earth's gravity reaches the ISS, why do the astronauts still experience weightlessness?

> **Sample Answer:** The answer is because they are in free fall. In a vacuum, gravity causes all objects to fall at the same rate. The mass of the object does not matter. If a person drops a hammer and a feather, air will make the feather fall more slowly. But if there were no air, they would fall at the same acceleration. Some amusement parks have free-fall rides, in which a cabin is dropped along a tall tower. If a person let go of an object at the beginning of the fall, the person and the object would fall at the same acceleration. Because of that, the object would appear to float in front of the person. That is what happens in a spacecraft. The spacecraft, its crew and any objects aboard are all falling toward but around Earth. Since they are all falling together, the crew and objects appear to float when compared with the spacecraft.

Wrap Up

* Review the student responses using the Review Workspace in the TI-Nspire™ CX Navigator™ Teacher Software

Assessment

Options for assessment include grading the embedded questions in the tns file and saving them to the portfolio. Students may also develop a health assessment plan discussing other factors that may affect different body systems. An extension may be discovering what other body systems will be affected when there is an issue with your excretory system.

TI-Nspire Navigator

Note 1: Make sure all of your students are following along and collecting their data properly using events with entry. Having all of your handheld screens displayed on your computer and/or projector will allow you to move freely around the room assisting students, while making sure everyone is in the right place.

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![TI logo] **Getting Started with the TI-Nspire™ CX Navigator™ Teacher Software**
TI PROFESSIONAL DEVELOPMENT

Activity Overview

In this activity, you will explore the basic features of the Documents Workspace in the TI-Nspire™ Navigator™ Teacher Software. You will add pages with Calculator and Graphs applications, and explore menus and submenus of each application as well as the five tabs within the Documents Toolbox.

Materials

- TI-Nspire™ CX or TI-Nspire™ CX CAS Navigator™ Teacher Software (v4.x) if using TI-Nspire™ CX handhelds
- TI-Nspire™ or TI-Nspire™ CAS Navigator Teacher Software (v3.9) if using TI-Nspire™ CX, TI-Nspire™ with Touchpad, or TI-Nspire™ with Clickpad

Step 1:

Open the TI-Nspire™ CX Navigator™ Teacher Software and click on the **Documents** tab. A new document may be opened by going to **File** and selecting **New TI-Nspire™ Document – Handheld Page Size** or **New TI-Nspire™ Document – Computer Page Size.**

- The **Handheld Page Size** allows documents to be viewed on all platforms. The content will be scaled when viewed on a tablet or larger screen.
- In **Computer Page Size**, content will not be scaled when viewed on smaller platforms and all content may not be visible on a handheld device.

Step 2:

Go to **File > New TI-Nspire™ Document – Handheld Page Size.** Select ![calculator icon] **1:Add Calculator**.

Step 3:

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 ![tools icon] **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 menu .
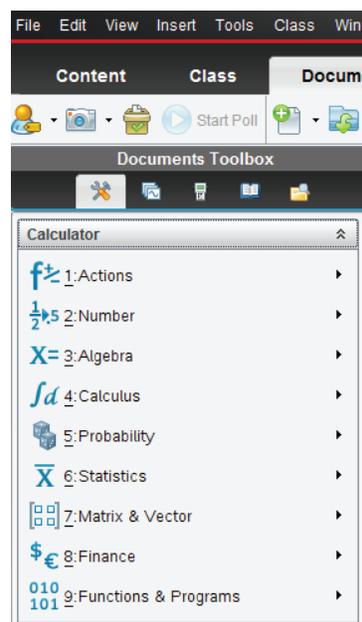
Getting Started with the TI-Nspire™ CX Navigator™ Teacher Software
TI Professional Development

Step 4:

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**.
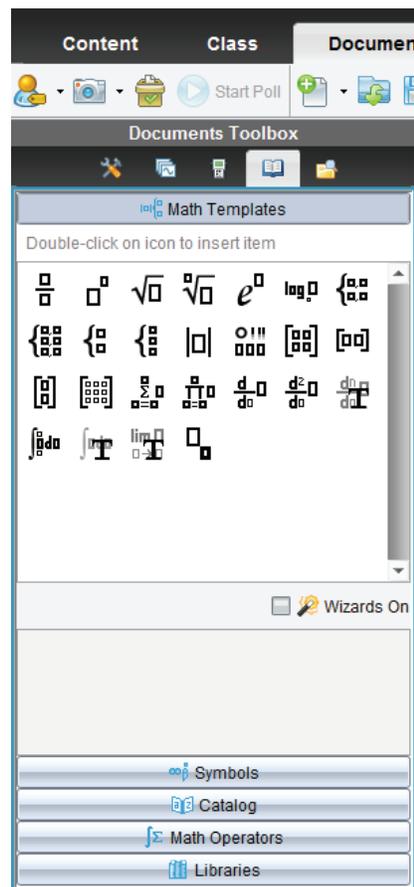
Step 5:

