Environmental Science with TI-Nspire™ Technology

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.

TI-Nspire™ CX Scavenger Hunt – The Calculator Application

TI PROFESSIONAL DEVELOPMENT

Activity Overview

In this activity, you will learn how to perform basic calculations in the Calculator application. You will also be introduced to various features and commands.

1. Press [on] twice. There are three sections on the screen. In the bottom section, there are seven icons which represent seven different applications. Predict what these applications are:

   ____

2. What happens to the screen when you press and hold [ctrl] and then tap [−] several times? What happens when you tap [+] instead?

   ____

3. Open a New Document by using the Touchpad to move your cursor to New Document. Click by pressing [click]. If the handheld asks you, "Do you want to save?" answer 'no.'
   How did you answer "no"? ________________________________

4. Select 'Add Calculator' by pressing [enter]. How else could you select it?

   ____

5. Press [6] [^] [5] and [enter]. How does the problem appear on your screen? ____________
   What is the answer? __________ Press [2] [8] [^] and explain what happens when you press [^].

   ____

   Where is the cursor located? _____________ Find 28^3 _________________.

6. Find 36^2 _________. There is a quicker way to type 36^2 without using [^]. Instead we can use the [x²]. Where is it located, and why is it faster this way? _______________________

7. Type [3] [÷] [8] and [enter]. What is the answer? ________
   Try [3] [÷] [8] again, only this time press [ctrl] and [enter]. What is the answer? ___________
   One more time, type in [3] [÷] [8], but this time include a decimal point at the end and then press [enter]. What is the answer? ____

8. Press [ctrl] [÷]. What appears on your screen? _______ Where is the cursor? ___________
   Type in [1] [2], press [tab], type in [9] [8], and press [enter].
   What is the answer? ________ What did pressing [tab] do? _________________

9. Press ▲ once so the last answer is highlighted, and then press [enter]. What happens?

   ____

   Press ◀ once. Where is the cursor? _________

TI-Nspire™ CX Scavenger Hunt – The Calculator Application

TI PROFESSIONAL DEVELOPMENT

Delete the current number by pressing [del]. Type in [2][8], and press [enter]. What is the answer?

____

10. Press ▲ several times, and then press [enter]. Try this a few times. What happens?

____

11. Press ▲ twice (to highlight the last problem you entered) and press [del]. What happens?

____

Press [del] several more times. What is happening each time you press [del]?

____

12. Press [ctrl] and ▲. What do you see? _____________
Press [del][enter]. What does the screen say? _______________

13. Press [ctrl][0]. This is a calculator screen, but what looks different about it? __________________
Now type in [3][(][5][−][8] and [enter]. What is the answer? __________
You typed in 3(5-8, but what does the problem look like on the handheld? ________________

14. Press [ctrl][x²] to get a square root. Then type [2][3][−][7], move one space to the right, and type [+][2][enter]. What is the answer? ______
What does the problem look like on the screen? _______________
What happened to the square root bar? _____________
Where did the cursor move when you moved one space to the right? ________________

15. Press [(][(−)][1][7][)][x²][enter]. What is the answer? ______________
What makes the [(−)] button different from the [−] button? ___________________________

16. Press [⌂ on], and open a New Document. Select 'No' when it asks if you want to save the document. Press [ctrl][⌂ on] to turn off the handheld. **These are the last things you should do on your handheld before you put it away each day!**

17. How can you clear your screen entirely? ____

18. How can you recall the last answer? ____

19. How do you know where you are typing on the Calculator screen? _________________________

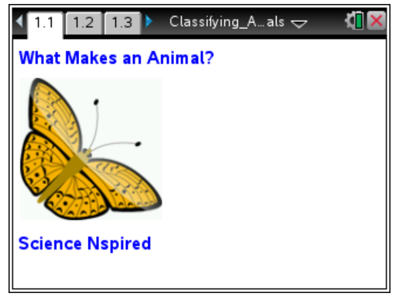
20. How can you make sure your answer is in the form of a decimal and not a fraction?

____

What Makes an Animal?
Student Activity

Name ________________
Class ________________

Open the *What_Makes_an_Animal.tns* file.



What makes animals so special? What distinguishes the animal Kingdom from the other kingdoms? What do animals as seemingly different as cats, birds, and sea urchins really have in common?

In this lesson, you will learn some of the general characteristics of animals, and you will practice distinguishing one animal from another.

Zoology, the study of animals, covers the huge range of organisms in the Kingdom Animalia. There are more than 2 million species in this Kingdom, but they all have more in common with each other than with species from other kingdoms!

You will learn the five characteristics of all animals, and then use a dichotomous key to identify some of these animal species.

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

Move to pages 1.3 – 1.4.

1. Read the information about animals. Page 1.3 discusses the connection between animals and eukaryotic cells. Page 1.4 discusses how animals are multicellular.

Answer question 1 here and/or in the .tns file.

Q1. Name one multicellular eukaryote that is NOT an animal.

Move to page 1.6.

2. Read the information about why animals are heterotrophs.

Answer question 2 here and/or in the .tns file.

Q2. If an organism is not a heterotroph, it might be classified as a(n)________.

Move to pages 1.8 – 1.9.

3. Read the information on animal movement and animal development.

Answer questions 3–5 here and/or in the .tns file.

Q3. A mushroom must consume food (decaying plant material). Is it an animal? Explain.

What Makes an Animal?
Student Activity

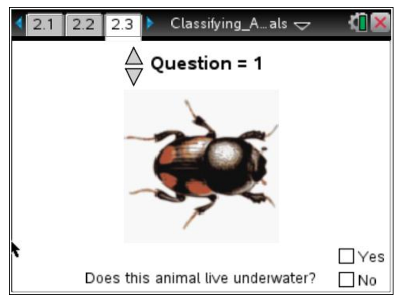
Name ______________
Class ______________

Q4. Why is motility important for animals?

Q5. Does an organism need a backbone to be an animal? Explain.

Now that you have been introduced to the Animal Kingdom, you will use a tool, called a dichotomous key, that biologists use when identifying organisms. A dichotomous key asks a series of yes or no questions based on observable traits in order to identify an organism. A unique set of answers points to the correct animal. This can be adapted and used as a helpful tool for identification of organisms in the wild.

Move to pages 2.1 – 2.3.



4. Read the directions in the pop-up box for completing the simulation of the dichotomous key. To close the directions, can click the [X]. Answer the questions for all nine animals. If the name that appears at the end of the questions does not match what you think the animal is, click the down arrow to go to revisit the questions.

   If needed at any time during the simulation, press [menu] to view the directions again.

Answer questions 6–16 in the .tns file. Answer questions 17–19 here and/or in the .tns file.

Q17. For which three animals were you asked about having wings?

A. Butterfly
B. Frog
C. Beetle
D. Snail

Q18. For which two animals were you asked about a tail?

A. Lizard
B. Fish
C. Frog
D. Whale

Q19. Which of the organisms you classified met the five characteristics of animals?

A. Beetle
B. Butterfly
C. Fish
D. Frog
E. Horse
F. Lizard
G. Snail
H. Starfish
I. Whale

Science Objectives

- Students will learn the five basic characteristics of the animal kingdom.
- Students will learn to use a dichotomous key to distinguish one animal from another.

Vocabulary

- zoology
- organelle
- heterotroph
- motile
- body plan
- dichotomous key
- eukaryote
- multicellular
- autotroph
- sessile
- developmental stage

About the Lesson

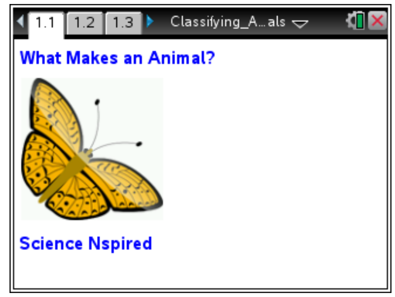
- In this lesson students learn about basic animal biology and identification of different animal species.
- Students will:
  - Identify and describe the five characteristics of all organisms in the Animal Kingdom.
  - Contrast these characteristics with those of other kingdoms.
  - Use a dichotomous key to identify nine different species of animals.

TI-Nspire™ Navigator™

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

Activity Materials

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



TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Open a Directions Box

Tech Tips:

Make sure that students understand how to select an answer to a question using enter.

Lesson Materials:

Student Activity

- What_Makes_an_Animal_ Student.doc
- What_Makes_an_Animal _ Student.pdf

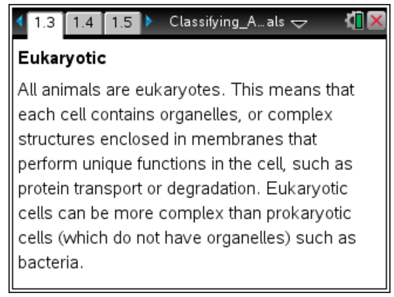
TI-Nspire document

- What_Makes_an_Animal.tns

Discussion Points and Possible Answers

Allow students to read the introduction on the activity sheet.

Move to pages 1.3 – 1.4.



1. Students will read information about the first two characteristics of animals, eukaryotic cells and multicellular.

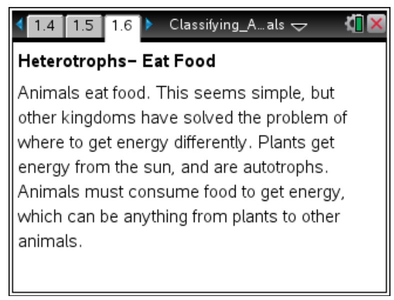
   Students will be introduced to the five characteristics of animals. Classroom discussion could compare and contrast these traits to other kingdoms.

Have students answer question 1 on the activity sheet, in the .tns file, or both.

Q1. Name one multicellular eukaryote that is NOT an animal.

Sample Answers: Any plant or fungus, not bacteria

Move to page 1.6.



2. Students will read information about the third characteristic of animals, eating food.

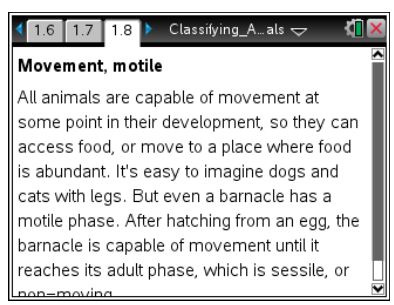
   Autotrophs don't require energy in the form of fixed carbon. There are many bacteria which are autotrophs. An auxotroph is similar, although requires a specific nutrient in its diet.

Have students answer question 2 on the activity sheet, in the .tns file, or both.

Q2. If an organism is not a heterotroph, it might be a(n)________.

Sample Answers: autotroph or auxotroph.

Move to pages 1.8 – 1.9.



3. Students will read information about the fourth and fifth characteristics of animals, movement and a fixed body plan.

Have students answer questions 3–5 on the activity sheet, in the .tns file, or both.

Q3. A mushroom must consume food (decaying plant material). Is it an animal? Explain.

Sample Answer: No, mushrooms are a fungus. They are not motile and have no fixed body plan or developmental stage.

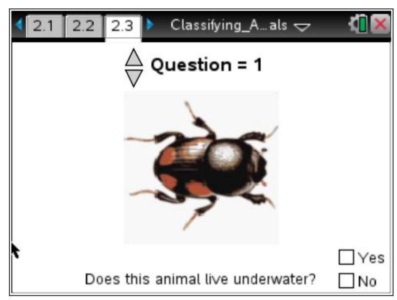
Q4. Why is motility important for animals?

Sample Answer: Heterotrophs need to get to food- either by going to it, or settling in a place where it will be (as in sea urchins and barnacles)

Q5. Does an organism need a backbone to be an animal? Explain.

Sample Answer: No. Bugs and worms are examples of invertebrate animals. 'Vertebrate' is a more narrow classification of certain animals.

Move to pages 2.1 – 2.3.



4. Students are to read the directions in the pop-up box for completing the simulation of the dichotomous key. To close the directions, they can click the ☒. They need to answer the questions for all nine animals, before answering the assessment questions that follow the simulation. If the animal name that appears at the end of the questions does not match with the picture, students can click the down arrow of the clicker to revisit the questions and change their answer(s).

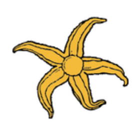
   If needed at any time during the simulation, students can press menu if they would like to view the directions again.

Have students answer questions 6–16 in the .tns file.

Q6. What animal is this?

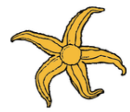
Answer: A. Beetle

Q7. What animal is this?



Answer: H. Starfish

Q8. Does this animal demonstrate motility?



Answer: Yes

Q9. What animal is this?

Answer: F. Lizard

Q10. What animal is this?

Answer: B. Butterfly

Q11. Is this animal a heterotroph?

Answer: Yes

Q12. What animal is this?

Answer: E. Horse

Q13. What animal is this?

Answer: G. Snail

Q14. What animal is this?

Answer: I. Whale

Q15. What animal is this?

Answer: C. Fish

Q16. What animal is this?

Answer: D. Frog

Have students answer questions 17–19 on the activity sheet, in the .tns file, or both.

Q17. For which three animals were you asked about having wings?

Answer: A. Butterfly, C. Beetle, D. Snail

Q18. For which two animals were you asked about a tail?

Answer: A. Lizard, C. Frog

Q19. Which of the organisms you classified met the five characteristics of animals?

Answer: All

TI-Nspire Navigator Opportunities

Choose a student to be a Live Presenter to demonstrate how to negotiate the animal identification simulation. The questions in the activity may be distributed as Quick Polls or used as a formative or summative assessment.

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. The Slide Show will be utilized to give students immediate feedback on their assessment.

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Introduction to Data Collection

TI PROFESSIONAL DEVELOPMENT

Activity Overview

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

Materials

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

Step 1:

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

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

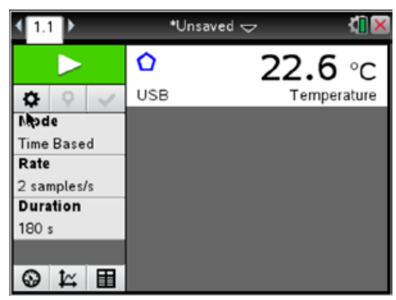
A new document will appear. Though you have the opportunity to add one of the seven built-in TI-Nspire applications, do not select an application at this time.

Step 2:

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

Plug the TI Stainless Steel Temperature probe into the EasyLink adapter, and <u>then</u> 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:

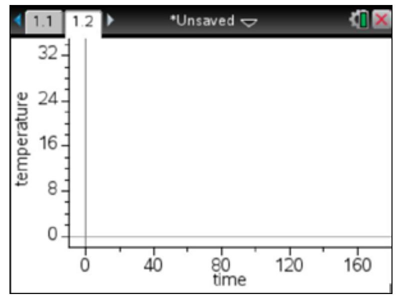
- What is the temperature? What are the units?
- How often does the temperature reading update?
- What are the default settings for the mode, rate, and duration?
- What happens as [tab] is pressed?
- What do you think each of these icons represent? 

Step 4:

Let the temperature probe reach 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.

Prepare to start collecting the data by pressing [tab] until the **Start Collection** button ▶ at the top of the screen is highlighted. Start heating the probe. Then press [enter]. Alternately, you can hover the cursor over the Start Collection 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 Start 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 check ✓ appears. Clicking this will store the latest data set.

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, use the Touchpad to position the pointer over the TableView 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:

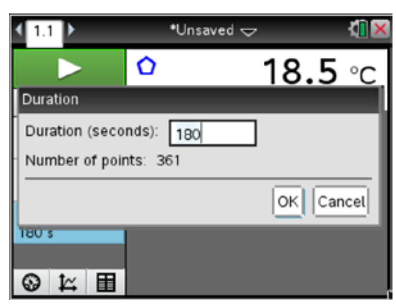
To save the results from the first experiment, use the Touchpad to position the pointer over the Store latest Data icon and press .

- What changes do you notice on the screen?

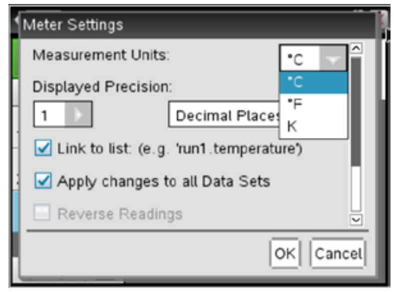
Step 11:

Now design an experiment that will cool the temperature probe.

Consider changing some of the options by clicking an area of interest (Mode, Rate, Duration, Settings). For example, change the default settings of three minutes by clicking on Duration and entering a new value (in seconds).



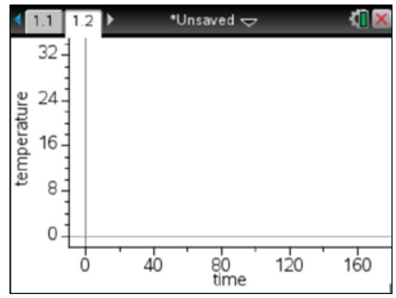
Note that these options are also under the menu. Based on what you learned in the heating experiment, adjust the settings as needed for your cooling experiment.



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 Start button ▶, and press enter to start.

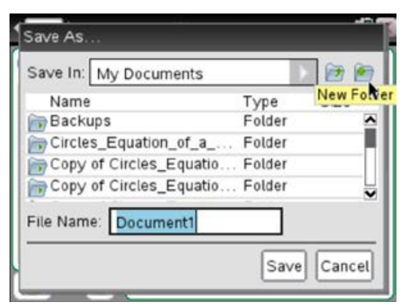
Step 14:

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 as a document, press ctrl S, name the document, and select a folder to place it in. If necessary, create a new folder.



Like Moths Around a Flame

Student Activity

Name ____________

Class ____________

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

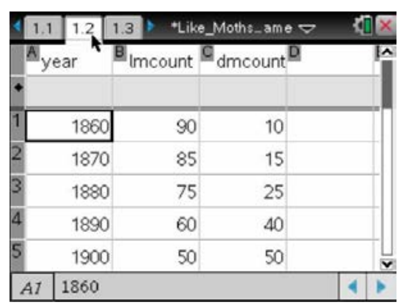
Imagine that you have a piece of red construction paper on your desk in front of you. If you wrote your name on the construction paper with a red marker and then wrote your name on the same paper with a black marker, which would be easier to read? If you showed the paper to one of your friends across the room, which do you think they would see? A similar scenario happens all the time in nature. Blending into the environment (camouflage) can help an animal avoid being seen, which may help it avoid being eaten by a predator.

In England, there is a species of insect called the peppered moth that provides us with a great example of camouflage, and this helps us understand the process of natural selection. Some of these moths are dark-colored, and some are light-colored. The color of each moth is determined by its genes for color, so a moth that is born dark stays dark, and a moth that is born light stays light.

The peppered moth is most active during the nighttime hours (nocturnal) and it spends its days resting on things like tree trunks. From the mid-1800s until the mid-1900s, people observed that the number of moths of each color changed. Why did these changes occur? In this activity you will examine data about moths, graph the data, and draw some conclusions.

Move to page 1.2.

1. Examine the data in the spreadsheet, which shows the number of moths of each color by decade. In 1860, for example, if a sample of 100 moths were counted, 90 of them would have been light (lmcount) and 10 of them would have been dark (dmcount). In this activity, you can assume that the counts for the sample accurately reflect the proportions in the entire population.



	A year	B lmcount	C dmcount
1	1860	90	10
2	1870	85	15
3	1880	75	25
4	1890	60	40
5	1900	50	50

A1 1860

Move to pages 1.3 and 1.4. Answer the following questions here or in the .tns file.

Q1. Which of the following is an **independent** variable in this activity? (More than one response may be correct.)

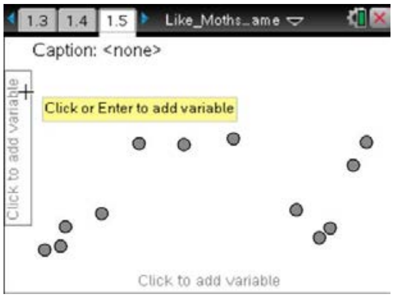
A. the number of dark-colored moths
B. the number of light-colored moths
C. the year

Q2. Which of the following is a **dependent** variable in this activity? (More than one response may be correct.)