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.
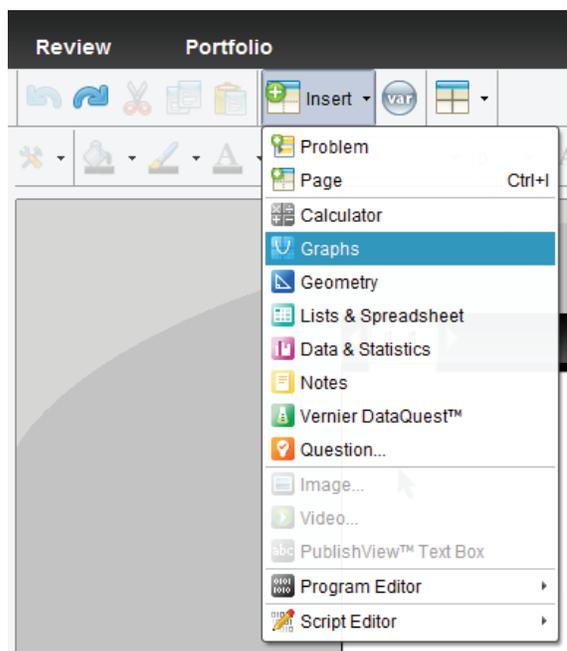
![TI logo] **Getting Started with the TI-Nspire™ CX Navigator™ Teacher Software**
TI PROFESSIONAL DEVELOPMENT

Step 6:

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 or lower-left 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 y-intercept of the graph. When the translational cursor, ✛, appears, translate the line up or down by clicking and dragging it.
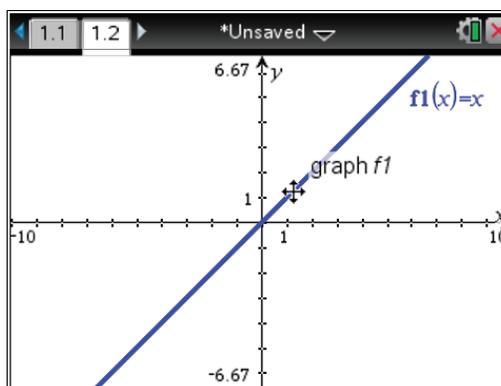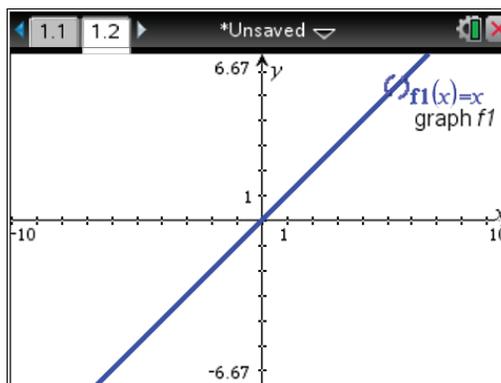
Step 7:

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⎦.

Getting Started with the TI-Nspire™ CX Navigator™ Teacher Software
TI PROFESSIONAL DEVELOPMENT

Step 8:

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.
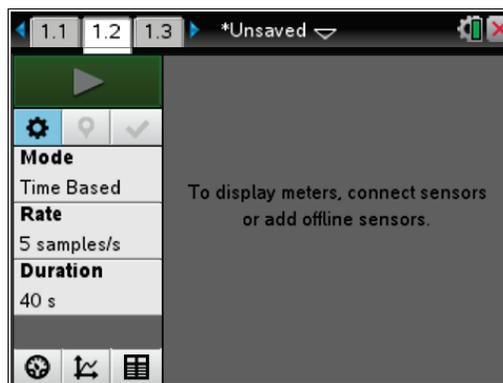
Step 9:

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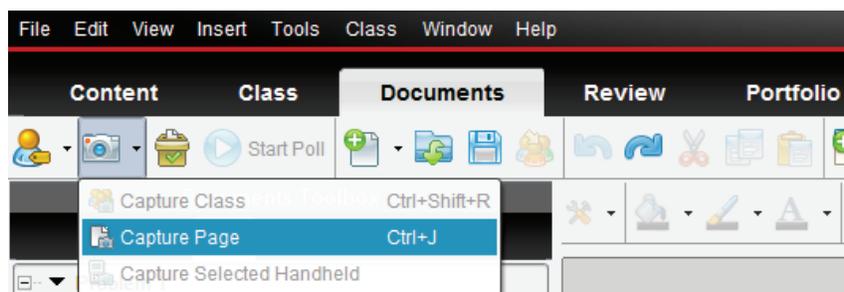
Page layouts allow multiple applications to appear on one screen. Explore the various page layouts that are available by clicking **Page Layout**.

The **Document Tools** contains tools and commands for the current application. These are the same menu options as those in the **Document Tools** tab in the Documents Toolbox.
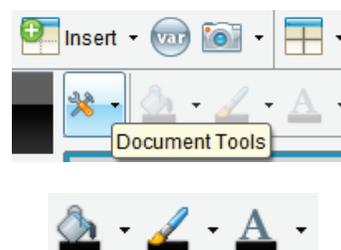
To change the fill color, line color, or text color, select an object and then select a color from the appropriate menu. To receive additional information about a given menu, hover the cursor over it. Not all color menus are available in all applications.

Getting Started with the TI-Nspire™ CX Navigator™ Teacher Software

TI PROFESSIONAL DEVELOPMENT

Step 10:

The Status Bar allows the user to access Document Properties, Settings, and to adjust the zoom of the SideScreen.

The Zoom to Fit feature automatically scales the document page to fit the available window size. Alternately, the zoom can be manually increased or decreased using the Zoom menu. The Boldness feature is enabled when using a PublishView™ document.

Note: The Zoom to Fit feature is only available in the TI-Nspire™ CX or TI-Nspire™ CX CAS Navigator Teacher Software (v4.x)

Step 11:

View the Document Properties by going to **File > Document Properties**. The Document Properties also can be viewed by going to the Status Bar and double-clicking **Page Size: Handheld** or **Page Size: Computer**. The page size displayed depends upon the type of TI-Nspire document originally opened.

Step 12:

View the Document Settings by going to **File > Settings > Document Settings**. The Document Settings also can be viewed by double-clicking **Settings** in the Status Bar**.**
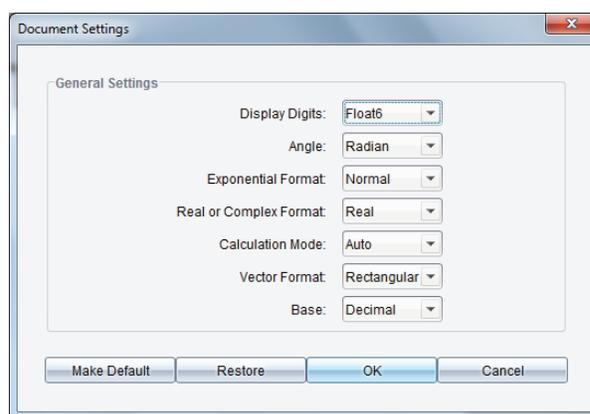
Note: To move across fields in the Document Settings window, press TAB. To change the setting in a given field, press the down arrow, select the desired setting, and press TAB to move to the next field. To exit the window, press ENTER.

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Getting Started with the TI-Nspire™ CX Navigator™ Teacher Software
TI PROFESSIONAL DEVELOPMENT

Step 13:

Preview the document in Handheld or Computer view by clicking ▊ Document Preview ▾ .

Step 14:

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

Note: If using the TI-Nspire™ or TI-Nspire™ CAS Navigator Teacher Software (v3.9), there are emulator keypads for TI-Nspire™ CX, TI-Nspire™ with Touchpad, and TI-Nspire™ with Clickpad.

Step 15:

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.
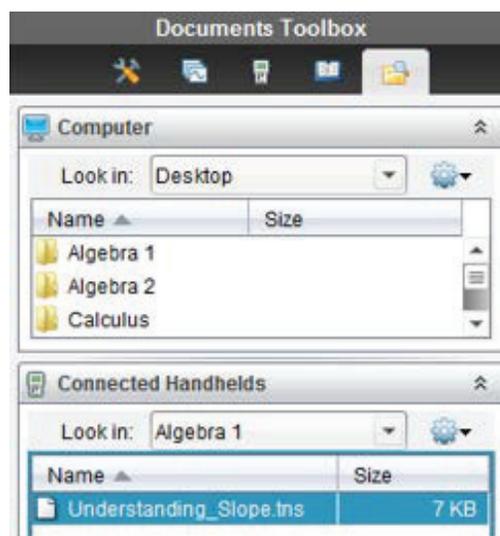
Real Graphs
Student Activity 📱💻🖱️

Name _____

Class _____

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

In this investigation, we will interpret the rate of change and initial value of functions in light of the situation it models and its graph. We will be exploring the plots of several sets of data that have been already been collected. We will be looking for data pairs that show a linear relationship and that reveal some *contextual* pattern. That is, if the plot of two data sets seems to form a linear pattern, does the relationship seem to make sense in the context of the data?