A. the number of dark-colored moths
B. the number of light-colored moths
C. the year

Move to page 1.5.

2. Select the *x*-axis to choose an independent variable(s) for the *x*-axis. Choose a dependent variable(s) for the *y*-axis. To add a second variable to the *y*-axis, select **Menu > Plot Properties > Add Y Variable**. Examine the graph and look for trends in the data.



Tech Tip: To add a second variable to the *y*-axis, select **> Plot Properties > Add Y Variable**. You may need to back-out to the main Tools Menu to see the desired menu option.

Move to page 1.6. Answer question 3 here or in the .tns file. Answer questions 4–11 here.

Q3. Describe the trend(s) you see in the numbers of light-colored moths as the decades passed. Also, describe the trend(s) you see in the numbers of dark-colored moths.

Q4. From 1950 to 1970, what was the change in the number of light-colored moths? During this time, what was the change in the number of light-colored moths per year? per decade?

Q5. From 1950 to 1970, what was the change in the number of dark-colored moths? During this time, what was the change in the number of dark-colored moths per year? per decade?

Q6. Using your answers for questions 4 and 5, predict when (after 1970) you would expect the number of each type of moth to be the same. Explain your prediction.

Like Moths Around a Flame

Student Activity

Name ______________

Class ______________

Q7. During the middle 1800s, England began what was called the Industrial Revolution. Industry increased rapidly, and with that increase came a much greater need for energy. Since nuclear power plants were still decades away, what was the source of energy that England used to power their huge increase in industry? What was the environmental impact of using this type of fuel? How do you think this impact influenced the numbers of light- and dark-colored moths?

Q8. During the middle 1900s, environmentalists really started voicing their concerns about the harmful effects that industry was having on the environment. England and other countries started paying closer attention to cleaning up the environment by reducing emissions from industrial factories. These concerns helped to promote policies like the Clean Air Act in many countries. As these policies became implemented, new forms of energy started being used, and industry was required to reduce emissions from their existing factories. What was the environmental impact of the Clean Air Act? How do you think this impact influenced the numbers of light- and dark-colored moths?

Q9. Explain how your answers to questions 7 and 8 could be used to explain the effects of natural selection on the population of peppered moths in England.

Q10. What do you think would happen to the environment and to the moth population if factories went back to using older energy sources for their power, and the Clean Air Acts were eliminated? Explain your response.

Q11. Brainstorm and then describe another example of natural selection in animals, and one in plants.

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Like Moths Around a Flame

SCIENCE NSPIRED

Science Objectives

- Students will determine how humans can influence natural selection by manipulating the environment.
- Students will relate two sets of data, and analyze the patterns in long-term data.
- Students will develop an understanding of the effect of the environment on natural selection.

Vocabulary

- camouflage
- dependent variable
- environmental impact
- independent variable
- natural selection
- nocturnal

About the Lesson

- In this lesson, students examine some data about moths.
- As a result, students will:
  - Understand that the environment has an effect on natural selection.
  - Graph data and compare two sets of data.
  - Find patterns in long-term data and draw conclusions.

TI-Nspire™ Navigator™

- Send out the *Like_Moths_Around_a_Flame.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 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

- Like_Moths_Around_a_Flame_Student.doc
- Like_Moths_Around_a_Flame_Student.pdf

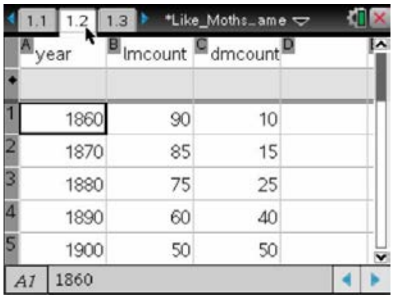
TI-Nspire document

- Like_Moths_Around_a_Flame.tns

Discussion Points and Possible Answers

Move to page 1.2.

1. Students examine the data in the spreadsheet, which shows a comparison of the number of moths of each color by decade. In 1860, for example, if 100 moths were counted, 90 of them would have been light, and 10 of them would have been dark. In this activity, students are told to assume that the counts for the sample accurately reflect the proportions in the entire population.



	A year	B lmcount	C dmcount	D
1	1860	90	10	
2	1870	85	15	
3	1880	75	25	
4	1890	60	40	
5	1900	50	50	

A1 1860

Teaching Tip: In this activity, there are two sets of data that have the same independent variable. Make sure students realize that both dependent variables share the same independent variable.

Move to pages 1.3 and 1.4

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

Q1. Which of the following is an independent variable in this activity? (More than one response may be correct.)

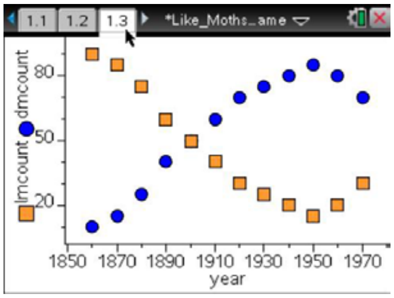
Answer: C. the year

Q2. Which of the following is a dependent variable in this activity? (More than one response may be correct.)

Answer: A. the number of dark-colored moths and B. the number of light-colored moths

Move to page 1.5.

2. Students construct a graph by choosing variables for each axis. To add a second *y*-axis variable, they will select **Menu > Plot Properties > Add Y Variable**. Their graphs should look like the graph at the right. Students then look for trends in the data.



Tech Tip: To add a second variable to the y-axis, students should select **> Plot Properties > Add Y Variable**. Students may need to back-out to the main Tools Menu to see the desired menu option.

Move to page 1.6.

Have students answer question 3 in the .tns file, on the activity sheet, or both, and questions 4–11 on the activity sheet.

Q3. Describe the trend(s) you see in the numbers of light-colored moths as the decades passed. Also describe the trend(s) you see in the numbers of dark-colored moths.

<u>Answer</u>: The light-colored moth population decreases until 1950, and then starts to increase. The dark-colored moth population increases until 1950, and then starts to decrease.

Q4. From 1950 to 1970, what was the change in the number of light-colored moths? During this time, what was the change in the number of light-colored moths per year? per decade?

<u>Answer</u>: The count of light-colored moths increased by 15. This was an increase of .75 light-colored moths per year and an increase of 7.5 light-colored moths per decade.

Q5. From 1950 to 1970, what was the change in the number of dark-colored moths? During this time, what was the change in the number of dark-colored moths per year? per decade?

<u>Answer</u>: The count of dark-colored moths decreased by 15. This was a decrease of .75 dark-colored moths per year, and a decrease of 7.5 dark-colored moths per decade.

Q6. Using your answers for questions 4 and 5, predict when (after 1970) you would expect the number of each type of moth to be the same. Explain your prediction.

<u>Answer</u>: I expect the counts of each type of moth to be equal in the 1990s. Explanations will vary.

Q7. During the middle 1800s, England began what was called the Industrial Revolution. Industry increased rapidly, and with that increase, came a much greater need for energy. Since nuclear power plants were still decades away, what source of energy did England use to power their huge increase in industry? What was the environmental impact of using this type of fuel? How do you think this impact influenced the numbers of light- and dark-colored moths?

<u>Answer</u>: The source of energy that England used to power their huge increase in industry was coal. The environmental impact of using this type of fuel was that there was more soot in the air, falling onto the trees and discoloring the light-colored bark. The impact on moths: Dark-colored moths would increase, and light-colored moths would decrease.

Q8. During the middle 1900s, environmentalists really started voicing their concerns about the harmful effects that industry was having on the environment. England and other countries started paying closer attention to cleaning up the environment by reducing emissions from industrial factories. These concerns helped to promote policies like the Clean Air Act in many countries. As these policies became implemented, new forms of energy started being used, and industry was required to reduce emissions from their existing factories. What was the environmental impact of the Clean Air Act? How do you think this impact influenced the numbers of light- and dark-colored moths?

Answer: The environmental impact of the Clean Air Act was that there was less soot in the air, so less fallout onto the trees. The impact on moths: Light-colored moths would increase, and dark-colored moths would decrease.

Q9. Explain how your answers to questions 7 and 8 could be used to explain the effects of natural selection on the population of peppered moths in England.

Answer: Depending on the color of the tree bark, either the light- or dark-colored moths would be selected *for* or selected *against*. Those selected *for* would be more likely to reproduce, while those selected *against* would not.

Q10. What do you think would happen to the environment and to the moth population if factories went back to using older energy sources for their power, and the Clean Air Acts were eliminated? Explain your response. (Point students back to the answer from question 7 if they need help identifying "older energy sources".)

Answer: It is likely that the population of the dark-colored moths would increase because of the darker colored bark. Dark moths would be selected *for*.

Q11. Brainstorm and then describe another example of natural selection in animals, and one in plants

Answer: Answers will vary.

TI-Nspire Navigator Opportunities

Use TI-Nspire Navigator to capture screen shots of student progress and to retrieve the file from each student at the end of the class period. The student questions can be electronically graded and added to the student portfolio.

Wrap Up

When students are finished with the activity, pull back the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions using Slide Show. Make sure the concept of balancing torques is firm in their understanding and not balancing forces.

Assessment

- Formative assessment will consist of questions embedded in the .tns file. 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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Which Fish?
Student Activity

Name ______________
Class ______________

Open the *Which_Fish.tns* file.

Learning to identify animals in the wild can be very difficult if you don't know what you are looking for. However, learning about some of the features that vary from one species to the next can help.

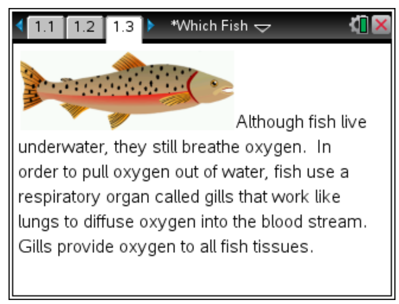
Ichthyology is the study of fish. In this lesson, you'll be learning about this diverse branch of zoology, which covers creatures in a huge range of ecosystems. There are tens of thousands of fish species, living in oceans, lakes and rivers throughout the Earth!

First you will learn about some unique features of fish structure. Then you will practice identifying some fish based on these characteristics.

Move to pages 1.2 – 1.4.

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

1. Read the information about the two organs that allow fish to remain underwater.



Answer question 1 here and/or in the .tns file.

Q1. What would happen to a fish with no air bladder? Explain.

Read pages 1.6 – 1.7.

2. Read the information about the observable characteristics that can be used to identify different species of fish.

Answer questions 2–4 here and/or in the .tns file.

Q2. Which fins steer a fish?

A. Dorsal fins
B. Pelvic fins
C. Anal fins
D. Caudal fins

Q3. What does the air bladder do?

A. Holds air for breathing
B. Helps with steering
C. Camouflages the fish
D. Provides buoyancy

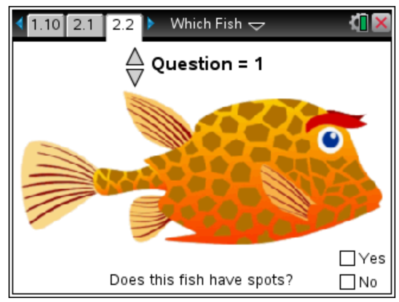
Q4. What is one purpose of fish scales?

A. Absorb oxygen
B. Improve swimming
C. Provide buoyancy
D. Protect skin

Move to pages 2.1 – 2.2.

3. Read the information on page 2.1. Then on page 2.2, answer the questions in the simulation to determine the names of the different fish.

   Click ☒ to close the directions and view the simulation. If needed at any time during the simulation, you can press menu to view the directions again.



Answer questions 5–13 in the .tns file.

Which Fish?

SCIENCE NSPIRED

Science Objectives

- Students will learn some basics of fish anatomy, including features that can help in fish identification.
- Students will use a simulation to help identify 9 different species of fish based on these characteristics.

Vocabulary

- ichthyology
- air bladder
- dorsal fin
- pelvic fin
- caudal fin
- gills
- buoyancy
- pectoral fin
- anal fin

About the Lesson

- In this lesson students learn about basic fish biology, and they will identify a variety of fish species.
- Students will:
  - Identify and describe the function of organs that are unique to fish.
  - Use the fins and pattern of the scales of fish to identify nine different species of fish.

TI-Nspire™ Navigator™

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

Activity Materials

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

TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Open a Directions Box

Tech Tips:

Make sure that students understand how to select an answer to a question using enter.

Lesson Materials:

Student Activity

- Which_Fish_ Student.doc
- Which_Fish_ Student.pdf

TI-Nspire document

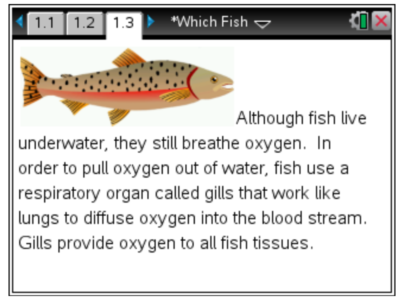
- *Which_Fish*.tns

Discussion Points and Possible Answers

Allow students to read the introduction on the activity sheet.

Move to pages 1.2 – 1.4.

1. Students should read the introductory material on pages 1.3-1.4. This will introduce them to two organs of fish, gills, and the air bladder.



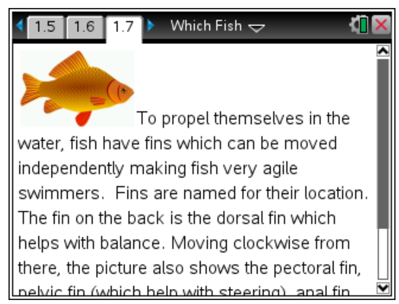
Have students answer question 1 on the activity sheet, in the .tns file, or both.

Q1. What would happen to a fish with no air bladder? Explain.

<u>Sample Answer:</u> The fish would use energy to stay at any depth in the water. The fish might sink.

Move to pages 1.6 – 1.7.

2. Have students read the information about the observable characteristics that can be used to identify different species of fish. Fins and scales will be important for the identification activity at the end of the lesson.



Have students answer questions 2–4 on the activity sheet, in the .tns file, or both.

Q2. Which fins steer a fish?

<u>Answer:</u> B. Pelvic fins

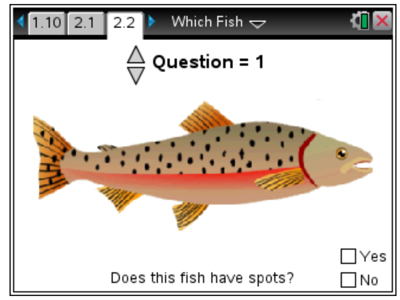
Q3. What does the air bladder do?

<u>Answer:</u> D. Provides buoyancy

Q4. What is one purpose of fish scales?

<u>Answer:</u> D. Protect skin

Move to pages 2.1 – 2.2.



3. After this basic introduction to fish structure, students will read the information on page 2.1 and then use the simulation, representing a dichotomous key, on page 2.2 to identify nine fish species. The directions given to students on how to use the simulation are given below:

   Directions

   1. Observe each fish carefully.
   2. Answer the question yes or no.
   3. Click the question clicker to go to the next question.
   4. Click on the fish to choose a new one.

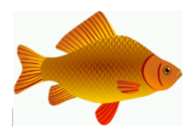
   Students can click X to close the directions and view the simulation. If needed at any time during the simulation, students can press menu if they would like to view the directions again.

Have students answer questions 5–13 in the .tns file.

Q5. What is the name of this fish?

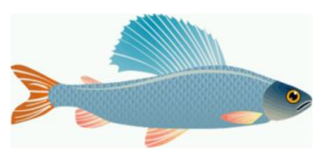
Answer: Eastern Razorfish

Q6. What is the name of this fish?



Answer: Eastern Carp

Q7. What is the name of this fish?



Answer: Caribbean Jewel Fish

Q8. What is the name of this fish?

Answer: Green Darter

Q9. What is the name of this fish?

Answer: Stippled Darter

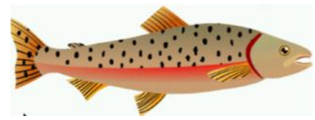
Q10. What is the name of this fish?

Answer: Greater Pike

Q11. What is the name of this fish?

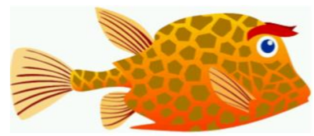
Answer: Pink Sturgeon

Q12. What is the name of this fish?



Answer: Northern Trout

Q13. What is the name of this fish?



Answer: Spotted Trunkfish

TI-Nspire Navigator Opportunities

Choose a student to be a Live Presenter to demonstrate how to negotiate the fish identification simulation. The questions in the activity may be distributed as Quick Polls or used as a formative or summative assessment

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. The Slide Show will be utilized to give students immediate feedback on their assessment.

Hare Today, Gone Tomorrow

Student Activity

Name ________________

Class ________________

Open the TI-Nspire document *Hare_Today_Gone_Tomorrow.tns.*
In this activity, you will determine how to graph the relationship between populations of lynx and snowshoe hare, and then analyze the data about the populations.

Pre-lab Information

All ecosystems have predator/prey relationships at work in them. The predator and the prey depend on each other to keep their populations healthy and their gene pools strong. Predators and prey depend on each other so much that the population numbers of one directly affect the numbers of the other, and this results in what are called wildlife population cycles.

The lynx-snowshoe hare relationship is one that has been well documented. The lynx is a large cat that can be found mainly in Alaska and Canada. It can grow to be about a meter in length, with an adult mass of 10–15 kg. Usually living 10–15 years, lynx are solitary animals that stalk and ambush their favorite prey, the snowshoe hare. Female lynx give birth to 2–3 kittens in the spring of the year, and the kittens remain with their mother for several months. The Snowshoe hare are very closely related to rabbits, and grow to be about half a meter in length and have a mass of 1–2 kg during their 2–4 year lifespan. They get their name from their huge hind feet, which can be up to 15 cm long. During the course of the year, the snowshoe hare gradually change color from a summer brown to a winter white. Females have 2–3 litters each year, each litter consisting of 3–4 young.

For decades, the population cycling of the lynx and the snowshoe hare has been well documented. As long ago as the early 1800s, fur traders kept track of the populations of these two animals, and as the years passed, they started to notice a trend in the population of each. The snowshoe hare populations go through dramatic peaks and crashes, with one such cycle usually lasting 7–10 years. When the hare population is at its peak, the lynx population is on the rise, too, but the peaks and crashes in the lynx population lag behind those of the hare by a couple of years. As the lynx numbers drop, the hare numbers rebound—and on and on. If these population cycles are graphed, you can see the graph of the predator population chasing the graph of the prey population, but always staying a couple of years behind.

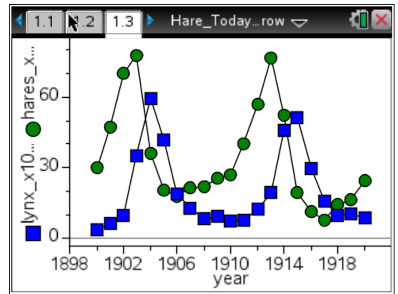
Hare Today, Gone Tomorrow
Student Activity

Name ______________

Class ______________

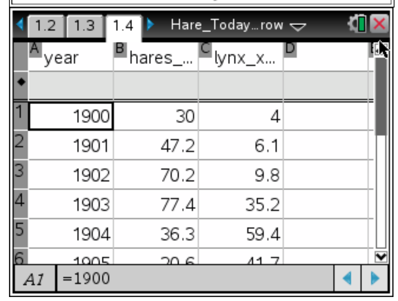
Move to page 1.3.

1. Review the data on the graph. The populations of lynx and snowshoe hare are given for a period of 20 years.



Move to page 1.4.

2. View the spreadsheet data to observe how the population numbers fluctuate over this time period.



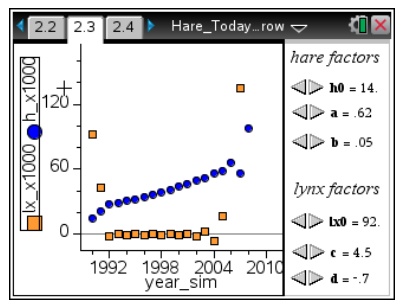
Move to pages 2.1–2.3.