When looking at a plot, determine 1) if the plot represents a function; 2) if the function is linear; and, 3) if both of these are true, what is the function that models the pattern? When a linear function is obtained of the form y = mx + b, examine the slope and *y*-intercept both numerically and contextually. That is, explore what the values of m and b are and what they mean in the real world.

To truly "know" a situation, explore it graphically (with a graph plot), numerically (with a table of data), and analytically (with an equation or function). In addition to these, provide a context for the situation and the ability to communicate about all of these items.

Move to page 1.2.

The following sets of data exist in this Problem.

Set Name	Meaning
bounce_height	Height of the bouncing ball above the ground.
c_temp	Current temperature in degrees Celsius.
Distance	Distance from the start.
Dollar	Number of dollar Bills.
f_temp	Current temperature in degrees Fahrenheit.
Humidity	The current Relative Humidity, in percentages.
k_temp	Current temperature in Kelvin, a unit of measurement for temperature.
Nickel	Number of nickels.
Price	The amount charged for an item.
Profit	The amount of money made.
Second	The number of seconds that have passed.
Step	Steps taken in the walk.
Temp	The current temperature.

Real Graphs

Student Activity

Name _____

Class _____

1. To start looking at the plots of these data sets, select the x-axis and select the Independent variable; then select the y-axis, and choose a corresponding Dependent variable to produce a plot. Create a plot for one data set pair and answer the following:

   a. What was the choice for the Independent variable?

   b. What was the choice for the Dependent variable?

   c. Is there a pattern? Explain:

2. Look for functions that are **linear**. Repeat the process in step 1, and document your work. Record the following information: *x*-variable, *y*-variable, the plot, whether there is a pattern or not, whether it is a function or not, and whether the function is linear or not.

3. If a relationship between two sets of data seems to have a pattern, determine a function that best models the pattern found. Are the two variables related?
   - It might be possible to see if the relationship makes sense before the function is named.
   - Looking at individual data points on the plot might give some insight also. To do this, hover the cursor over a point.

Note: Also look at the full lists of data by using a Calculator Page by pressing [var] [enter] within the page.

4. It is also possible to look at these lists on a Lists & Spreadsheet page. Add a new Lists & Spreadsheet page, and move the cursor to the top of the column. Type the name of a data list, OR press [var] to choose the name from a listing of all data lists.

> **Tech Tip:** To add a Calculator page, select ➕ at the top of the screen. Then select Calculator. On the keyboard, press [var], select the data list you wish to view from the pop-up menu, then press ENTER. To add a Lists & Spreadsheet page, select ➕ at the top of the screen. Then select Lists & Spreadsheet. Press the top of the spreadsheet to bring up the keyboard. Then select the top of a column, press [var]. From the pop-up menu, select the data list you wish to view. To add or modify data in a spreadsheet cell, double-tap the cell.

Real Graphs

Student Activity

Name _____

Class _____

As we try to make sense of any relationship we might see, we want to determine which data pairs seem to be connected in a cause and effect manner. In other words, is there a relationship between the data for **price** and the data for **humidity**? How would someone explain that a price of $1,000 somehow determines a Relative Humidity of 49%?

5. Consider this as different plots are analyzed:
    a. Initially, choose only pairs to plot that might be related. If something appears to be linear, can the pattern be defended?

    b. Report the data pairs that appear to produce functions that are linear, and give the functions in the y = mx + b form.

6. Looking at the slope of the functions of note in the previous problem, report the value, units, and meaning of these slopes.

    a. Value:

    b. Units:

    c. Meaning:

7. Repeat the process from the previous question for the y-intercepts. Don't forget to give the units and meaning in the context of the ordered pairs.

    a. Value:

    b. Units:

    c. Meaning:

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Real Graphs

Student Activity

Name _____

Class _____

Move to page 2.1.

Here are some more data sets to examine. Again, we are looking at patterns.

Set Name	Meaning
Area	The surface area of a wire.
Calorie	The number of calories in food.
Degree	The angle measure in degree units.
Fin	The number of 5 dollar bills.
Heat	The temperature at some point.
Hour	The hour in a day.
Mass	The amount of mass in an object.
Month	The number of months from January some year.
Quarter	The number of quarters you have.
Radian	The angle measure in radians.
relative_humid	The Relative Humidity in percent.
Sunlight	The amount of sunlight landing on a surface.
Temperature	The current temperature.

8. Make a plot for one data set pair, and answer the following:

    a. Choice for the Independent variable?

    b. Choice for the Dependent variable?

    c. Pattern? Explain:

9. Look for functions that are **linear**. Repeat the process in step 8, and document your work. Record the following information: *x*-variable, *y*-variable, the plot, whether there is a pattern or not, whether it is a function or not, and whether the function is linear or not.

10. Report the data pairs that appear to produce functions that are linear, and give the functions in the $y = mx + b$ form.

Real Graphs

Student Activity

Name _____

Class _____

11. Looking at the slope of the functions of note in the previous problem, report the value, units, and meaning of these slopes.

    a. Value:

    b. Units:

    c. Meaning:

12. Repeat the process from the previous question for the y-intercepts. Don't forget to give the units and meaning in the context of the ordered pairs.

    a. Value:

    b. Units:

    c. Meaning:

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Math Objectives

- Students will explore the plots of various data sets, looking for patterns.
- Students will identify plots that appear to be functions.
- Students will determine which plots appear to form a linear pattern, and then acquire the best function that models the pattern, in the form of $y = mx + b$.
- Students will analyze the linear function, looking at the slope and the y-intercept in the context of the data that was used. They will identify the units of these values and their contextual meaning.
- Students will use functions to model relationships between quantities.
- Students will interpret the rate of change and initial value of a linear function in terms of the situation it models and in terms of its graph or a table of values (CCSS Mathematical Standard).
- Students will apply the mathematics they know to solve problems arising in everyday life, society, and the workplace (CCSS Mathematical Practice).

Vocabulary

- function
- model
- y-intercept
- slope
- table

- linear function
- variables
- independent variable
- dependent variable
- set

About the Lesson

- This lesson involves identifying patterns of data from given lists.
- As a result, students will:
  - Identify patterns that might represent functions, and in particular, linear functions.
  - Represent realistic relationships.
  - Identify the best function to fit the data and examine its parts in context.

TI-Nspire™ Navigator™

- Transfer a TI-Nspire document.
- Use Class Capture to examine student work and responses.
- Use Live Presenter to allow the students to demonstrate their technique.
- Use Quick Poll for Formative Assessment and reporting.

Activity Materials

- Compatible TI Technologies: ⬛ TI-Nspire™ CX Handhelds, ⬛ TI-Nspire™ App for iPad®, ⬛ TI-Nspire™ Software
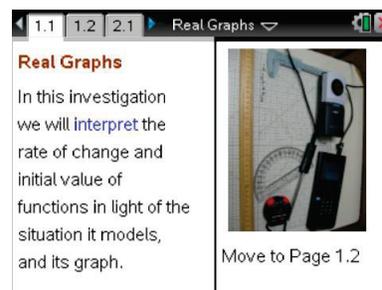
Tech Tips

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:
Student Activity
- Real_Graphs_Student.pdf
- Real_Graphs_Student.doc

TI-Nspire document
- Real_Graphs.tns

Real Graphs   TEACHER NOTES

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## Discussion Points and Possible Answers

> **Teacher Tip:** Students will need to be familiar with the graphical and
> analytical views of a linear equation. That is, they should recognize a linear
> graph when they see it, and they should be familiar with $y = mx + b$ form.
> Note that in actual collected data, the vertical line test for a function might
> appear to fail. Given that all measured numbers have an uncertainty (see
> sig-figs), an x-value might appear to precipitate two different y-values.

When looking at a plot, determine 1) if the plot represents a function; 2) if the function is linear; and, 3)
if both of these are true, what is the function that models the pattern? When a linear function is
obtained of the form y = mx + b, examine the slope and y-intercept both numerically and contextually.
That is, explore what the values of m and b are and what they mean in the real world.

To truly "know" a situation, explore it graphically (with a graph plot), numerically (with a table of data),
and analytically (with an equation or function). In addition to these, provide a context for the situation
and the ability to communicate about all of these items.

Move to page 1.2.

The following sets of data exist in this Problem.