3. Equations can be used to model the populations of the lynx and the snowshoe hare. On the next two pages, you will play with an **iterative** model for lynx and hare populations from 1990 on. The model uses two formulas:

   hare: b2=b1+0.1*(a*b1+b*b1*c1)

   lynx: c2=c1+0.1*(c*c1+d*b1*c1)

   In the spreadsheet, **Menu > Data > Fill** was used to copy the formulas down the columns. The values of cells b1 and c1 were set to the starting populations (the variables h0 and lx0). Then b2 and c2 were calculated from the values of cells b1 and c1, and so on. On pages 2.2 or 2.3, use the left and right arrows to experiment with changing the values of h0, lx0, a, b, c, and d.



Move to page 2.3.

4. Review the graph produced by the spreadsheet. Decide how you might improve the model by adjusting the variables or formulas. See if you can make a graph that shows fluctuating populations!

Hare Today, Gone Tomorrow

Student Activity

Name ______________

Class ______________

Use your model results to help answer the following questions.

Q1. How did you determine how to produce a fluctuating graph? Describe the method used. Sketch the best graph of the lynx and hare population cycling that you were able to produce.

Q2. As the hare population increases, why does the lynx population increase?

Q3. Hares are *herbivores* (plant eaters) and tend to stay in the same general location throughout their lives. At the peak of their population cycle, hares can reach a population density of up to 1500 per square kilometer. Besides predation, describe another factor that might affect the hare population.

Q4. How does your answer to Question 2 affect the lynx population?

Q5. In the arctic, there is a chicken-sized bird called a ptarmigan (pronounced TAR-muh-gun) that is also a food source for the lynx. Describe how the fluctuations in the snowshoe hare population numbers might affect the population of ptarmigan.

Q6. Why do the crashes in lynx numbers lag behind the crashes in hare numbers?

Q7. When female lynx are in poor condition, fewer will breed, and those that do, breed may not even have any kittens. Why might this occur? How would this affect the lynx population? How would this affect the hare population? When might the females start producing kittens again?

Hare Today, Gone Tomorrow

Student Activity

Name ______________

Class ______________

Q8. Choose ecosystems from two other biomes and describe a predator/prey interaction that might occur there.

Hare Today, Gone Tomorrow

TEACHER NOTES

SCIENCE NSPIRED

Science Objectives

- Students will develop a method of graphing a population cycling model.
- Students will demonstrate an understanding of population dynamics.
- Students will describe several factors affecting animal populations.

Vocabulary

- predator
- prey
- population cycling
- population dynamics

About the Lesson

- This lesson provides an opportunity for students to:
  - Graph a population cycling model.
  - Analyze the data and investigate the predator/prey relationship between the lynx and the snowshoe hare.

TI-Nspire™ Navigator™

- Send out the *Hare_Today_Gone_Tomorrow.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 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

- Hare_Today_Gone_Tomorrow_Student.pdf
- Hare_Today_Gone_Tomorrow_Student.doc

TI-Nspire document

- Hare_Today_Gone_Tomorrow.tns

Hare Today, Gone Tomorrow

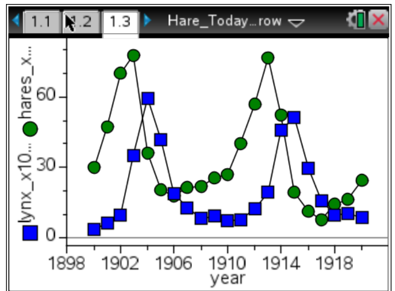
SCIENCE NSPIRED **TEACHER NOTES**

Discussion Points and Possible Answers

In this activity, students will determine how to graph the relationship between populations of lynx and snowshoe hare, and then analyze the data about the populations. They begin by reading about predators and prey on the student activity sheet.

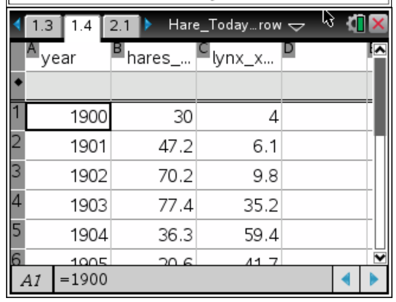
Move to page 1.3.

1. Students will review the data on the graph. The populations of lynx and snowshoe hare are given for a period of 20 years.



Move to page 1.4.

2. Students then analyze the spreadsheet data to observe how the population numbers fluctuate over this time period. They should notice that the population numbers are never negative.



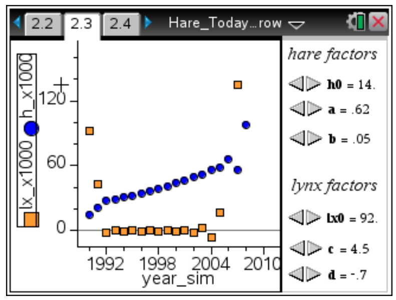
Move to pages 2.1–2.3.

3. Students read about using **iterative** equations to model the populations of the lynx and the snowshoe hare. The model uses two formulas:

   hare: b2=b1+0.1*(a*b1+b*b1*c1)

   lynx: c2=c1+0.1*(c*c1+d*b1*c1)

   In the spreadsheet, **Menu > Data > Fill** was used to copy the formulas down the columns. The values of cells b1 and c1 were set to the starting populations (the variables h0 and lx0). Then b2 and c2 were calculated from the values of cells b1 and c1, and so on. Students will use the left and right arrows to experiment with changing the values of h0, lx0, a, b, c, and d.



Techear Tip: You may want to have students brainstorm the type of variables that could affect a population. The variables are not defined so the students can hypothesize. This is an inquiry lesson

Move to page 2.3.

4. Students review the graph produced by the spreadsheet model. They decide how they might improve the model by adjusting the variables or formulas. Students are then challenged to make a graph that shows fluctuating populations.

Tech Tip: To zoom in on an area of the graph, select **Menu > Window Zoom > Zoom - In**. Then, have students select the region that they want to zoom in on. To zoom out on an area, select **Menu > Window Zoom > Zoom – Out.** Then, have students select the region that they want to zoom out of.

Tech Tip: To zoom in on an area of the graph, students can press two fingers to the screen and then move them apart from each other. To zoom out of an area, press two fingers to the screen and move them in towards one another.

Have students answer the questions on the activity sheet.

Q1. How did you determine how to produce a fluctuating graph? Describe the method used. Sketch the graph of the lynx and hare population cycling that you have produced.

Answer: Student graphs and method descriptions will vary. Look for trends, such as a steady increase in the hare population, followed by an increase in the lynx population about two years later. As the hare population declines, the lynx population should also decline after a similar lag. The students may wish to try starting with a hare population that is twice the lynx population.

Q2. As the hare population increases, why does the lynx population increase?

Answer: The lynx population increases as the hare population increases because there are more prey for the lynx to eat.

Q3. Hares are herbivores (plant eaters) and tend to stay in the same general location throughout their lives. At the peak of their population cycle, hares can reach a population density of up to 1500 per square kilometer. Besides predation, describe another factor that might affect the hare population.

Answer: Other factors that affect the hare population include availability of food, weather, birthrate, and so on.

Q4. How does your answer to question 2 affect the lynx population?

Answer: When there are more hares, more lynx can live in that area.

Q5. In the arctic, there is a chicken-sized bird called a ptarmigan (pronounced TAR-muh-gun) that is also a food source for the lynx. Describe how the fluctuations in the snowshoe hare population numbers might affect the population of ptarmigan.

Answer: When the hare population is low, the lynx may eat more ptarmigan, thereby reducing its population. When the hare population is high, the ptarmigan population may be high as well, since lynx prefer hares. Look for interrelatedness of populations.

Q6. Why do the crashes in lynx numbers lag behind the crashes in hare numbers?

Answer: It takes a while for the lynx to suffer the effects of a reduced food supply. They may find other food sources, but, if not adequate, they will begin to die. Their birthrate will also decline sometime after their food source declines.

Q7. When female lynxes are in poor condition, fewer will breed, and those that do, may not have kittens. Why might this occur? How would this affect the lynx population? How would this affect the hare population? When might the females start producing kittens again?

Answer: The female lynxes are struggling to survive, so their fertility declines. When a female is malnourished, she probably will not support kittens. As the lynx population declines, the hare population can start to rebound. With a renewed food source of hares, the female lynxes will start to produce kittens again.

Q8. Choose ecosystems from two other biomes and describe a predator/prey interaction that might occur there.

Answer: Answers will vary.

TI-Nspire Navigator Opportunities

Use TI-Nspire Navigator to capture screen shots of student progress and to retrieve the file from each student at the end of the class period. The student questions can be electronically graded and added to the student portfolio.

Wrap Up

When students are finished with the activity, pull back 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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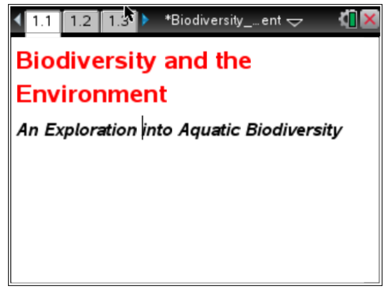
Biodiversity and the Environment
Student Activity

Name ________________

Class ________________

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

You may often hear of classrooms, schools, or towns having a certain amount of "diversity." Used in this way, "diversity" refers to variety within a single species: OURS!



Even though students in your classroom, school, or town might seem to be diverse on the surface, they are all human, just like you. Outside of your school's walls, there are many different species of organisms living with and among each other. The number of species and the abundance of individuals in populations are governed by the interactions between organisms and between organisms and their physical environment. Biodiversity—the variety of life forms in an ecosystem or biome—is a measure of the health of an ecosystem. Each ecosystem contains an assembly of species that are adapted to the range of conditions typically found in that environment. If conditions change dramatically, some species may not be able to survive, resulting in lower diversity. In this activity, you will examine some of the factors influencing the **biodiversity** of an ecosystem.

Move to page 1.2.

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

1. Read the background information.

<u>Background Information</u>

Organisms are impacted by the abiotic, or nonliving, factors in their environments. The actions of organisms can affect abiotic factors and other biotic factors. Abiotic factors are important drivers for biodiversity. As the variety of physical characteristics in an ecosystem increases, so does species diversity. This is because each species is adapted to tolerate a certain range of abiotic conditions.

On a global scale, there is an interesting relationship between biodiversity and temperature. Generally, species diversity increases from the poles to the equator. This is known as the *Latitudinal Diversity Gradient*. Scientists have not reached consensus on the primary mechanism for this global pattern, but the greater amount of solar energy and larger available area near the equator are thought to be important.

Move to pages 1.3 – 1.5. Answer questions 1-3 below and/or on your handheld.

Q1. Give two examples of abiotic factors in an environment.

Q2. Which of the following ecosystems is likely to support the highest biodiversity?

A. Forest with three soil types and varied land features

B. Forest with one soil type and relatively flat land

C. Forest with three soil types, varied land features, and a small stream

Q3. Which of the following is an example of a biotic factor influencing another biotic factor?

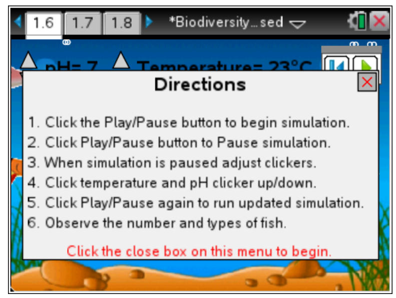
A. Lower soil phosphorus concentrations decrease plant productivity.

B. Higher plant diversity increases animal diversity.

C. Concentrations of hippopotamuses in ponds increase water turbidity.

D. Accumulation of wood debris increases forest fire intensity.

Move to page 1.6.



2. On page 1.6, you will see a model of a lake ecosystem. Carefully read the directions that are covering the picture of the lake. When you understand what your task is, click and make the adjustments that the directions recommend. Pay close attention to what happens as the temperature and pH of the lake are changed. Press menu if you need to view the directions again.

Move to pages 1.7 – 1.8. Answer questions 4 and 5 below and/or on your handheld.

Q4. What are the variables that you can regulate in the simulation? (Select all that apply.)

A. pH

B. population density

C. plant diversity

D. temperature

Q5. Which of the following represent "biotic" factor(s) in the simulation? (Select all that apply.)

A. fish biomass

B. dissolved oxygen

C. plant diversity

D. water pH

Move to pages 1.9 – 1.10. Answer question 6 below and/or on your handheld.

3. Read the content information about pH on page 1.9.

Q6. A lake with a pH of 6.5 would be considered:

A. neutral

B. highly acidic

C. slightly acidic

D. slightly basic

Move to pages 1.11 – 1.12.

4. On page 1.11, you will read about the meaning of biodiversity. After reading the information on this page, move to page 1.12. On this page, you will be instructed to return to the simulation on page 1.6 and review what happens when the pH and temperature of the water are changed.

Move to pages 1.13 – 1.16. Answer questions 7-10 below and/or on your handheld.

Q7. How do temperature and pH affect each other?

A. As temperature goes up, pH goes up.

B. As temperature goes up, pH goes down.

C. As temperature goes down, pH goes up.

D. Temperature and pH do not affect each other.

Q8. In general, there is a greater diversity of fish when the water is warmer.

A. Agree

B. Disagree

Q9. As the water becomes more acidic, the diversity of fish decreases. Which is the best explanation?

A. The maximum sustainable number of individuals is reduced by acidic conditions.

B. Only a small number of species are adapted to survive in acidic conditions.

C. Most fish prefer very basic conditions.

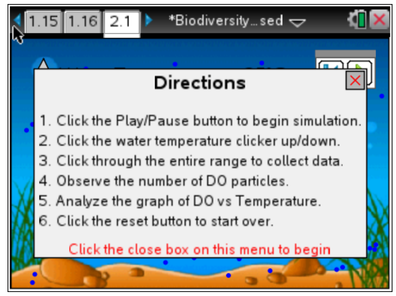
Biodiversity and the Environment
Student Activity

Name ______________
Class ______________

Acid rain from fossil fuel combustion can strongly impact the pH of aquatic ecosystems. In recent years, the U.S. has recorded acid rain with a pH as low as 4.3.

Q10. Go back to the simulation and set the temperature at 20°C and the pH at 7. Note the population and species values. Now change the pH to 5 and keep the temperature at 20°C. What do you observe?

Move to page 2.1 for the simulation on dissolved oxygen.



5. This next simulation deals with the relationship between water temperature and the levels of dissolved oxygen in the water. As in the first simulation, read the directions in the pop-up window. When you are ready to run the simulation, close the directions box by clicking ☒. You will then vary the water temperature and collect data on dissolved oxygen levels.

Move to pages 2.2 – 2.8. Answer questions 11-17 below and/or on your handheld.

Q11. What happened to the amount of dissolved oxygen as you increased the temperature of the water?

Q12. Which term do you think best describes the relationship between water temperature and dissolved oxygen levels?

A. Direct   B. Inverse

Q13. Water has less capacity to hold dissolved oxygen as temperature increases, because gas molecules move faster and spread apart in warmer water.

A. Agree

B. Disagree

Q14. Which of the following factors do NOT contribute to higher dissolved oxygen levels?

A. photosynthesis

B. turbulence

C. decomposition of organic matter

D. low water temperature

Biodiversity and the Environment
Student Activity

Name ______________
Class ______________

Q15. Fish such as salmon and trout need a lot of oxygen to survive. Which water temperature do you think would be best for these fish?

A. 40°C

B. 30°C

C. 20°C

D. 10°C

Q16. Catfish have a lower oxygen requirement than many freshwater fish. In which aquatic habitat are they likely to be better adapted than other fish?

A. mountain stream

B. shallow tropical lake

C. deep temperate lake

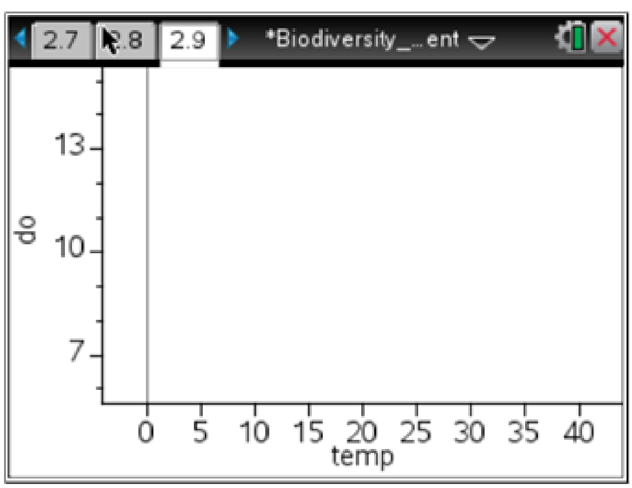
Q17. Oxygen is rarely a limiting abiotic factor in aquatic ecosystems.

A. Agree

B. Disagree

Move to page 2.9.

6. On page 2.9, there is a graph of the data that was collected automatically as you made changes to the water temperature in the simulation. Plot the data below as it appears in the graph on your handheld.



Move to pages 2.10 – 2.11. Answer questions 18 and 19 below and/or on your handheld.

Q18. Which words could be placed in the blanks below to make the statement true? (Select all that apply.)

As water temperature goes _____, the dissolved oxygen level goes _____.

A. up; up

B. up; down

C. down; up

D. down; down

Q19. Predict what would happen if the water continued to get warmer and warmer.

A. The dissolved oxygen levels would continue to drop and level off at 0 ppm.

B. The dissolved oxygen levels would level off near 6 ppm.

C. The dissolved oxygen levels would continue to drop and eventually become negative.

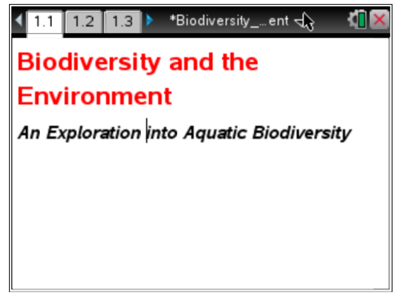
Move to page 2.12.

7. The final page of the activity shows you the actual data that was collected as you made changes to the temperature of the water in the dissolved oxygen simulation.

Biodiversity and the Environment

TEACHER NOTES

SCIENCE NSPIRED



Science Objectives

- Students will simulate adjusting the pH of a lake and draw conclusions about the relationship between pH and biodiversity.
- Students will learn the difference between biotic and abiotic factors and how abiotic factors affect biotic factors.
- Students will simulate adjusting the temperature of a lake and draw conclusions about the relationship between water temperature and dissolved oxygen levels in the lake.

Vocabulary

- pH
- biotic
- acid
- base
- abiotic
- biodiversity
- dissolved oxygen

About the Lesson

In this activity, students will observe model environments, adjust abiotic variables in those environments, observe the results of those adjustments, and then draw conclusions about the effects of the abiotic world on the biotic world.

- As a result, students will:
  - Learn the fundamental meaning of "biotic" and "abiotic" factors, and how each impacts the other to determine biodiversity.
  - Form a basic understanding of pH and how it affects biodiversity of an aquatic ecosystem.
  - Develop an understanding of the relationship between water temperature and dissolved oxygen levels.

TI-Nspire™ Navigator™

- Send out the .tns file.
- Monitor student progress using Screen Capture.
- Use Live Presenter to have students demonstrate how to negotiate the simulations and to spotlight student answers.
- Collect student responses from assessment items that are embedded throughout the document.

Activity Materials

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

TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Manipulate sliders to adjust variables
- Answer assessment questions within a document

Tech Tips:

Make sure that students know how to move between pages by pressing ctrl ◀ (left arrow) and ctrl ▶ (right arrow).

Lesson Materials:

Student Activity

- Biodiversity_and_the_Environment_Student.doc
- Biodiversity_and_the_Environment _Student.pdf

TI-Nspire document

- Biodiversity_and_the_Environment.tns

Discussion Points and Possible Answers

Move to page 1.2.

1. After opening the document, students should read the background information on page 1.2.

Move to pages 1.3 – 1.5.