Set Name	Meaning
bounce_height	Height of the bouncing ball above the ground.
c_temp	Current temperature in degrees Celsius.
Distance	Distance from the start.
Dollar	Number of dollar bills.
f_temp	Current temperature in degrees Fahrenheit.
Humidity	The current Relative Humidity, in percentages.
k_temp	Current temperature in Kelvin, a unit of measurement for temperature.
Nickel	Number of nickels.
Price	The amount charged for an item.
Profit	The amount of money made.
Second	The number of seconds that have passed.
Step	Steps taken in the walk.
Temp	The current temperature.

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1. To start looking at the plots of these data sets, select the x-axis and select the Independent variable; then select the y-axis, and choose a corresponding Dependent variable to produce a plot. Create a plot for one data set pair and answer the following:

   a. What was the choice for the Independent variable?
   b. What was the choice for the Dependent variable?
   c. Is there a pattern? Explain:

   Sample Answers: Student answers will vary.

   > **Teacher Tip:** Students should explore the plots of various sets using some list for the x-axis and a different one for the y-axis. It is not particularly important to have any pattern in their choices initially. Once they find a pattern, they then should determine if this is just a coincidence, or if this pattern actually represents a relationship between the two variables. As this lesson progresses, the students should pick the data pairs with some thought in mind that they might be related.
   > The students will need to introduce new Pages into the document to create additional plots as they start the documentation process. They might also want to build a table in their documents to record their work.

2. Look for functions that are **linear**. Repeat the process in step 1, and document your work. Record the following information: *x*-variable, *y*-variable, the plot, whether there is a pattern or not, whether it is a function or not, and whether the function is linear or not.

   Sample Answers:

x-variable	y-variable	Plot	Pattern	Function	Linear
price	Nickel		Yes	Yes	Yes
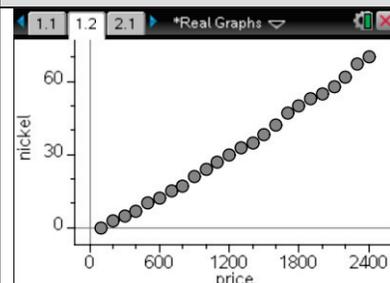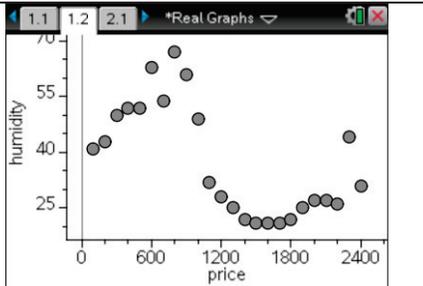
price	Humidity		Maybe	Probably not	No

OR in a spreadsheet:

> **Tech Tip:** Variables in Problem 1, in this case Lists, are known only in this Problem by the TI-Nspire. When you move to Problem 2, we have another set of variables. Tabbing is the quick way to move from x-axis selection to y-axis selection and the graph area. Students can also move their cursors and select an area to get to these locations. Right-select will give more options on the x-axis, the y-axis, and the graph area. Note that the Caption option at the top of the page is set to <none>, so what we see are points that randomly represent a row of the data lists.
>
> As they document their work, students will need to avoid using the exact list name, since the names are already known to the TI-Nspire as a list (variable) rather than simply a name. If they place the name for the list in quotes, this is not a problem. Add pages and applications quickly by using the keystrokes `ctrl` `I`.

> **TI-Nspire Navigator Opportunity:** *Class Capture and Live Presenter*
> **See Note 1 at the end of this lesson.**

Real Graphs

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3. If a relationship between two sets of data seems to have a pattern, determine a function that best models the pattern found. Are the two variables related?
    *   It might be possible to see if the relationship makes sense before the function is named.
    *   Looking at individual data points on the plot might give some insight also. To do this, hover the cursor over a point.

Note: Also look at the full lists of data by using a Calculator Page by pressing [var] [enter] within the page.

4. It is also possible to look at these lists on a Lists & Spreadsheet page. Add a new Lists & Spreadsheet page, and move the cursor to the top of the column. Type the name of a data list, OR press [var] to choose the name from a listing of all data lists.

Tech Tip: To add a Calculator page, select ✚ at the top of the screen. Then select Calculator. On the keyboard, press [var], select the data list you wish to view from the pop-up menu, then press ENTER. To add a Lists & Spreadsheet page, select ✚ at the top of the screen. Then select Lists & Spreadsheet. Press the top of the spreadsheet to bring up the keyboard. Then select the top of a column, press [var]. From the pop-up menu, select the data list you wish to view. To add or modify data in a spreadsheet cell, double-tap the cell.

Tech Tip: If the student only highlights the top "cell" on a column and presses [var], they will be prompted to choose from a menu. They should then select "Select 3:Link To:" and move to the name of their desired list. If they press [enter] after selecting 3, the list of variables will appear with the selection of the [var] key.

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

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As we try to make sense of any relationship we might see, we want to determine which data pairs seem to be connected in a cause and effect manner. In other words, is there a relationship between the data for **price** and the data for **humidity**? How would someone explain that a price of $1,000 somehow determines a Relative Humidity of 49%?

5. Consider this as different plots are analyzed:

   a. Initially, choose only pairs to plot that might be related. If something appears to be linear, can the pattern be defended?

   Answer: The relationships noted in the table below are all inverses.

   b. Report the data pairs that appear to produce functions that are linear, and give the functions in the $y = mx + b$ form.

   Answer:

Independent (x)	Dependent (y)	Function/Linear
c_temp	k_temp	$y = x + 273.15$
f_temp	c_temp	$y = 5/9 \, x - 160/9$
k_temp	f_temp	$y = 9/5 \, x - 459.67$
nickel	dollar	$y = 0.05 \, x$
price	profit	$y = -2 \, x + 5000$
second	bounce_height	Yes/No
step	distance	$y = 1.32 \, x$
temp	humidity	$Y = -1.18 \, x + 94.8$

   TI-Nspire Navigator Opportunity: *Class Capture, Live Presenter, and Quick Poll*
   See Note 3 at the end of this lesson.

6. Looking at the slope of the functions of note in the previous problem, report the value, units, and meaning of the slopes.

   a. Value:
   b. Units:
   c. Meaning:

   Sample Answers:

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(x)	(y)	Slope	Units	Meaning
c_temp	k_temp	1	K/°C	There is one Kelvin degree for each degree Celsius.
f_temp	c_temp	5/9	°C/°F	There are 5 degrees of Celsius for every 9 degrees of Fahrenheit.
k_temp	f_temp	9/5	°F/K	There are 9 degrees of Fahrenheit for every 5 degrees Kelvin.
nickel	dollar	0.05	dollar/nickel	There are 5 dollars for every 100 nickels; or, since 5/100 reduced to 1/20, you could say 1 dollar for every 20 nickels.
price	profit	-2	dollar/dollar	There is a 2 dollar loss for every 1 dollar on the price.
step	distance	1.32	feet/step	There are 1.32 feet in 1 step.
temp	humidity	-1.18	%/°F	There is a drop of 1.18% in the Relative Humidity for every 1 degree increase in the Fahrenheit temperature.

Teacher Tip: You might need to do one or two of the "Meaning" of the slope items to help students see what you want reported. Direct the students to address only one view of the ordered pairs, avoiding the inverses, and focusing on the pairings that make the most sense to them. For example, is it (nickel,dollar) or (dollar,nickel). Without more information on how the data was collected, we might not be able to identify the Independent variable.

TI-Nspire Navigator Opportunity: *Class Capture, Live Presenter, Quick Poll*
See Note 4 at the end of this lesson.

7. Repeat the process from the previous question for the y-intercepts. Don't forget to give the units and meaning in the context of the ordered pairs.

a. Value:
b. Units:
c. Meaning:

Answer:

(x)	(y)	y-int	Units	Meaning
c_temp	k_temp	273.15	K	When the temperature is 0 degrees Celsius, it is 273.15 Kelvin.
f_temp	c_temp	– 160/9	°C	When the temperature is 0 degrees Fahrenheit it is -17.8 degrees Celsius.
k_temp	f_temp	– 459.67	°F	When the temperature is 0 Kelvin, it is -459.67 degrees Fahrenheit.
nickel	dollar	0	dollar	When you have no nickels, you have 0 dollars.
price	profit	5000	dollar	When you charge 0 for the item, you make $5000.
step	distance	0	feet	When you take 0 steps, you move 0 feet.
temp	humidity	94.8	%	When the temperature is 0 degrees, your RH would be 94.8%.

Teacher Tip: As before, you might need to do one or two of the "Meaning" of the *y*-intercept items to help students see what you want reported.

TI-Nspire Navigator Opportunity: *Class Capture, Live Presenter, Quick Poll*
See Note 5 at the end of this lesson.

Move to page 2.1.

Here are some more data sets to examine. Again, we are looking at patterns.