Have students answer questions 1–3 on either the handheld, on the activity sheet, or both.
These three questions assess the students' background knowledge of biotic factors, abiotic factors and biodiversity. It is recommended that these questions be used for discussion purposes after the students answer them.

Q1. Give two examples of abiotic factors in an environment.

Suggested Answers: water, air, climate, rain, snow, rocks, oxygen, carbon dioxide, etc.

Q2. Which of the following ecosystems is likely to support the highest biodiversity?

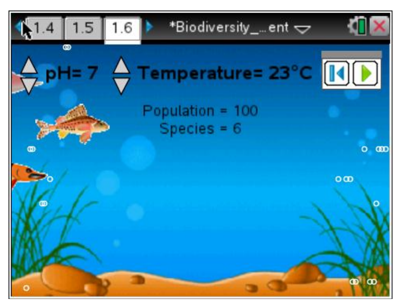
Answer: C. Forest with three soil types, varied land features, and a small stream (This ecosystem has the greatest diversity of physical characteristics so it is likely to harbor more species uniquely adapted to each environmental condition).

Q3. Which of the following is an example of a biotic factor influencing another biotic factor?

Answer: B. Higher plant diversity increases animal diversity. (Plant diversity is a biotic factor that influences animal diversity-- another biotic factor. Hippopotamuses and wood debris are also biotic factors, but they are influencing abiotic factors in those examples.)

Move to page 1.6.

2. On page 1.6 are some instructions for the student about the simulation of the aquatic ecosystem. After reading the directions on the page that overlays the lake, the students should close the instruction window by clicking ☒. If needed at any time during the simulation, students can press menu if they would like to view the directions again.



In order to see the impact of changing pH and temperature on the biodiversity of the lake, students should only adjust ONE variable at a time. For example, guide the students to work through the entire range of the pH scale, making observations of the effects of changing the pH. Then, the pH should be reset to 7 and the temperature should be changed. Remind students that if both variables are changed at the same time, it's difficult to determine which is impacting the ecosystem.

Move to pages 1.7 – 1.8.

Have students answer questions 4 and 5 on the handheld, the activity sheet, or both.

Q4. What are the variables that you can regulate in the simulation? (Select all that apply.)

Answers: A. pH and D. Temperature

Q5. Which of the following represent "biotic" factor(s) in the simulation? (Select all that apply.)

Answers: A. fish biomass and C. plant diversity

Move to pages 1.9 – 1.10.
Have students answer question 6 on the handheld, the activity sheet, or both.

3. Have students read the content information about pH on page 1.9. The concept of pH may be new to students, so it is recommended that the teacher take some time to discuss it.

Q6. A lake with a pH of 6.5 would be considered:

Suggested Answer: C. slightly acidic

Move to pages 1.11 – 1.12.

4. On page 1.11, the students will read about the meaning of biodiversity. After reading the information on this page, they should move to page 1.12. On this page, they will be instructed to return to the simulation on page 1.6 and review what happens when the pH and temperature of the water are changed.

Move to page 1.13 – 1.16.

Have students answer questions 7–11 on the handheld, the activity sheet, or both.

Q7. How do temperature and pH affect each other?

Answer: D. Temperature and pH do not affect each other.

Q8. In general, there is a greater diversity of fish when the water is warmer.

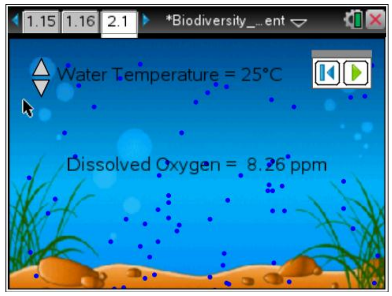
Answer: B. Disagree

Q9. As the water becomes more acidic, the diversity of fish decreases. Which is the best explanation?

Answer: B. Only a small number of species are adapted to survive in acidic conditions.

Q10. Go back to the simulation and set the temperature at 20°C and the pH at 7. Note the population and species values. Now change the pH to 5 and keep the temperature at 20°C. What do you observe?

Suggested Answer: The number of species and the number of fish has declined.



Move to page 2.1 for the simulation on dissolved oxygen.

5. After finishing the first simulation and all of the questions, the students should move to the second simulation, which deals with the relationship between water temperature and the levels of dissolved oxygen in the water. The process for the students will be the same as in the first simulation.

Move to pages 2.2 – 2.8.

Have students answer questions 11–17 on the handheld, the activity sheet, or both.

Q11. What happened to the amount of dissolved oxygen as you increased the temperature of the water?

Answer: The amount of dissolved oxygen decreased when water temperature was increased.

Q12. Which term do you think best describes the relationship between water temperature and dissolved oxygen levels?

Answer: B. Inverse

Q13. Water has less capacity to hold dissolved oxygen as temperature increases, because gas molecules move faster and spread apart in warmer water.

Answer: A. Agree

Q14. Which of the following factors do NOT contribute to higher dissolved oxygen levels?

Answer: D. Low water temperature

Q15. Fish such as salmon and trout need a lot of oxygen to survive. Which water temperature do you think would be best for these fish?

Answer: D. 10^{o}C

Q16. Catfish have a lower oxygen requirement than many freshwater fish. In which aquatic habitat are they likely to be better adapted than other fish?

Answer: C. shallow tropical lake (this aquatic environment is expected to experience highest temperatures and will not have deeper, cooler water for refuge)

Q17. Oxygen is rarely a limiting abiotic factor in aquatic ecosystems.

Answer: B. Disagree. (Diurnal and seasonal changes in dissolved oxygen often create hypoxic conditions, which severely affects the physiology and overall productivity of many aquatic organisms)

Move to page 2.9.

6. On page 2.9, there is a graph of the data that was collected automatically as the students made changes to the water temperature in the simulation. Spend some time with the students analyzing the graph.

Move to pages 2.10 – 2.11.

Have students answer questions 18 and 19 on the handheld, the activity sheet, or both.

Q18. Which words could be placed in the blanks below to make the statement true? (Select all that apply.)

As water temperature goes _____, the dissolved oxygen level goes _____.

Answers: B. up; down and C. down; up

Q19. Predict what would happen if the water continued to get warmer and warmer.

A. **Answer:** A. The dissolved oxygen levels would continue to drop and level off at 0 ppm.

Move to page 2.12.

7. The final page of the activity shows the student the actual data that was collected as they made changes to the temperature of the water in the dissolved oxygen simulation.

TI-Nspire Navigator Opportunities

Make a student a Live Presenter to demonstrate how to negotiate the cell diagrams. The questions in the activity may be distributed as Quick Polls or used as a formative or summative assessment

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. 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.

Extension

If a Vernier Dissolved Oxygen Sensor is available, you could experimentally determine that cold water is able to hold more dissolved oxygen than warm water. Half-fill a bottle with warm water and shake it for a few seconds, then test the dissolved oxygen level. Next, do the same with cold water

.

Arctic Wars—Lynx vs. Snowshoe Hare
Student Activity

Name ______________
Class ______________

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

In this activity, you will investigate how different variables affect the dynamics of the lynx and snowshoe hare populations.

One of the most studied predator/prey relationships in nature is the lynx and snowshoe hare cycle. The lynx is a large cat about a meter in length, with an adult mass of 10–15 kg.

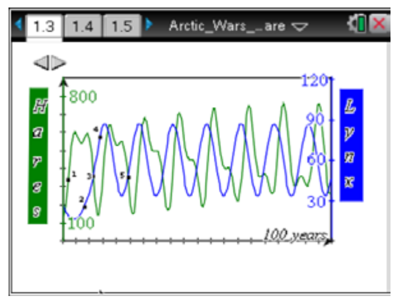
Lynx live a solitary life, which averages 10–15 years. Female lynx give birth to 2–3 kittens in the spring of each year, and the kittens remain with their mother for several months. The snowshoe hare is its favorite prey.

Snowshoe hares, which are very closely related to rabbits, reach lengths of about half a meter and a mass of 1–2 kg. During their 2–4 year lifespan, hares have 2 to 3 litters per year with 3–4 young in each litter. They have several arctic predators, including the lynx.

Move to pages 1.2–1.4. Answer Questions 1 and 2 here or in the .tns file. Answer Questions 3 and 4 here.

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

1. Analyze the graph on page 1.3.



Q1. What is happening at Point 1 on the graph?

A. The predator population is rapidly increasing.
B. The prey population is rapidly increasing.
C. Both populations are rapidly increasing.

Q2. What is happening at Point 2 on the graph?

A. The prey population is rapidly decreasing.
B. The predator population is gradually increasing.
C. The prey population is staying the same.

Q3. Describe what is happening at Point 3 on the graph.

Q4. Analyze the rest of the graph. What overall pattern does the graph indicate?

Move to page 1.5. Answer Question 5 here or in the .tns file. Answer Questions 6–8 here.

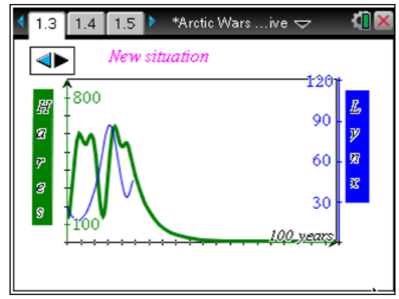
Arctic Wars—Lynx vs. Snowshoe Hare

Student Activity

Name _______________

Class _______________

2. Return to page 1.3 and click the ▶ icon in the top left of the screen. Analyze the graph for the new situation.



Q5. What could have caused the hare population to behave as it did in the new situation?

A. abundance of food for the hares

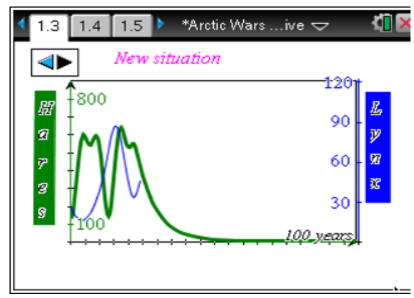
B. disease that affected the hares

C. excessive predation by the lynx

D. excessive hunting of the lynx

Q6. For each of the answer choices that you did not select in Question 5, explain why it is incorrect.

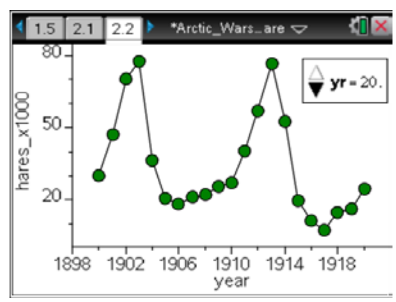
Q7. On the graph, draw a line that shows the predicted population of the lynx.



Q8. Explain your rationale for the predator graph you drew in Question 7.

Move to pages 2.1 and 2.2. Answer Question 9 here or in the .tns file.

Q9. Follow the directions on page 2.1 and draw the lynx graph below.



Move to page 2.3. Answer Question 10 on the activity sheet.

3. On page 2.2, add the lynx data by pressing **Menu > Plot Properties > Add Y Variable**.

Q10. How did your prediction match the actual data? Explain.

Arctic Wars—Lynx vs. Snowshoe Hare

TEACHER NOTES

SCIENCE NSPIRED

Science Objectives

- Students will analyze a predator prey graph that represents the population cycling of the lynx and the snowshoe hare.
- Students will hypothesize what is actually occurring at different points of the predator prey graph.
- Students will predict future trends that will occur in a predator prey population.

Vocabulary

- population cycling
- predator
- prey

About the Lesson

- This lesson *Arctic_Wars_Lynx_vs_Snowshoe_Hare.tns* involves investigating population cycling patterns that exist between a predator and its prey.
- As a result, students will:
  - Interact with a given situation to make predictions in an unknown situation.
  - Draw conclusions from graphs.
  - Predict future trends that will occur in a predator prey population.

TI-Nspire™ Navigator™

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

Activity Materials

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

TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages

Tech Tips:

Make sure students understand how to select an answer to a question using enter

Lesson Materials:

Student Activity

- Arctic_Wars_Lynx_vs_Snowshoe_Hare_Student.doc
- Arctic_Wars_Lynx_vs_Snowshoe_Hare_Student.pdf

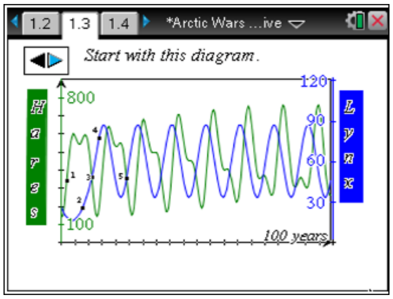
TI-Nspire document

- Actic_Wars_Lynx_vs_Snowshoe_Hare.tns

Discussion Points and Possible Answers

Move to page 1.3.

1. Have students answer Questions 1 and 2 on either the handheld, on the activity sheet, or both. Answer Questions 3 and 4 on the activity sheet.



Q1. What is happening at Point 1 on the graph?

Answer: B. The prey population is rapidly increasing.

TI-Nspire Navigator Opportunities

It may be helpful to display the graph for the class to see the individual points being discussed.

Q2. What is happening at Point 2 on the graph?

Answer: B. The predator population is gradually increasing.

Q3. Describe what is happening at Point 3 on the graph.

Possible Answer: The predator population is increasing because of the availability of prey (food). The prey population is decreasing because of the increased predation by the predator population.

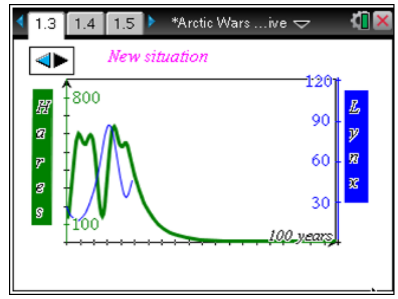
Q4. Analyze the rest of the graph. What overall pattern does the graph indicate?

Possible Answer: There is a repeating pattern. Whenever the prey population peaks, the predator population increases and peaks. There is a lag between the time when the prey population peaks and the predator population peaks. The two graphs are not mirror images of each other. The same pattern occurs when the prey population decreases.

Move to page 1.5.

Have students answer Question 5 on either the handheld, on the activity sheet, or both. Have students answer questions 6–8 on the activity sheet.

2. Students will return to page 1.3, choose a new situation, and analyze the graph.



Tech Tip: Students just click the ▶ or ◀ to move between situations.

Q5. What could have caused the hare population to behave as it did in the new situation?

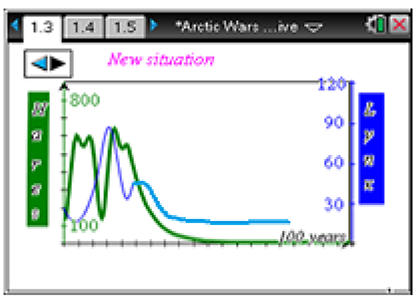
Answer: B. disease that affected the hares

Q6. For each of the answer choices that you did not select in Question 5, explain why it is incorrect.

Sample Answer: Both choices A and D would result in an increase in the hare population. Choice C would result in a decline, but not to zero.

Q7. On the graph below, draw a line that shows the predicted population of the lynx.

Sample Answer:



Q8. Explain your rationale for the predator graph you drew in Question 7.

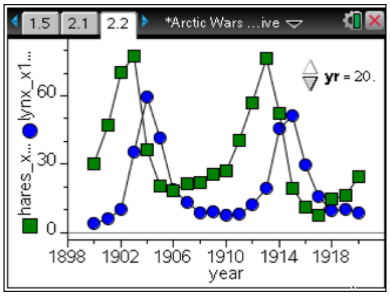
Sample Answer: Since there are other prey besides the snowshoe hare, the predator population will not decrease to zero. It will decrease sooner and to a lower point than in the previous situation. Your students might also hypothesize that another rabbit population will move in. They might also say that, because of increased habitat space, other prey populations will increase. Each scenario would depend upon the time of the year the disease outbreak occurred. Accept any answer that correctly explains the graph.

Move to pages 2.1 and 2.2.

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

Q9. Follow the directions on page 2.1 and draw the lynx graph below.

Sample Answer: Sample graph shown.



Move to page 2.3.

Have students answer Question 10 on the activity sheet.

3. Students return to page 2.2 and add the lynx data by pressing **Menu > Plot Properties > Add Y Variable**.

Q10. How did your prediction match the actual data? Explain.

Answer: Answers will vary.

TI-Nspire Navigator Opportunities

Send out actual data from a predator prey relationship for your students to graph. Capture the graphs for class analysis. Have your students change the data and watch the changes that occur on the graph.

Wrap Up

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

Discuss with your students the variety dynamics at work in a population. Have your students form hypotheses that include additional factors that were not included in this activity. Also discuss other predator prey relationships besides the lynx and the snowshoe hare

Assessment

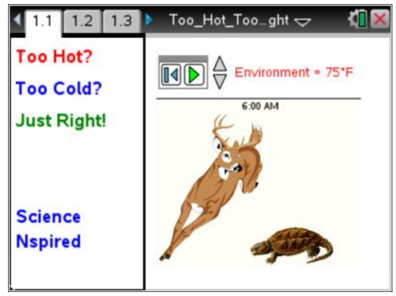
- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved. The Slide Show will be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test.

Too Hot? Too Cold? Just Right!

Student Activity

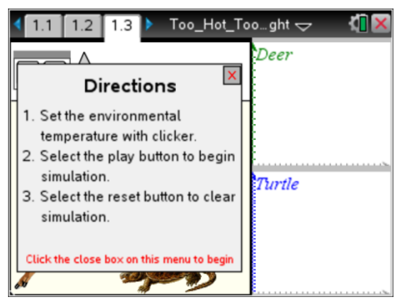
Name ______________

Class ______________



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

Have you ever been in a REALLY cold environment? The coldest temperature ever recorded on Earth was –129°F in Antarctica! How about REALLY hot places? The hottest recorded temperature on Earth was 136°F in Libya, Africa! Both of these extremes are pretty hard to imagine, and both would be virtually impossible to live in. Thankfully, temperatures in most places are much more reasonable than that. However, people and other animals manage to live in places that we consider really cold and really hot. How do they do it? Can ALL animals live anywhere they want? Or do some have an easier time handling extreme temperatures? In this activity, you will observe the metabolic rates of two different animals in various environmental temperatures. One of these animals is an endotherm ("warm-blooded") and the other is an ectotherm ("cold-blooded").



Move to pages 1.2 and 1.3. Answer the following questions here.

On page 1.2, there are some general instructions on how to run the simulation with the deer and the turtle.

Each plot shows the environmental temperature along with the body temperatures of the animal.

1. First, run the simulation at 75°F by selecting the Play button ▷. The entire simulation runs for about a minute and models temperatures for two days. When the simulation is complete sketch the graphs as instructed below.

Q1. To the right, draw a sketch of the graphs that were produced when the environmental temperature was 75°F.

Plots at 75°F

Too Hot? Too Cold? Just Right!

Student Activity

Name ______________

Class ______________

2. Now reset the simulation by selecting . Use the down arrow to lower the environmental temperature and run the simulation again. Then raise the environmental temperature above 75°F and run the simulation again.

Q2. Draw a sketch of the graphs that were produced when the environmental temperature was ***lower*** than 75°F.

Plots at _____°F

Q3. Draw a sketch of the graphs that were produced when the environmental temperature was ***higher*** than 75°F.

Plots at _____°F

Move to pages 2.1 – 2.3. Answer questions 4 – 6 here or in the .tns file.
Answer questions 7 – 14 here.

Q4. Which animal's temperature fluctuated with the environmental temperature?

A. turtle
B. deer
C. both
D. neither

Q5. Which animal's temperature remained pretty constant, even when the environmental temperature changed?

A. turtle
B. deer
C. both
D. neither

Q6. Which variable were you able to manipulate in the simulation?

A. time
B. temperature
C. animal size
D. animal metabolism

Too Hot? Too Cold? Just Right!

Student Activity

Name ________________

Class ________________

Q7. As the sun rose and the temperature got warmer, what happened to the metabolism of the turtle? Why?

Q8. As the sun rose and the temperature got warmer, what happened to the metabolism of the deer? Why?

Q9. As the sun set and the temperature got cooler, what happened to the metabolism of the turtle? Why?