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Set Name	Meaning
Area	The surface area of a wire.
Calorie	The number of calories in food.
Degree	The angle measure in degree units.
Fin	The number of 5 dollar bills.
Heat	The temperature at some point.
Hour	The hour in a day.
Mass	The amount of mass in an object.
Month	The number of months from January some year.
Quarter	The number of quarters.
Radian	The angle measure in radians.
relative_humid	The Relative Humidity in percent.
Sunlight	The amount of sunlight landing on a surface.
Temperature	The current temperature.

8. Make a plot for one data set pair, and answer the following:

    a. Choice for the Independent variable?
    b. Choice for the Dependent variable?
    c. Pattern? Explain:

    Sample Answers: Student answers will vary.

> **Teacher Tip:** The second problem below could be optional. The sets are
> separated from the ones in Problem 1 so as to not overwhelm the student.
> The steps are the same as Problem 1. Use the same Teacher Notes, Tech
> Tips, and Navigator Notes as before.

9. Look for functions that are **linear**. Repeat the process in step 8, and document your work. Record the following information: *x*-variable, *y*-variable, the plot, whether there is a pattern or not, whether it is a function or not, and whether the function is linear or not.

    Sample Answers: Answers might be similar to what was suggested above in Question #2.

10. Report the data pairs that appear to produce functions that are linear, and give the functions in the *y = mx + b* form.

<u>**Sample Answers:**</u> All of these relationships are inverses.

Independent (x)	Dependent (y)	Function/Linear
radian	degree	y = 57.3 x
heat	area	Yes/No
hour	temperature	Yes/No
Hour	relative_humid	Yes/No
Mass	calorie	Yes/No
month	sunlight	Yes/No
quarter	fin	Y = 0.05 x

11. Looking at the slope of the functions of note in the previous problem, report the value, units, and meaning of these slopes.

    a. Value:
    b. Units:
    c. Meaning:

<u>**Sample Answers:**</u>

(x)	(y)	Slope	Units	Meaning
radian	Degree	57.3	°/radians	There are 57.3 degrees in 1 radian.
quarter	Fin	0.05	fin/quarter	There are 5 five-dollar bills in 100 quarters.

12. Repeat the process from the previous question for the y-intercepts. Don't forget to give the units and meaning in the context of the ordered pairs.

    a. Value:
    b. Units:
    c. Meaning:

<u>**Sample Answers:**</u>

(x)	(y)	Slope	Units	Meaning
radian	degree	0	°	If you have 0 radians, you have 0 degrees.
quarter	fin	0	fin	If you have 0 quarters, you have 0 five-dollar bills.

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Wrap Up

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

- Two sets of data don't necessarily have a relationship.
- How to create and examine a plot of data.
- How to recognize a function from a plot of data.
- How to determine if a plot appears to be linear.
- How to determine a line of best fit for a linear set of data.
- How to analyze a linear function and make sense of the slope and *y*-intercept.

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TEACHER NOTES

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TI-Nspire Navigator

Note 1

Question 2, Class Capture and Live Presenter

Take screenshots of the student's first plots and sort; show what they selected; discuss plots that have patterns; identify patterns that appear to be linear; show and discuss plots that appear to be non-functions; show linear function patterns, show non-linear function patterns.

Use Live Presenter to have a student show the class how to set up the plots, add pages, and document their work in the Lists & Spreadsheet.

Note 2

Question 4, Class Capture and Live Presenter

Take screenshots of the class as they look at the data and have a student become the Presenter to show others how to do this. A screenshot showing all of the points as ordered pairs can be arranged with some coordination with the class or using the data-aggregation feature.

Note 3

Question 5, Quick Poll, Class Capture, and Live Presenter

Quick Poll the class and collect justifications of a relationship between some pairs that are producing plots that appear to be linear. You could also collect the functions for a given plot using this option in Quick Poll. Take screenshots to help student see how others are solving the problem. Use the Live Presenter option to have a student show how they got the function.

Note 4

Question 6, Class Capture, Live Presenter, and Quick Poll

Take screenshots to show the class how individuals are answering these questions. Use the Live Presenter option to have one student explain how they are documenting their answers. Use Quick Poll to get some of the answers, such as the units, or values, or meanings for a given data pair.

Note 5

Question 7, Class Capture, Live Presenter, and Quick Poll

Take screenshots to show the class how individuals are answering these questions. Use the Live Presenter option to have one student explain how they are documenting their answers. Use Quick Poll to get some of the answers, such as the units, or values, or meanings for a given data pair.