Q10. As the sun set and the temperature got cooler, what happened to the metabolism of the deer? Why?

Q11. What do you predict would be the normal body temperature of the deer?

A. It depends largely on the environmental temperature.
B. About 72°F
C. About 100°F

Q12. What do you predict would be the body temperature of the turtle?

A. It depends largely on the environmental temperature.
B. About 50°F
C. About 110°F

Q13. During cold winter months, it's common to see deer, but not common to see turtles. Why not? What happens to the turtles?

Q14. What strategies to you think deer use in the cold winter months to retain their body heat?

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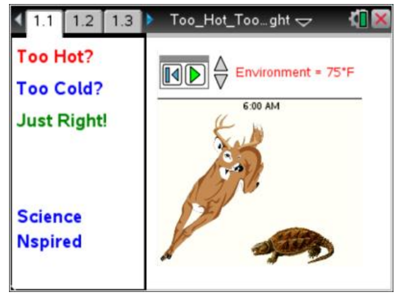
Too Hot? Too Cold? Just Right!

Science Objectives

- Students will simulate environmental temperature changes and observe the effect of temperature change on the metabolic rates of two different animals.
- Students will develop an understanding of the effect of environmental temperatures on endotherms and ectotherms.
- Students will develop an understanding of the relationship between environmental temperature and animal metabolism.



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 Files:

Student Activity

- Too_Hot_Too_Cold_Just_Right_Student.doc
- Too_Hot_Too_Cold_Just_Right_Student.pdf
- Too_Hot_Too_Cold_Just_Right.tns

Vocabulary

- circadian rhythms
- ectotherm
- endotherm
- hibernate
- homeostasis
- insulation

About the Lesson

- This lesson involves students using TI-Nspire technology to simulate the effect of environmental temperature on the metabolisms of both endothermic and ectothermic animals.
- As a result, students will:
  - Differentiate between endothermic and ectothermic animals.
  - Develop an understanding of the physiological needs of endothermic and ectothermic animals.

TI-Nspire™ Navigator™

- Send out the *Too_Hot_Too_Cold_Just_Right.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

Discussion Points and Possible Answers

Regulating body temperature is one of the most critical survival mechanisms for animals. Being able to stay warm or cool can be a real challenge for animals. Although endotherms can regulate their body temperatures, they still need to make use of strategies that help them strictly maintain that temperature. Ectotherms are even more environmentally dependent for their body temperatures.

This would be a good time to brainstorm with your students about the strategic ways that various animals warm up and cool down. This may also be a good time to discuss Circadian rhythms with the students. Circadian rhythms are the daily "patterns" of animals. Some animals are nocturnal—active at night—and others are diurnal—active during the day. If all animals had the same Circadian rhythms, competition for available resources would be more intense.

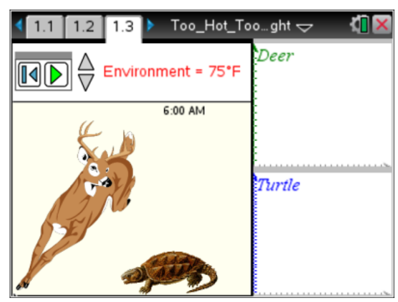
TI-Nspire Navigator Opportunities

Allow students to volunteer to be the Live Presenter and demonstrate how to adjust the environmental temperatures, start the simulation, and reset the simulation.

Move to pages 1.2 and 1.3.

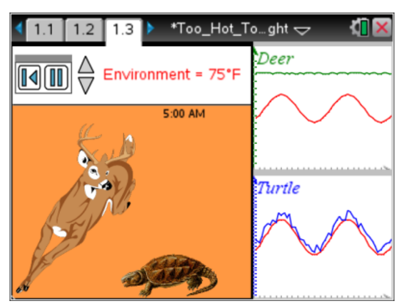
Have students answer Questions 1 – 3 on the activity sheet.

1. Students read the instructions on page 1.2 and then run the simulation on page 1.3 at 75°F. Each plot shows the animal's body temperature and the environmental temperature. The simulation, when run to completion, displays temperature and metabolism for two entire days.



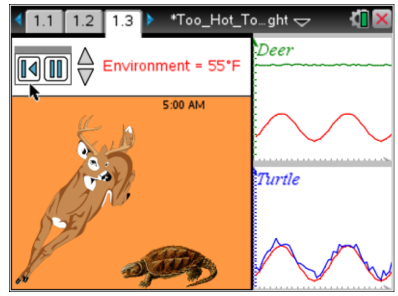
Q1. To the right, draw a sketch of the graphs that were produced when the environmental temperature was 75°F.

Sample Answer: The simulation to the right was run at a temperature of 75°F.



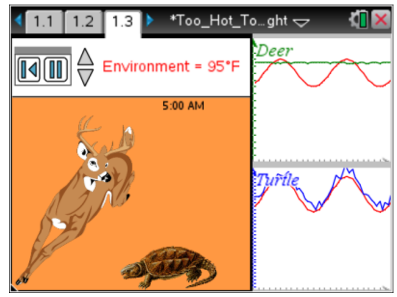
2. Students reset the simulation by selecting [reset icon]. They use the down arrow to lower the environmental temperature and run the simulation again. Then they raise the environmental temperature above 75°F and run the simulation again.

Q2. Draw a sketch of the graphs that were produced when the environmental temperature was ***lower*** than 75°F.



Sample Answer: The simulation to the right was run at a temperature of 55°F. Note the difference in position of the plots in the graph area.

Q3. Draw a sketch of the graphs that were produced when the environmental temperature was ***higher*** than 75°F.



Sample Answer: The simulation to the right was run at a temperature of 95°F. Again, note the positions of the plots.

Move to pages 2.1 – 2.3.

Have students answer questions 4 – 6 on either the device, on the activity sheet, or both.

Have students answer questions 7 – 14 on the activity sheet.

Q4. Which animal's temperature fluctuated with the environmental temperature?

Answer: A. turtle

Q5. Which animal's temperature remained pretty constant, even when the environmental temperature changed?

Answer: B. deer

Q6. Which variable were you able to manipulate in the simulation?

Answer: B. temperature

Q7. As the sun rose and the temperature got warmer, what happened to the metabolism of the turtle? Why?

Answer: It increased. The turtle is an ectotherm, and its body temperature depends on the environmental temperature.

Q8. As the sun rose and the temperature got warmer, what happened to the metabolism of the deer? Why?

Answer: It stayed the same. Deer are endotherms, so their body temperatures don't fluctuate very much.

Q9. As the sun set and the temperature got cooler, what happened to the metabolism of the turtle? Why?

Answer: It decreased. The turtle is an ectotherm, and its body temperature depends on the environmental temperature.

Q10. As the sun set and the temperature got cooler, what happened to the metabolism of the deer? Why?

Answer: It stayed the same. Deer are endotherms, so their body temperatures don't fluctuate very much.

Q11. What do you predict would be the normal body temperature of the deer?

Answer: About 100°F

Q12. What do you predict would be the body temperature of the turtle?

Answer: It depends largely on the environmental temperature.

Q13. During cold winter months, it's common to see deer, but not common to see turtles. Why not? What happens to the turtles?

Answer: The turtles are probably hibernating in the mud at the bottom of ponds and lakes.

Q14. What strategies to you think deer use in the cold winter months to retain their body heat?

Sample answer: Grow more and longer hair; put on body fat as winter approaches; stay out of the cold wind.

Wrap Up

When students are finished with the activity, pull back 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 student worksheet or the .tns file. 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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Watch the Birdie—Breathe!

Student Activity

Name ________________

Class ________________

Open the TI-Nspire document *Watch_the_Birdie_Breathe.tns*

In this activity, you will analyze data in a spreadsheet and graph to explore the relationship between the outside temperature and the amount of oxygen a bird uses.

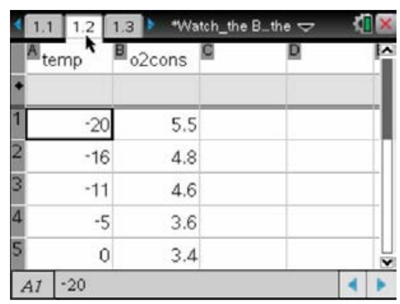
Press ctrl ▶ and ctrl ◀ to navigate through the lesson.

Birds and mammals are very unique critters! They are like reptiles, amphibians, and fish in a lot of ways. But they have one characteristic that sets them apart from all other animals—they are "warm-blooded". The technical word for warm-blooded is ***endothermic***, which means "inside" (endo-) "heat" (-therm).

YOU are an endotherm! You regulate your body heat inside yourself, and you work very hard to keep your body heat at a constant temperature. On the other hand, ***ectotherms***, or "cold-blooded" animals, largely depend on the heat in their environment to keep their bodies warm. Fish, amphibians, and reptiles are ectotherms. Being an endotherm has its advantages, but there is a price to pay. As you look at the data in this activity and answer the questions, think about what this price is and how endotherms deal with it.

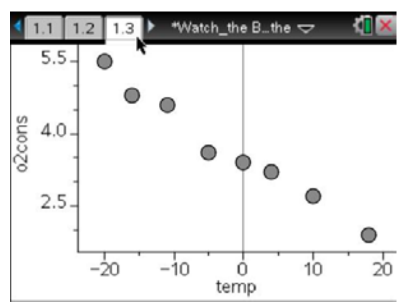
Move to page 1.2.

1. Review the data in the spreadsheet. The temperatures represent the environmental temperatures in degrees Celsius and the oxygen used data is in mL/g of body weight/hour for a small bird, such as a sparrow. Note that the first four temperatures are negative values.



Move to page 1.3.

2. Review the scatter plot. Generate a line of best fit for the data. Press **Menu > Analyze > Regression > Show Linear (mx+b)**.



Move to page 1.4. Use the data to help answer the following questions here or in the .tns file.

Q1. Write the equation for your line of best fit: ___________________________

Q2. What is the rate of change (slope) of the relationship between temperature and oxygen consumption? Make sure you label the rate with units.

Watch the Birdie—Breathe!

Student Activity

Name ______________

Class ______________

Q3. Which variable is the independent variable in the graph, temperature or oxygen consumption?

Q4. Which variable is the dependent variable in the graph?

Q5. Describe the appearance of the graph.

Q6. What is the relationship between temperature and oxygen consumption?

Q7. What is the source of the heat that an endotherm generates?

Q8. The colder it gets, the more oxygen the bird uses. What is the process the bird uses to consume the oxygen that it inhales?

Q9. When would a bird need to eat more, in the summer or in the winter? Explain.

Q10. What are a bird's "choices" for finding and consuming food when the weather gets really cold?

Q11. Why does a bird's oxygen consumption decrease as temperature increases?

Q12. What label should be attached to the rate of change (slope) in this problem? Describe what the rate of change means in the context of this problem.

Q13. If the data in the original data table is from observations of a small bird like a sparrow or a robin, predict how the data would differ for a much larger bird, such as a bald eagle.

Q14. Predict which birds, small birds or large birds, would need to eat more food per gram of body mass. Explain.

Q15. How do you predict the data and graph would be different if you were analyzing oxygen consumption for an ectothermic (cold-blooded) animal, such as a lizard or a turtle?

Watch The Birdie—Breathe!

SCIENCE NSPIRED

Science Objectives

- Students will analyze a mathematical model for the graphical representation of a data set.
- Students will develop an understanding of the relationship between environmental temperature and animal metabolism.

Vocabulary

- dependent variable
- ectotherm
- endotherm
- independent variable

About the Lesson

- This lesson involves students using TI-Nspire technology to analyze a graph of data representing the relationship between the environmental temperature and the resulting metabolism of an endothermic animal.
- As a result, students will:
  - Draw conclusions about how temperature affects metabolism.
  - Compare the temperature effects on both endothermic and ectothermic animals.

TI-Nspire™ Navigator™

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

Activity Materials

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

TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Add a line of best fit to a graph

Tech Tips:

Make sure that students know how to use the touchpad keys (◄, ▲, ►, and ▼) to navigate through menus.

Lesson Materials:

Student Activity

- Watch_the_Birdie_Breathe_Student.doc
- Watch_the_Birdie_Breathe_Student.pdf

TI-Nspire document

- Watch_the_Birdie_Breathe.tns

Discussion Points and Possible Answers

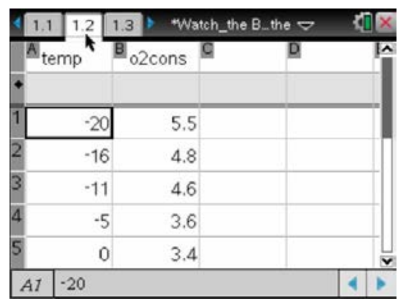
Temperature affects the metabolism of animals in different ways. Endothermic (warm-blooded) animals maintain a fairly constant body temperature, which gives them the advantage of being able to live in virtually any environment on Earth. Ectothermic (cold-blooded) animals have a body temperature that is, in large part, regulated by their external environment. Because of this, they are most abundant in warm environments and have a difficult time surviving in cold environments.

Birds and mammals, the only classes of endotherms, must eat more food in colder environments. This is because they lose so much heat to the environment. Ectotherms show the opposite behavior; eating more when it's warmer because of the increase in their metabolisms. The food energy that an organism consumes is "burned" during aerobic cellular respiration, which requires oxygen. Therefore, the higher the bird's metabolism, the higher the rate of cellular respiration and therefore oxygen consumption.

Students will explore this through data in this activity. After analyzing data in the spreadsheet, they will model the graph data with a regression model.

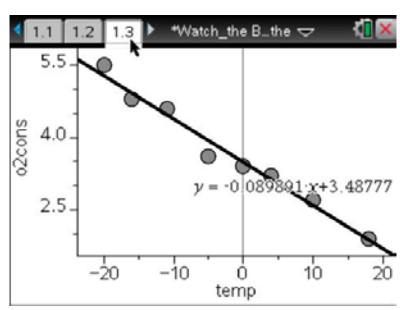
Move to pages 1.2–1.3.

1. Review the data in the spreadsheet. The temperatures represent the environmental temperatures in degrees Celsius and the oxygen used data is in mL/g of body weight/hour for a small bird, such as a sparrow.



> **Tech Tip:** To analyze which variable should be the independent variable, students may wish modify the graph. The variable for an axis can be changed by clicking on a variable name at the bottom of the screen or left side of the screen or by **pressing Menu > Plot Properties > Remove X Variable** (or **Remove Y Variable**). Then add a variable by clicking on the box that appears on the screen or by **pressing Menu > Plot Properties > Add X Variable** (or **Add Y Variable**).

2. The regression equation in the form of y = mx + b appears when the linear regression is generated. To generate the regression equation, press **Menu > Analyze > Regression > Show Linear (mx+b)**.



Move to page 1.4. Have students answer the questions on pages 1.4–1.18 here or on their worksheet.

Q1. Write the equation for your line of best fit: _________________

Answer: $y = -0.09x + 3.488$

Q2. What is the rate of change (slope) of the relationship between temperature and oxygen consumption? Make sure you label the rate with units.

Answer: –0.09 mL / g / hour / °C

Q3. Which variable is the independent variable in the graph, temperature or oxygen consumption?

Answer: temperature (**temp**)

Q4. Which variable is the dependent variable in the graph?

Answer: oxygen consumption (**o2cons**)

Q5. Describe the appearance of the graph.

Answer: Answers will vary: As temperature goes up, oxygen consumption goes down.

Q6. What is the relationship between temperature and oxygen consumption?

Answer: Inverse

Q7. What is the source of the heat that an endotherm generates?

Answer: Burning of food via cellular respiration

Q8. The colder it gets, the more oxygen the bird uses. What is the process the bird uses to consume the oxygen that it inhales?

Answer: Cellular respiration

Q9. When would a bird need to eat more, in the summer or in the winter? Explain.

Answer: Winter, because they burn up their food faster in the winter in order to maintain their body temperature.

Q10. What are a bird's "choices" for finding and consuming food when the weather gets really cold?

Answer: Eat more or find somewhere warmer to live (migrate).

Q11. Why does a bird's oxygen consumption decrease as the temperature increases?

Answer: There is not as great a difference between body temperature and environmental temperature (not as steep of a temperature gradient), so heat is not lost as quickly.

Q12. What label should be attached to the rate of change (slope) in this problem? Describe what the rate of change means in the context of this problem.

Answer: mL O2/g/hour/degree C. For each degree increase or decrease, the oxygen consumption increases or decreases by a certain value

Q13. If the data in the original data table is from observations of a small bird like a sparrow or a robin, predict how the data would differ for a much larger bird, such as a bald eagle.

Answer: The oxygen consumption per gram would not have been as high because of the volume of the larger bird

Q14. Predict which birds, small birds or large birds, would need to eat more food per gram of body mass. Explain.

Answer: Small birds because they lose heat to the environment more quickly because of their high SA/V ratio

Q15. How do you predict the data and graph would be different if you were analyzing oxygen consumption for an ectothermic (cold-blooded) animal, such as a lizard or a turtle?

Answer: It would have been just the opposite: as temperature increased, the oxygen consumption would have increased

TI-Nspire Navigator Opportunities

Perhaps make a student a Live Presenter to demonstrate to the other students how to generate a linear regression.

Wrap Up

When students are finished with the activity, pull back 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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Recipe for a Living World

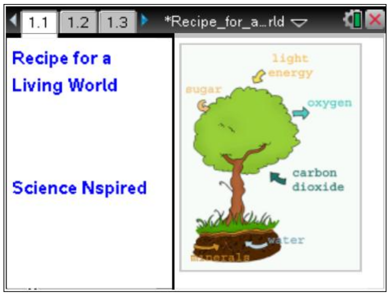
Student Activity

Name ________________

Class ________________

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

Very few recipes have an ingredients list that is so short or so simple. The recipe card could read like this:



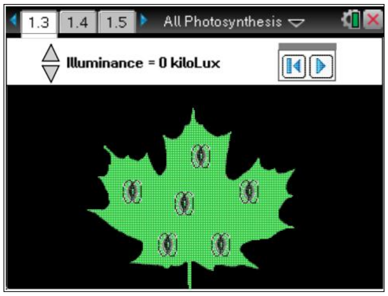
1. Take equal parts carbon dioxide, gas, and water.
2. Allow the CO_2 and H_2O to meet inside a plant cell.
3. Expose the plant cell to light.
4. Make sure the correct equipment is available in the plant cell, and that the temperature is right.
5. In only a few minutes, you will have some sugar and some oxygen gas. Get rid of the oxygen and feed Planet Earth with the sugar!
6. Repeat.

Seriously? Who would believe this?! And yet, it's true! Plants, as well as some simpler organisms such as algae, carry on photosynthesis. This process involves using a gas (CO_2) from the air, liquid water (H_2O) from the ground, light energy, and some cellular equipment and supplies. The end result is to produce enough food for almost every organism on Earth—including themselves! Next time you look at a plant and think to yourself, "BORING! They just stay in one place and don't do ANYTHING!" – think again! There is enough going on inside that plant to put the busiest kitchen to shame!

Many variables affect the rate and efficiency of photosynthesis. In the first simulation, you will adjust and observe the effect of the color (wavelength) of visible light on the rate of photosynthesis. In the second simulation, you will manipulate the intensity of the light on a plant and observe how this variable impacts photosynthesis rates.

Move to pages 1.2–1.3.

Read the background information on page 1.2.



1. On page 1.3 you will see a picture of a leaf with 6 ***stomata*** that will be used as a monitor of the rate of photosynthesis as the ***illuminance*** (or intensity) of light is increased. In real life, stomata are microscopic, and there are often thousands of them on one leaf. During this simulation, the more stomata are open, the greater the rate of photosynthesis. ***Pay attention to the stomata as you make your adjustments.***
2. When you are ready, click on the start arrow. Then click on the "up arrow" to change the wavelength of light (λ) to which the leaf is exposed. Again, watch both the stomata and the illuminance value as you proceed. Continue to increase the wavelength until it will no longer change, then move to the graph on page 1.4.

Recipe for a Living World

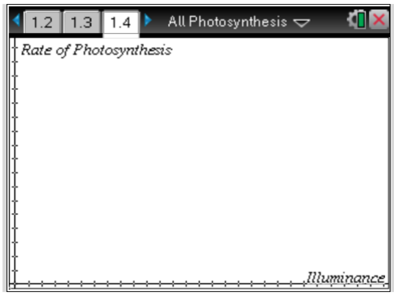
Student Activity

Name ______________

Class ______________

Move to pages 1.4–1.5.

Q1. Sketch your graph in the space to the right. To reset the simulation and run it again, click on the reset button.



Move to pages 1.6–1.8. Answer the following questions here or in the .tns file.

Q2. As the light intensity increases, the rate of photosynthesis __________.

A. increases B. decreases C. stays the same

Q3. As the rate of photosynthesis increases, which of the following substances would you expect to decrease?

A. oxygen C. glucose

B. carbon dioxide D. chlorophyll

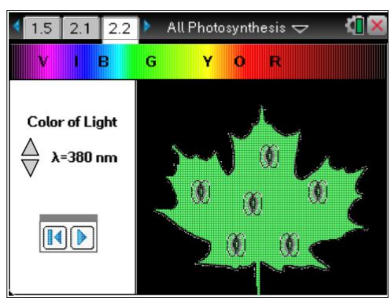
Q4. During which of the following months would you expect photosynthesis rates to be highest in the Southern Hemisphere?

A. January C. June

B. April D. August

Move to page 2.1–2.5.

Read the brief background information on page 2.1.



3. On page 2.2, you'll see another picture of a leaf with stomata. However, for this simulation, you will change the ***wavelength*** of visible light to which the leaf is exposed. The ***visible spectrum*** (ROYGBIV) is displayed across the top of the screen. As with the simulation in Problem 1, the more stomata that are open, the greater the rate of photosynthesis. Pay attention to both the spectrum and the stomata as you make your adjustments. When you are ready, select the start arrow. Then click on the "up arrow" to change the wavelength. Changing wavelength changes the color, of the light to which the leaf is exposed. After you reach the upper limit of the wavelength (780 nm), move to pages 2.3 and 2.4 and observe the graphs that were generated.

Recipe for a Living World

Student Activity

Name _______________

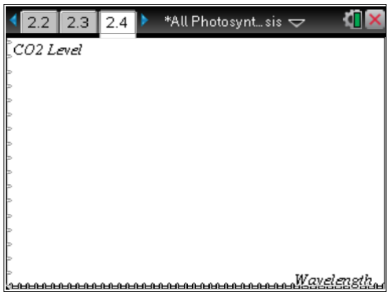
Class _______________

Q5. Sketch both graphs in the spaces to the right.

Q6. Explain why the graphs look the way they do.

Photosynthesis Rate:

CO_2 Level:



Q7. Why do you think ROYGBIV was displayed backward on page 2.2?

Q8. Which wavelengths of light were best for photosynthesis? How can you tell?

Q9. Which colors of light were best for photosynthesis?

Q10. Which wavelengths of light were least used for photosynthesis?

Q11. Which colors of light were least used for photosynthesis?

Recipe for a Living World

Student Activity

Name ______________

Class ______________

Q12. How does your answer to Question 11 explain the color of most plants?

Q13. During the simulation, how could you tell which wavelengths were best for photosynthesis and which ones were not?

Q14. What would happen if a plant were exposed ONLY to green light? Why?

Q15. Describe a place on Earth where photosynthesis rates would tend to be consistently very high. Explain.

Science Objectives

- Students will develop a deeper understanding of the variables affecting the rate of photosynthesis in plants.
- Students will manipulate variables, such as light intensity and wavelength of light, to observe the effects on photosynthesis rates.

Vocabulary

- illuminance
- photosynthesis
- stomata
- visible spectrum
- wavelength

About the Lesson

- In this lesson students will observe the effects of certain variables on the rate of photosynthesis in a plant.
- As a result, students will:
  - Better understand the importance of the visible portion of the electromagnetic spectrum.
  - Develop an understanding of reflection and absorption of light energy by a pigment.

TI-Nspire™ Navigator™

- Send out the *Recipe_for_a_Living_World.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.
- Collect embedded assessment questions from Problem 1.

Activity Materials

- Compatible TI Technologies: TI- Nspire™ CX Handhelds, TI-Nspire™ Apps 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

- Recipe_for_a_Living_World_Student.doc
- Recipe_for_a_Living_World_Student.pdf

TI-Nspire document

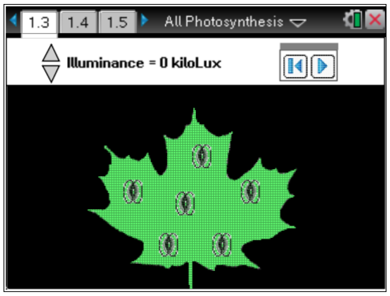
- Recipe_for_a_Living_World.tns

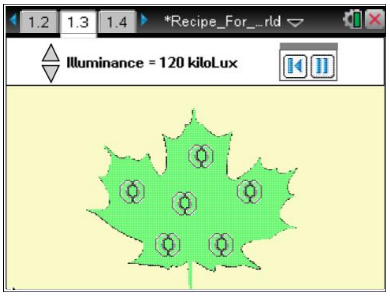
Discussion Points and Possible Answers

Move to page 1.2.

Students read the brief background information on page 1.2. Because light is typically not included as a substance in the generalized equation for photosynthesis, it is often overlooked. Without light, however, the entire process of photosynthesis would grind to a halt. Many components must be in place in order for photosynthesis to occur. Yet if there is no energy input at the outset, no food can be made. In the simulation found in Problem 1, students will observe the effects of light intensity (illuminance, measured in kiloLux) on the rate of photosynthesis.

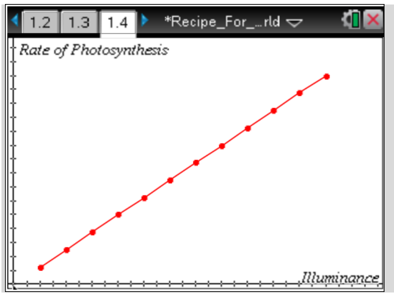
Move to page 1.3.





1. On page 1.3, students need to click on the start arrow and then repeatedly click on the "up arrow" to increase the light intensity from 0 to the maximum to 120 kiloLux. They will see the screen background go from black to bright as the illuminance is increased. The number of stomata that are open can be used as a guideline for the rate of photosynthesis as the light intensity is increased.
2. To run the simulation again, students may click on the reset arrow and start over. As they increase the light intensity, they generate a graph on page 1.4. Following the graph, the three questions below are found in the .tns document.

Move to pages 1.4-1.5.



Q1. Students sketch graph in the space to the right. To reset the simulation and run it again, click on the reset button.

Answer: See the graph to the right.

Move to pages 1.6–1.8.

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

Q2. As the light intensity increases, the rate of photosynthesis __________.

Answer: A. increases

Q3. As the rate of photosynthesis increases, which of the following substances would you expect to decrease?

Answer: B. carbon dioxide

Q4. During which of the following months would you expect photosynthesis rates to be highest in the Southern Hemisphere?

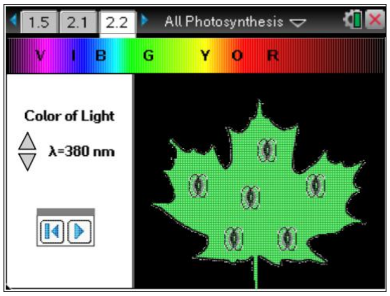
Answer: A. January

Discussion Points and Possible Answers

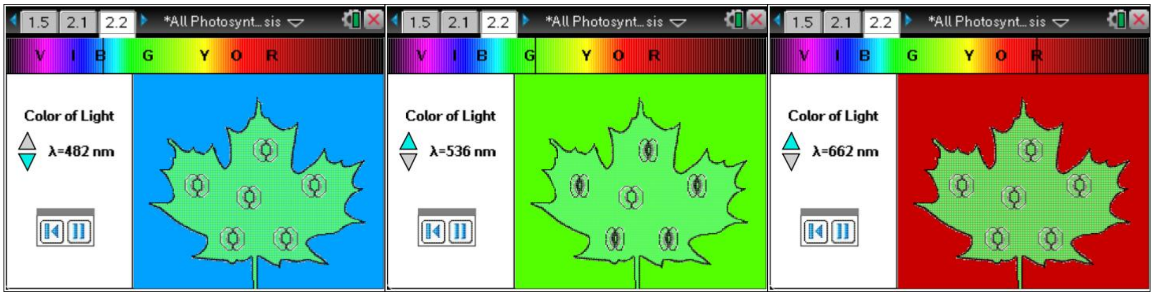
Move to pages 2.1–2.5.

Students will read the brief background information on page 2.1.

3. In this interactive simulation, students will observe the impact of the wavelength (color) of light on the rate of photosynthesis. To start the simulation on page 2.2, students click on the start arrow. They then click repeatedly on the "up arrow" to increase the ***wavelength*** of visible light to which the leaf is exposed. They should continue to increase the wavelength until they reach the upper limit of 780 nm. As they increase the wavelength, an indicator moves across the ***visible spectrum*** (ROYGBIV) at the top of the screen. The background of the screen also changes as the wavelength increases, as do the number of stomata that are open and closed. Remind students to pay attention to the opening and closing of the stomata at various wavelengths. This is an indication of the rate of photosynthesis. Sample screens are below. Sample graphs are on the right.

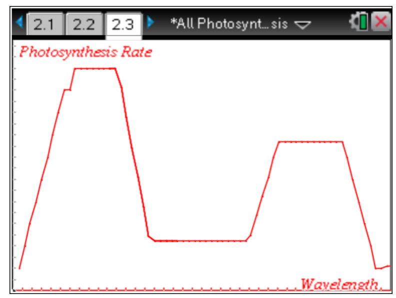


Light certainly plays a huge role in the efficiency and rate of photosynthesis. However, other variables not addressed in this activity, are involved. You may wish to discuss the importance of water to the photosynthetic process. And the most critical limiting factor to the rate of photosynthesis is often carbon dioxide, since the atmospheric concentration is only 0.04%. If environmental conditions are really good for photosynthesis, the plant can actually deplete the level of carbon dioxide around the leaf. This can lead to an undesirable result called "photorespiration." If desired, discuss this problem with your students, and introduce the idea of C4 and CAM plants to them. These plants manage to avoid photorespiration because of an alternative pathway to glucose production.



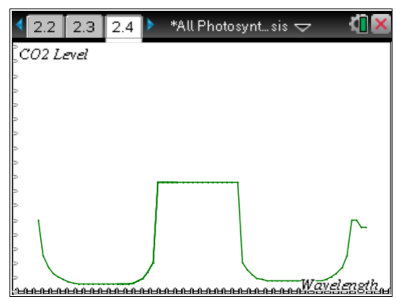
Students will answer the following questions on the student activity sheet.

Q5. Sketch both graphs in the spaces to the right.



Answer: See the sketches to the right.

Q6. Explain why the graphs look the way they do.



Photosynthesis Rate: The plant can absorb and use light energy with wavelengths in the blue and red ranges, but not with wavelengths in the green range. This is why there are peaks of activity in the blue and red ranges and a valley in the green range.

CO_2 Level: The CO_2 level in the air around a leaf will be inversely proportional to the rate of photosynthesis. Therefore the levels of CO_2 will be lower when the rate of photosynthesis is higher, and vice versa.

Q7. Why do you think ROYGBIV was displayed backward on page 2.2?

Answer: The spectrum is arranged by increasing wavelength, with the shorter wavelengths to the left (violet) and the longer wavelengths to the right (red).

Q8. Which wavelengths of light were best for photosynthesis? How can you tell?

Answer: About 440–460nm and 660–700nm. These regions of the spectrum showed the peaks in photosynthesis rate.

Q9. Which colors of light were best for photosynthesis?

Answer: Blue and red. These regions of the spectrum showed the peaks in photosynthesis rates.

Q10. Which wavelengths of light were least used for photosynthesis?

Answer: from about 530–620nm

Q11. Which colors of light were least used for photosynthesis?

Answer: mostly green and colors around green in the spectrum

Q12. How does your answer to Question 11 explain the color of most plants?

Answer: Plants are green because they have chlorophyll, which reflects green light, rather than absorbing it and using it for photosynthesis.

Q13. During the simulation, how could you tell which wavelengths were best for photosynthesis and which ones were not?

Answer: You could tell by looking and the "peaks" and "valleys" on the first graph.

Q14. What would happen if a plant were exposed ONLY to green light? Why?

Answer: Photosynthesis would occur very slowly, or not at all, and the plant would eventually die of starvation.

Q15. Describe a place on Earth where photosynthesis rates would tend to be consistently very high. Explain.

Answer: Best answer would be either a tropical rain forest or tropical oceans and seas. Light intensity is high and there is plenty of water available.

TI-Nspire Navigator Opportunities

Ask students to share their screens as they pause at various wavelengths in Problem 2. Discuss the results with the entire class. Question responses from Problem 1 may be collected and assessed using TI-Nspire Navigator.

Use TI-Nspire Navigator to capture screen shots of student progress and to retrieve the file from each student at the end of the class period. The student questions can be electronically graded and added to the student portfolio.

Wrap Up

When students are finished with the activity, pull back 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. 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.

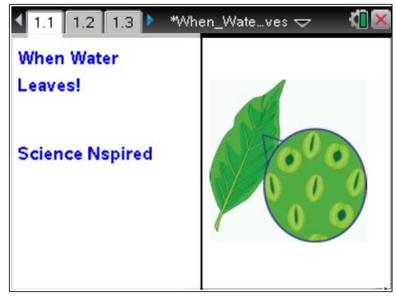
When Water Leaves!

Student Activity

SCIENCE NSPIRED

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

You have always known that plants needed water. When a plant goes only a few days without water, it starts to look pretty bad. What factors influence how quickly plants lose water? This will be explored during this activity.



Water is one of the ***reactants*** in the photosynthetic process, and it maintains the ***turgor pressure*** (pressure against cell walls) in plant cells. This outward pressure keeps the leaves of the plant from drooping. Droopy leaves display less surface area to the sun, thereby reducing ***photosynthesis***. This causes the plant to produce fewer nutrients.

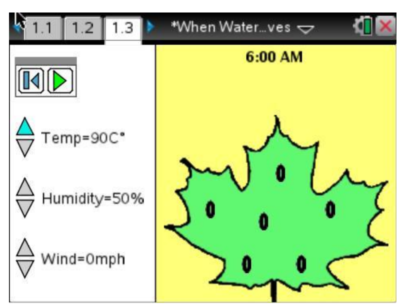
Plants take in water through their roots, and the water travels through the plant to the leaves. The water that is not used for either photosynthesis or maintaining turgor pressure is released from the leaves. In fact, most of the water that a plant takes in is never used by the plant. And the amount of water that leaves the plant is staggering. A 50 foot tall maple tree loses about 60 gallons of water per hour from the surfaces of its leaves.

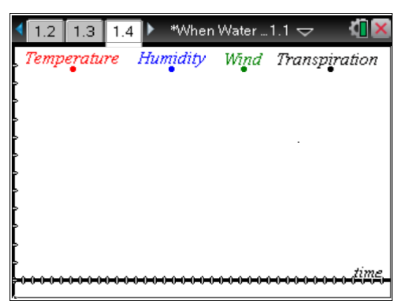
Transpiration is the process of water escaping from leaves through pores called ***stomata***. Stomata also allow for gas exchange (CO_2 and O_2) for the plant. A number of environmental factors affect transpiration rate, such as temperature, relative humidity, and wind. In the simulation in this activity, you will be able to manipulate these environmental factors and see what effect they have on transpiration rates.

Move to pages 1.2–1.4.

After reading the background information on page 1.2, move to page 1.3. Page 1.3 shows a picture of a leaf, along with some environmental conditions that you will eventually manipulate.

1. For the first simulation, leave the conditions as they are and click on the start arrow . The simulation takes a couple of minutes to run to completion. While the simulation is running on page 1.3, periodically move to 1.4 so you can see both the diagrammatic and graphical representations. When the simulation is finished, a graph with four plots will display patterns for you to analyze.





When Water Leaves! — Student Activity

SCIENCE NSPIRED

Answer the following questions (Q1- Q7) here.

Q1. In the graph space to the right, sketch and label the four plots.

Q2. Why did the "peaks" in the temperature and transpiration plots occur at nearly the same time?

Q3. Predict how the graph would change if you increased the temperature.

Q4. Predict how the graph would change if you decreased the temperature.

Q5. Does the transpiration rate change when the temperature changes? Explain.

2. Reset the animation on page 1.3 by clicking on the icon. Run the simulation two more times—one with the temperature set at 90°F and the other with the temperature set at 50°F. To adjust the temperatures, click on the up and down arrows next to the "Temp" control.
3. Sketch the graphs below.

Q6. **Graph at 90°F.**	Q7. **Graph at 50°F.**

4. Now you may change the environmental conditions in any ways you would like. Run the simulation at least four more times, record the conditions, and then sketch your resulting graphs.

Simulation 1: ***Temp: ______ Humidity: ______ Wind: ______*** ***Graph:***	***Simulation 2:*** ***Temp: ______ Humidity: ______ Wind: ______*** ***Graph:***
Simulation 3: ***Temp: ______ Humidity: ______ Wind: ______*** ***Graph:***	***Simulation 4:*** ***Temp: ______ Humidity: ______ Wind: ______*** ***Graph:***

Analysis Questions

Move to page 2.1-2.5.
Answer the following questions here or in the .tns file.

Q8. Which one of the following is true?

A. Plants make use of almost all of the water they take in.
B. Most of the water that a plant takes in is released through the leaves.
C. Water and oxygen are the two reactants in the process of photosynthesis.
D. Transpiration happens through the roots.

Q9. Water actually leaves the plant through small pores called ________________________.

Q10. Select all of the following that would increase the rate of transpiration. (More than one response may be correct.)

A. high humidity
B. strong winds
C. cool temperatures
D. low humidity
E. hot temperatures

Q11. What process in humans is most similar to transpiration in plants?

Q12. Which of the following could result if a plant does not have enough water? Choose all that would be correct. (More than one response may be correct.)

A. Photosynthesis rates would decrease.
B. Carbon dioxide usage would increase.
C. All of the stomata would open and stay open.
D. Turgor pressure in leaf cells would decrease.

Answer the following questions here.

Q13. Describe how the environmental temperature affects the rate of transpiration.

Q14. Describe how relative humidity affects the rate of transpiration.

Q15. Describe how wind affects the rate of transpiration.

Q16. Describe the weather conditions on a day when transpiration rates would most likely be high.

Q17. Describe the weather conditions on a day when transpiration rates would most likely be low.

Q18. How do you think plants regulate the rate of transpiration?

Q19. Describe how wind affects the rate of transpiration.

Q20. What structural adaptations do you think desert plants have to reduce transpiration? Explain how these adaptations reduce transpiration.

Q21. Describe a terrestrial environment in which plants might have really large leaves with lots of stomata.

Q22. Water regulation is critical for all animals and plants—including humans. Perspiring is one means by which humans regulate water for our bodies. How are perspiring and transpiration similar? How are they different?

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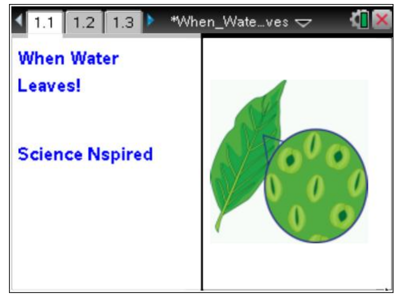
When Water Leaves!

TEACHER NOTES

SCIENCE NSPIRED



Science Objectives

- Students will investigate and discover relationships among dissolved oxygen levels, pH, and temperature.
- Students will manipulate the levels of temperature and pH to determine the effects on dissolved oxygen, population and species richness in a freshwater system.

Vocabulary

- gradient
- photosynthesis
- relative humidity
- stomata
- transpiration
- turgor pressure

About the Lesson

- This lesson involves students using TI-Nspire™ technology to model the effects of various environmental conditions on the rate of transpiration from the leaves of a plant.
- As a result, students will:
  - Better understand the process of transpiration.
  - Predict the effect of these environmental conditions on the plant.

TI-Nspire™ Navigator™

- Send out the .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 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

- When_Water_Leaves_Student.doc
- When_Water_Leaves_Student.pdf

TI-Nspire document

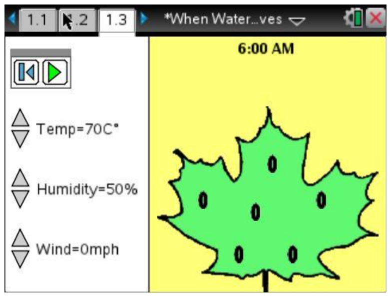
- When_Water_Leaves.tns

Discussion Points and Possible Answers

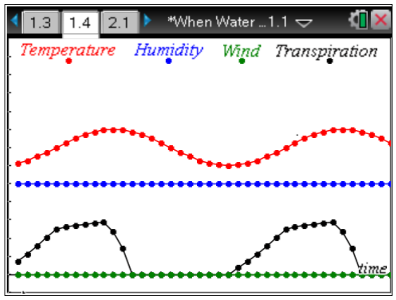
Water moves through a plant from roots to stem to leaves to air. The most important driving force behind this movement is transpiration. More generally, the movement of water is based on a gradient of water. The plant acts as a conduit between the soil and air. Since there is more water in the soil than in the air, water moves upward. Eventually water leaves the plant through stomata, and then more water moves up to replace it. The more water that leaves, the more is needed to replace it. A tree can transpire hundreds of gallons of water every day.

Move to pages 1.2–1.4.

After reading the background information on page 1.2, students will move to page 1.3. Page 1.3 shows a picture of a leaf, along with some environmental conditions that students will eventually manipulate.



1. The simulation in this activity models transpiration rates as environmental conditions change. First, the students should run the simulation at the default settings on Page 1.3 of the .tns file—and in the image at the right above. When they run this simulation, the graph that they see looks like the one at the right below. Notice that the relative humidity and wind plots do not change. The transpiration rate follows a similar pattern as the temperature went through the daily cycles.



Tech Tip: Ensure students reset the animation between trials. Resetting the animation deletes previous data and clears the graph.

Now, have students answer the Questions Q1- Q5 on the student activity sheet.

Q1. In the graph space to the right, sketch and label the four plots.

Answer: See the graph to the right of students' activity sheets.

Q2. Why did the "peaks" in the temperature and transpiration plots occur at nearly the same time?

Answer: Increases and decreases in temperature cause corresponding increases and decreases in molecular movement. Therefore, the rate of water evaporation corresponds to the temperature.

Q3. Predict how the graph would change if you increased the temperature.

Sample answer: Answers will vary.

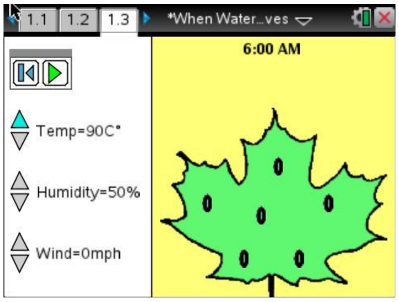
Q4. Predict how the graph would change if you decreased the temperature.

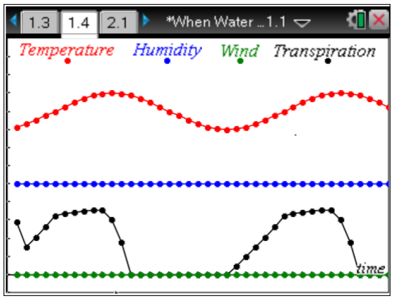
Sample answer: Answers will vary.

Q5. Does the transpiration rate change when the temperature changes? Explain.

Answer: The transpiration rate increases or decreases with the temperature.

Changing the Environmental Conditions

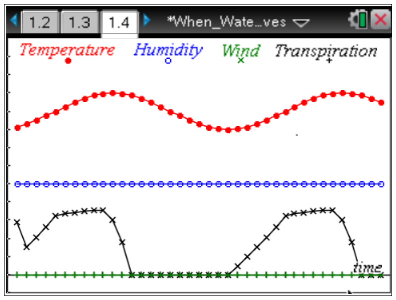




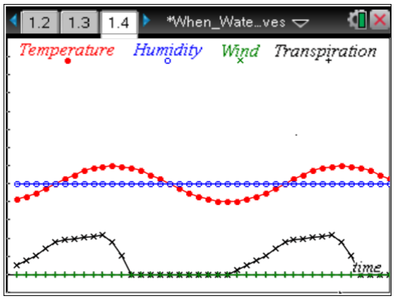
2. After running the simulation at the default settings, the students are asked to do two more simulations at different temperatures—one warmer at 90°F and one cooler at 50°F. The warmer one will show a corresponding increase in transpiration and the cooler one will show a decrease. A simulation that was run at 90°F is shown to the right.
3. After students run the simulations, they are asked to sketch the graphs.

Now, have students answer the Questions Q6- Q7 on the student activity sheet.

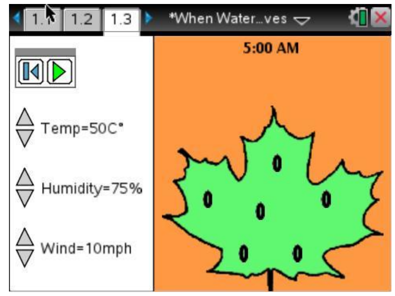
Q6. **Graph at 90°F.**

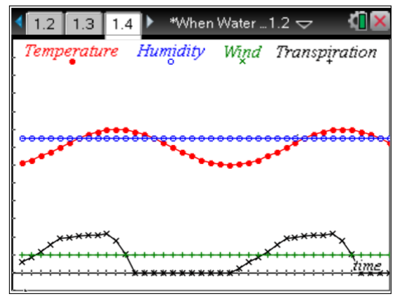


Q7. **Graph at 50°F.**



4. Finally, the students are asked to run the simulation at least four more times and adjust the environmental conditions in any way that they choose. They need to write down their chosen conditions and then sketch the resulting graphs in the spaces provided. One example of environmental conditions is shown to the right. The students need to simply click on the up and down arrows to the left of each condition to adjust that condition. Here is what the graph looks like with the conditions shown above the graph.





Analysis Questions

Move to page 2.1.

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

Q8. Which of the following is true?

Answer: B: Most of the water that a plant takes in is released through the leaves.

Q9. Water actually leaves the plant through small pores called ______________________.

Answer: stomata

Q10. Select all of the following that would increase the rate of transpiration. (More than one response may be correct.)

Answer: B. strong winds / D. low humidity / E. hot temperatures

Q11. What process in humans is most similar to transpiration in plants?

Answer: perspiring

Q12. Which of the following could result if a plant does not have enough water? Choose all that would be correct. (More than one response may be correct.)

Answer: A. Photosynthesis rates would decrease / D. Turgor pressure in leaf cells would decrease

Have students answer these final questions on the activity sheet.

Q13. Describe how environmental temperature affects the rate of transpiration.

Answer: Higher temperatures promote higher rates of transpiration—unless the stomata close up.

Q14. Describe how relative humidity affects the rate of transpiration.

Answer: Higher humidity reduces transpiration because the gradient is not as “steep”

Q15. Describe how wind affects the rate of transpiration.

Answer: Wind increases evaporation, thus increasing transpiration rates.

Q16. Describe the weather conditions on a day when transpiration rates would most likely be high.

Answer: Hot, low humidity, windy

Q17. Describe the weather conditions on a day when transpiration rates would most likely be low.

Answer: Cool, high humidity, calm winds

Q18. How do you think plants regulate the rate of transpiration?

Answer: Open and close their stomata at “strategic” times.

Q19. Describe how wind affects the rate of transpiration.

Answer: It increases the rate of evaporation and, therefore, the rate of transpiration.

Q20. What structural adaptations do you think desert plants have to reduce transpiration? Explain how these adaptations reduce transpiration.

Answer: Leaves have less surface area (like spines on cacti) and very few stomata. With fewer stomata, leaves lose less water through transpiration.

Q21. Describe a terrestrial environment in which the plants might have exceptionally large leaves with lots of stomata.

Answer: An example is a tropical rain forest, where lack of water is not a limiting factor.

Q22. Water regulation is critical for all animals and plants—including humans. Perspiring is one means by which humans regulate water for our bodies. How are perspiring and transpiration similar? How are they different?

Answer: Similar—both involve the loss of water from the organism through small pores on the surface. Different—the main purpose of perspiring is temperature regulation, while the main purpose of transpiration is to get rid of excess water. Humans have other ways of releasing excess water, namely urination and breathing.

TI-Nspire Navigator Opportunities

Ask students to share their screens showing the environmental conditions that they selected. They should also show the resulting graphs that they generated. Discuss the results with the entire class.

Wrap Up

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

Assessment

- Analysis questions are written into the student worksheet.
- Formative assessment will consist of questions embedded in the .tns file. 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.

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

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

Move to page 1.2.

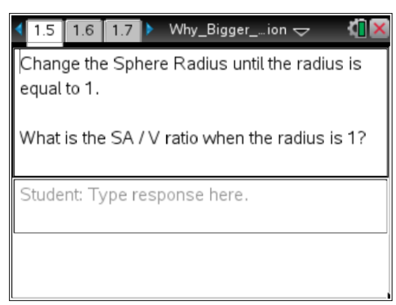
Did you know that the biggest cell on the planet is an ostrich egg? In contrast, most cells are FAR smaller. For example, red blood cells are only 7 or 8 MILLIONTHS of a meter in diameter, and the biggest bacterial cells are about 1/10th the size of red blood cells! Why are most cells so small? In Biology,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

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

1. Follow the directions within the simulation .tns file. To watch the animation on the handheld, select **Menu > Why Bigger is Not Better > Start Animation**. To stop the animation, select **Menu > Why Bigger is Not Better > Stop Animation**.

> **Tech Tip:** To watch the animation, select 🔧 **> Why Bigger is Not Better > Start Animation**. To stop the animation, select 🔧 **> Why Bigger is Not Better > Stop Animation**. You may need to back-out to the main Tools Menu 🔧 to see the desired menu option.

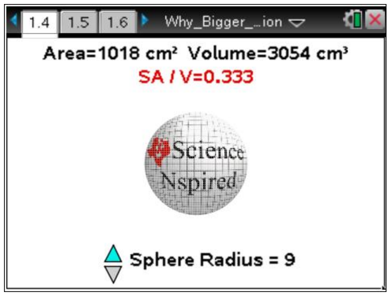
Move to pages 1.5 through 1.12.



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

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

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



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

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

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

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

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

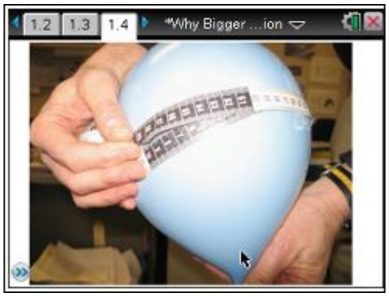
Q7. As the radius of a sphere (cell) _______, the SA/V ratio of that sphere (cell) ________.

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

Now, open *Why_Bigger_Is_Not_Necessarily_Better_Data_Collection.tns*.
Move to page 1.2.

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

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



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

> **Tech Tip:** To enter data into the spreadsheet on Page 1.5, tap a cell twice. The keyboard will appear. Enter the value and then select Enter.

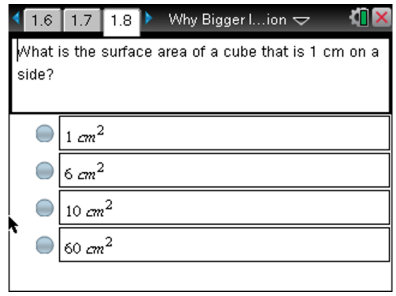
Next, you'll be graphing some of the data from the spreadsheet, so you can infer the relationship between the surface area and the volume of the balloon.

5. Page 1.7 is a Data and Statistics page. Select the horizontal axis, and select **volume** for your independent variable.

6. Select the vertical axis, and select **sa_to_vol** for your dependent variable.
7. Once you have plotted the data, determine which regression model best fits the data. To create a best fit line on the handheld, select **Menu > Analyze > Regression**.

> **Tech Tip:** To create a best fit line, select 🔧 **> Analyze > Regression**. Then, select the appropriate model. You may need to back-out to the main Tools Menu 🔧 to see the desired menu option.

Move to pages 1.8 through 1.17.



Q8. As your balloon got bigger, what happened to the surface area?
A. It got bigger. B. It got smaller. C. It stayed the same.

Q9. As your balloon got bigger, what happened to the volume?
A. It got bigger. B. It got smaller. C. It stayed the same.

Q10. As your balloon got bigger, what happened to the SA/V ratio?
A. It got bigger. B. It got smaller. C. It stayed the same.

Q11. If you know the circumference of a circle or a sphere, how can you calculate the radius?
A. Multiply the circumference by 2π
B. Divide the circumference by 2π
C. Multiply the circumference by πr^2
D. Divide the circumference by 2πr

Q12. Measurements for _______ are expressed as units^2, while measurements for _______ are expressed as units^3.
A. volume; surface area B. surface area; volume C. surface area; diameter D. volume; radius

Q13. The formula for the SA of a sphere is $4\pi r^2$. The formula for the volume of a sphere is (4/3)πr3. Plug these individual formulas into the fraction: SA/V. Then simplify the resulting fraction.

Q14. Two people are 6'3" tall. One weighs 170 pounds, while the other weighs 270 pounds. Which of these two people has a greater SA / V ratio?
A. The one weighing 170 pounds B. The one weighing 270 pounds

Q15. In really hot weather, which of the two people from the previous question would have a tougher time cooling off by getting rid of body heat?
A. The one weighing 170 pounds B. The one weighing 270 pounds

Q16. Mammals that live in the desert tend to be "lanky" with large, thin ears. Those that live in the arctic tend to be "round" shaped with very small, hair-covered ears. Why?

A. Managing body temperature is critical to survival in both environments.

B. It helps both be better camouflaged.

C. It helps them avoid predators.

Why Bigger is Not Necessarily Better

Science Objectives

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

Vocabulary

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

About the Lesson

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

TI-Nspire™ Navigator™

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

Activity Materials

- Latex balloons
- Tape measure (or meter sticks and string)
- Compatible TI Technologies: TI- Nspire™ CX Handhelds, TI-Nspire™ Apps 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

- Why_Bigger_is_Not_Necessarily_Better_Student.pdf
- Why_Bigger_is_Not_Necessarily_Better_Student.doc

TI-Nspire document

- Why_Bigger_is_Not_Necessarily_Better_Simulation.tns
- Why_Bigger_is_Not_Necessarily_Better_Collection.tns

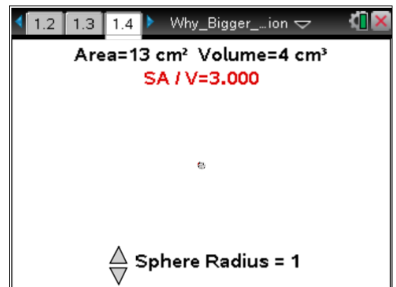
Discussion Points and Possible Answers (Simulation.tns)

Tech Tip: To watch the animation, select **Menu > Why Bigger is Not Better > Start Animation**. To stop the animation, select **Menu > Why Bigger is Not Better > Stop Animation**.

Tech Tip: To watch the animation, select **> Why Bigger is Not Better > Start Animation**. To stop the animation, select **> Why Bigger is Not Better > Stop Animation**. Students may need to back-out to the main Tools Menu to see the desired menu option.

Move to page 1.4.

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

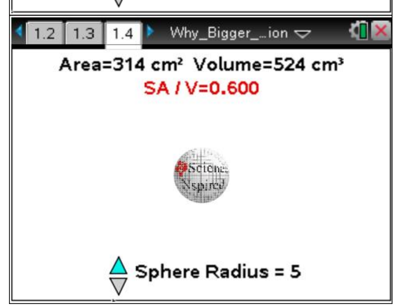


Answer: 3

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

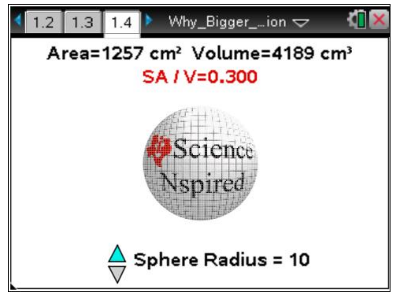
Answer: 1

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



Answer: 0.6

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



Answer: 0.3

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

Answer: They increased

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

Answer: The plasma membrane

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

Answer: increases; decreases

Discussion Points and Possible Answers (Collection.tns)

Tech Tip: To enter data into the spreadsheet on Page 1.5, select a cell twice. The keyboard will appear. Enter the value and then select Enter.

Tech Tip: To create a best fit line, select **Menu** or > **Analyze > Regression**. Then, select the appropriate model. Students may need to back-out to the main Tools Menu to see the desired menu option.

Q8. As your balloon got bigger, what happened to the surface area?

Answer: It got bigger

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

Answer: It got bigger

Q10. As your balloon got bigger, what happened to the SA/V ratio?

Answer: It got smaller

Q11. If you know the circumference of a circle or a sphere, how can you calculate the radius?

Answer: Divide the circumference by 2 π

Q12. Measurements for _______ are expressed as units^2, while measurements for _______ are expressed as units^3.

Answer: surface area; volume

Q13. The formula for the SA of a sphere is $4\pi r^2$. The formula for the volume of a sphere is $(4/3)\pi r^3$. Plug these individual formulas into the fraction: SA/V. Then simplify the resulting fraction.

Answer: 3/r

Q14. Two people are 6'3" tall. One weighs 170 pounds, while the other weighs 270 pounds. Which of these two people has a greater SA / V ratio?

Answer: The one weighing 170 pounds

Q15. In really hot weather, which of the two people from the previous question would have a tougher time cooling off by getting rid of body heat?

Answer: The one weighing 270 pounds

Q16. Mammals that live in the desert tend to be "lanky" with large, thin ears. Those that live in the arctic tend to be "round" shaped with very small, hair-covered ears. Why?

Answer: Managing body temperature is critical to survival in both environments

TI-Nspire Navigator Opportunity

Class Capture can be used to monitor students.

Wrap Up

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

Assessment

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

TI-Nspire™ CX Keypad Shortcuts

TI PROFESSIONAL DEVELOPMENT

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 used in the TI-Nspire™ and TI-Nspire™ CAS Teacher Software, as well as by selecting options from various menus and submenus.

Getting Help	
Open Hints	ctrl trig

Editing Text	
Cut	ctrl X
Copy	ctrl C
Paste	ctrl V
Undo	ctrl Z or ctrl esc
Redo	ctrl Y or ⇧shift esc
Toggle approximate and exact results	ctrl enter
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	⇧shift ÷
Manual data capture point	ctrl .
Clear	ctrl del
Caps lock	ctrl ⇧shift
Store	ctrl var
Square brackets	ctrl (
Curly brackets	ctrl)
Display Trig symbol palette	trig
Equals symbol	=
Display pi symbols palette (π, /, θ, and so on)	π▸
Display equality/inequality palette (>, <, ≠, ≥, ≤, |)	ctrl =
Display marks and letter symbols palette (? ! $ ‘ “ : ; _ \)	?!▸
Square root	ctrl x²
log	ctrl 10ˣ
ln	ctrl eˣ
ans	ctrl (–)

TI-Nspire™ CX Keypad Shortcuts

TI PROFESSIONAL DEVELOPMENT

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 [scratchpad]

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	[templates] or ctrl [flag]
Fraction template	ctrl ÷

TI-Nspire™ CX Keypad Shortcuts

TI PROFESSIONAL DEVELOPMENT

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 A
Check syntax and store (in Program Editor)	ctrl B
Find (in Program Editor)	ctrl F
Hide/Show Entry Line (in Graphs or Geometry) Go To (in Lists & Spreadsheet, Program Editor)	ctrl G
Find and Replace (in Program Editor)	ctrl H
Insert Math Box (in Notes)	ctrl M
Open the Scratchpad	[scratchpad key]
Recalculate (in Lists & Spreadsheet)	ctrl R
Add Function Table (in Lists & Spreadsheet, Graphs, and Geometry)	ctrl T
Group/ungroup	ctrl 4 / ctrl 6

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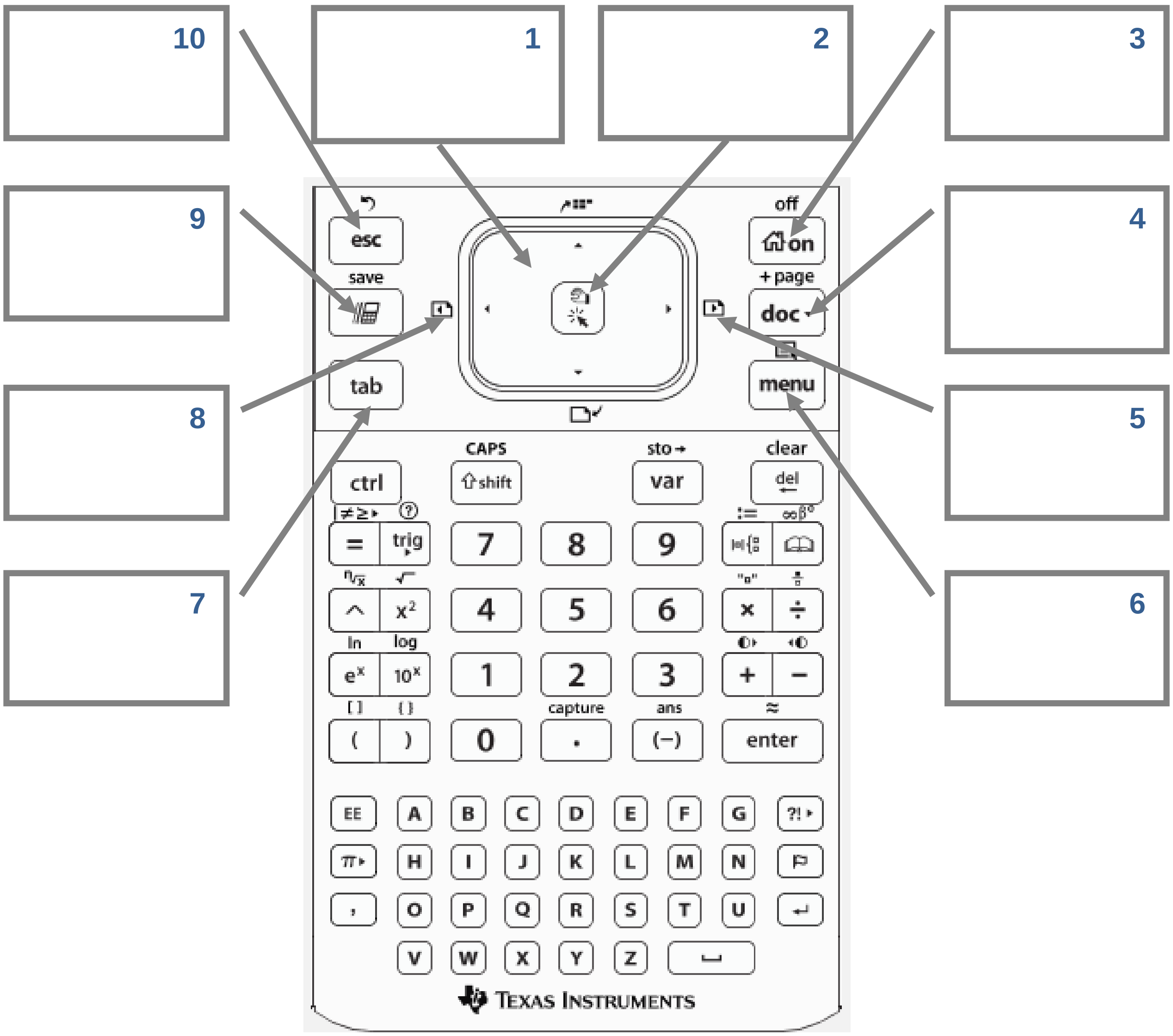
TI-Nspire™ CX Family Overview

TI PROFESSIONAL DEVELOPMENT

Activity Overview

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



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Introduction to Data Collection

TI PROFESSIONAL DEVELOPMENT

Activity Overview

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

Materials

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

Step 1:

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

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

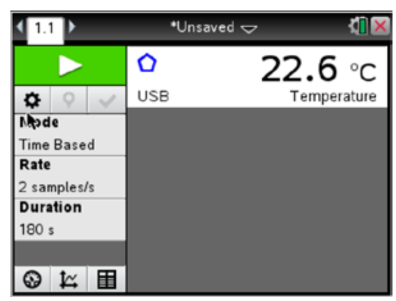
A new document will appear. Though you have the opportunity to add one of the seven built-in TI-Nspire applications, do not select an application at this time.

Step 2:

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

Plug the TI Stainless Steel Temperature probe into the EasyLink adapter, and <u>then</u> 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 these icons represent? 

Step 4:

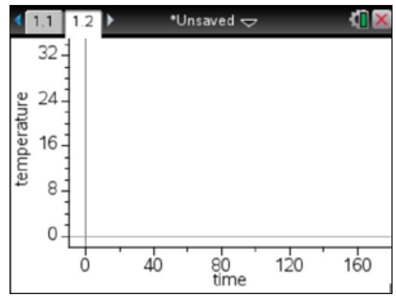
Let the temperature probe reach room temperature. Note your measure of the temperature of the room and compare it with others around you.

- 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.

Prepare to start collecting the data by pressing tab until the **Start Collection** button at the top of the screen is highlighted. Start heating the probe. Then press enter. Alternately, you can hover the cursor over the Start Collection 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 Start 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 check appears. Clicking this will store the latest data set.

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, use the Touchpad to position the pointer over the TableView 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:

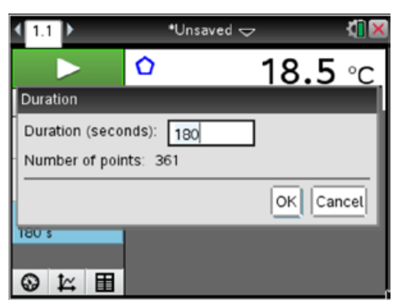
To save the results from the first experiment, use the Touchpad to position the pointer over the Store latest Data icon and press .

- What changes do you notice on the screen?

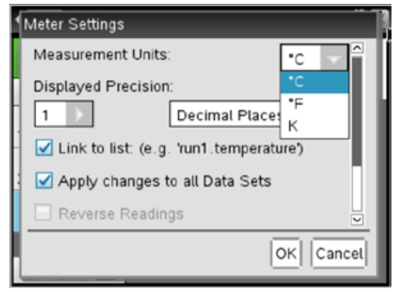
Step 11:

Now design an experiment that will cool the temperature probe.

Consider changing some of the options by clicking an area of interest (Mode, Rate, Duration, Settings). For example, change the default settings of three minutes by clicking on Duration and entering a new value (in seconds).



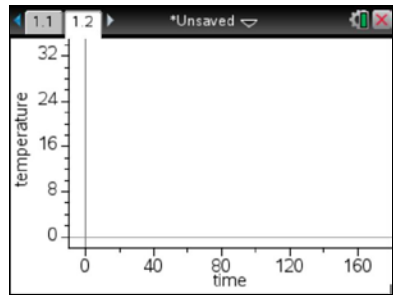
Note that these options are also under the menu. Based on what you learned in the heating experiment, adjust the settings as needed for your cooling experiment.



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 Start button, and press enter to start.

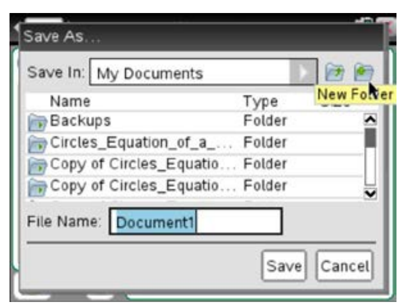
Step 14:

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 as a document, press ctrl S, name the document, and select a folder to place it in. If necessary, create a new folder.



MATH AND SCIENCE @ WORK

AP* BIOLOGY Student Edition

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SPACE BUGS

TI-Nspire™ Lab Activity

Background

From the beginning of the human spaceflight era, NASA has been mindful of the need to monitor the health and well-being of its astronauts. As such, specialists from the Immunology Laboratory at the NASA Johnson Space Center are investigating the effects of spaceflight on various aspects of human physiology, primarily the responses of the human immune system. The goal of this laboratory is to investigate the mechanisms responsible for physiological changes of the immune system, so that appropriate countermeasures or interventions can be developed for future human space exploration missions.

Another important aspect of human immunology is the study of infection by different pathogens. As part of this investigation, lab scientists from the Microbiology Laboratory at NASA Johnson Space Center routinely analyze infectious agents (bacteria, viruses, and fungi) which co-exist with astronauts on the space shuttle and on the International Space Station (ISS).

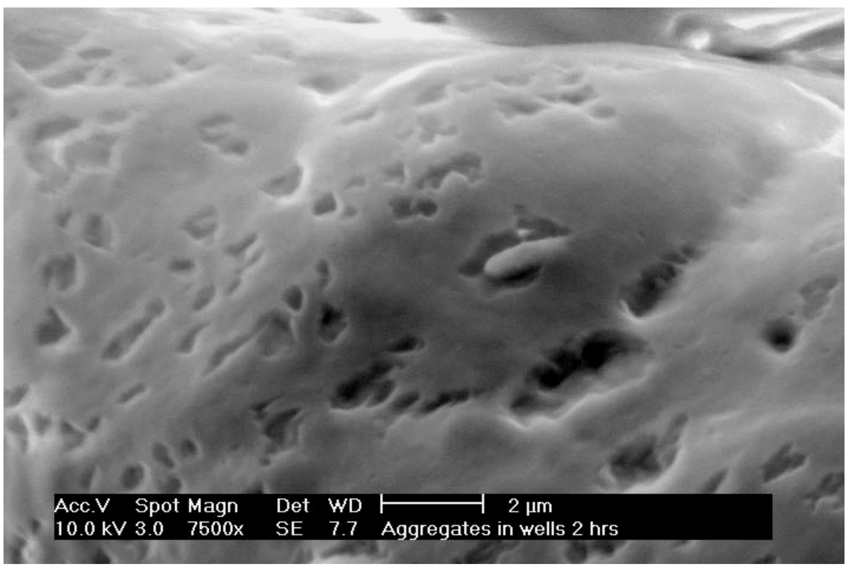


Figure 1: Environmental Scanning Electron Microscopy (ESEM) image of Salmonella enterica Typhimurium invading intestinal cell aggregates grown in vitro

Multiple spaceflight experiments have demonstrated that microorganisms change the way they grow and respond when cultured in the spaceflight environment. One change which concerns NASA scientists is evidence that microorganisms may change their virulence (disease-causing potential) during spaceflight. If microbes do cause disease at a higher rate in space, the astronauts are at greater risk, and it may be necessary for more protective measures to be put in place during a mission.

To better understand the potential risk, samples of microorganisms are collected from surfaces, air, and water located in the spacecraft. When these samples are returned to Earth, the DNA of these "space bugs" is evaluated to determine the presence of infectious agents which might infect the crew. While these “space bugs” are similar to microorganisms found on Earth, the microgravity environment may cause these microbes to behave differently than on Earth. Therefore, scientists continue to investigate how these microorganisms may change in space in order to better protect the crew.

Some microbial changes during spaceflight are the results of the way microbes respond to their environment. These are temporary changes. Other changes can occur that are permanent. These are DNA mutations, which can occur due to radiation. Changes can also occur when pieces of DNA (often in the form of circular DNA called plasmids) are shared with one another. Mutations caused by both radiation and exchange of plasmids can cause a number of changes in microorganisms, including changes in the virulence of organisms.

A variety of techniques are used to measure changes in DNA. A common way is through a process called DNA gel electrophoresis. This technique separates DNA based on its length and ability to move through a gel.

Lab Procedure

On your TI-Nspire handheld open the file, *Space_Bugs*. Work through the entire activity and answer the questions embedded throughout the document.

Mission

In this activity, you will be asked to analyze the basic composition of DNA. You will then look at how DNA is "cut up" with special molecular scissors (called *restriction enzymes*) so it can be analyzed. Finally, you will observe and evaluate the results of some simulated *DNA gel electrophoresis* trials.

Questions (embedded within the TI-Nspire document)

1.6 The DNA of S. aureus consists of 32.78% G-C base pairs. What percentage of the S. aureus DNA consists of A-T base pairs?

1.7 What percentage of the S. aureus DNA nucleotides is guanine?

1.8 What percentage of the S. aureus DNA nucleotides is cytosine?

1.9 What percentage of the S. aureus DNA nucleotides is adenine?

1.10 What percentage of the S. aureus DNA nucleotides is thymine?

1.11 The entire, circular chromosome of S. aureus consists of 29,585 base pairs. How many nucleotides comprise this chromosome?

1.12 How many of the S. aureus base pairs are A-T?

1.13 How many of the S. aureus base pairs are C-G?

1.14 How many thymine nucleotides are there in the S. aureus genome?

1.15 How many cytosine nucleotides are there in the S. aureus genome?

1.16 The human genome consists of about 3.15×10^9 base pairs, and 61.2% of these base pairs are A-T. How many of each of the four DNA nucleotides are in the human genome?

2.5 If the NasAI plasmid is digested with the restriction enzyme EcoRI, how many DNA fragments will be produced per plasmid?

2.6 If the NasAI plasmid is exposed to EcoRI, what will be the sizes of the fragments produced?

2.9 Why is the well into which the DNA is placed near the negative electrode?

3.7 Using the information from the XBaI gel on page 3.2, draw a possible plasmid restriction map on your student handout for the NasAI plasmid when it is exposed to the restriction enzyme, XBaI, or insert a geometry page and draw it there.

*To insert a geometry page, press **ctrl** and **doc**, then select **Add Geometry**. To create a circle, press **menu** and select **Shapes > Circle**. To create segments, press **menu** and select **Points & Lines > Segment**. To add text, press **menu** and select **Actions > Text**.*

4.2 If the plasmid is digested with both EcoRI and XBaI, how many DNA fragments will be produced per plasmid?

4.8 If the plasmid is exposed to both restriction enzymes, what will be the sizes of the fragments produced?

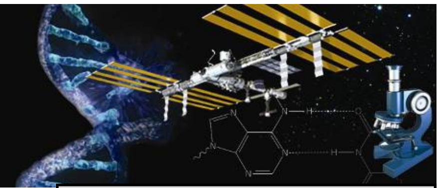
4.9 Not counting the uncut DNA, the gel only has seven bands of DNA instead of eight. Explain.

4.10 Explain why many of the DNA fragments in this gel are much smaller (migrated further) than in the other two gels.

4.11 Explain why the smaller DNA fragments end up furthest from the well.

MATH AND SCIENCE @ WORK

AP* BIOLOGY Educator Edition



Space Bugs

TI-Nspire™ Lab Activity

This lab may replace or reinforce AP Biology Lab 6: Molecular Biology. The Math and Science @ Work Free-Response problem, Microgravity Effects on Human Physiology: Immune System, may be used in conjunction with this lab.

Instructional Objectives

Students will

- analyze the nucleotide composition of DNA;
- evaluate restriction maps of bacterial plasmids;
- analyze models of DNA gel electrophoresis; and
- predict the sizes of unknown DNA fragments by comparing them to known fragment sizes.

Teacher Preparation

Load the TI-Nspire file, *Space_Bugs.tns*, to the students' handhelds.

Class Time Required

This lab requires 60-80 minutes.

- Introduction: 10 minutes
    - o Read and discuss the background section with the class before students work on the problem.
- Student Work Time: 40-60 minutes
- Post Discussion: 10 minutes

AP Biology Framework Alignment

Big Idea 3: Living systems store, retrieve, transmit, and respond to information essential to life processes.

- **Enduring understanding 3.A:** Heritable information provides for continuity of life.

    3.A.1: DNA, and in some cases RNA, is the primary source of heritable information.

    3.A.2: In eukaryotes, heritable information is passed to the next generation via processes that include the cell cycle and mitosis or meiosis plus fertilization.

Grade Level
10-12

Key Topic
Molecular Biology-DNA
Gel Electrophoresis

Teacher Prep Time
10 minutes

Lab Time
60-80 minutes

Materials/Equipment
- TI-Nspire Learning Handhelds
- TI-Nspire file, *Space_Bugs.tns*

AP Biology Framework Alignment
Essential Knowledge:
3.A.1, 3.A.2, 3.A.4, 3.B.1, 3.C.1, 3.C.2

NSES Science Standards
- Science and Technology
- Life Science

3.A.4: The inheritance pattern of many traits cannot be explained by simple Mendelian genetics.

- **Enduring understanding 3.B:** Expression of genetic information involves cellular and molecular mechanisms.

  3.B.1: Gene regulation results in differential gene expression, leading to cell specialization.

- **Enduring understanding 3.C:** The processing of genetic information is imperfect and is a source of genetic variation.

  3.C.1: Changes in genotype can result in changes in phenotype.

  3.C.2: Biological systems have multiple processes that increase genetic variation.

NSES Science Standards

Science and Technology

- Understandings about science and technology

Life Science

- Molecular basis of heredity

Background

This lab activity is part of a series of activities that apply Math and Science @ Work in NASA's scientific laboratories.

From the beginning of the human spaceflight era, NASA has been mindful of the need to monitor the health and well-being of its astronauts. As such, specialists from the Immunology Laboratory at the NASA Johnson Space Center are investigating the effects of spaceflight on various aspects of human physiology, primarily the responses of the human immune system. The goal of this laboratory is to investigate the mechanisms responsible for physiological changes of the immune system, so that appropriate countermeasures or interventions can be developed for future human space exploration missions.

Another important aspect of human immunology is the study of infection by different pathogens. As part of this investigation, lab scientists from the Microbiology Laboratory at NASA Johnson Space Center routinely analyze infectious agents (bacteria, viruses, and fungi) which co-exist with astronauts on the space shuttle and on the International Space Station (ISS).

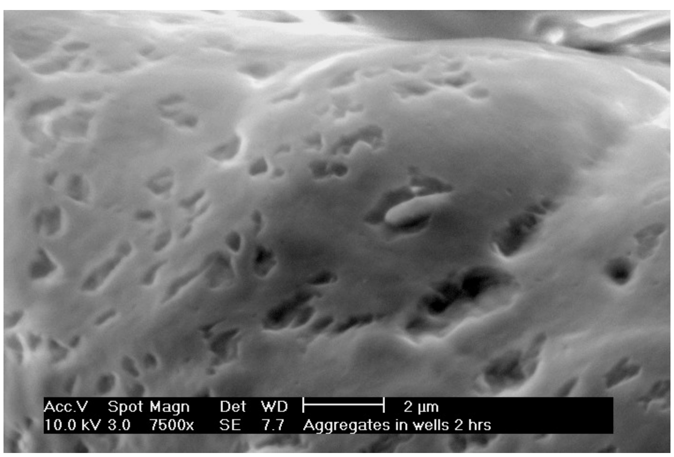


Figure 1: Environmental Scanning Electron Microscopy (ESEM) image of Salmonella enterica Typhimurium invading intestinal cell aggregates grown in vitro

Multiple spaceflight experiments have demonstrated that microorganisms change the way they grow and respond when cultured in the spaceflight environment. One change which concerns NASA scientists is evidence that microorganisms may change their virulence (disease-causing potential) during spaceflight. If microbes do cause disease at a higher rate in space, the astronauts are at greater risk, and it may be necessary for more protective measures to be put in place during a mission.

To better understand the potential risk, samples of microorganisms are collected from surfaces, air, and water located in the spacecraft. When these samples are returned to Earth, the DNA of these "space bugs" is evaluated to determine the presence of infectious agents which might infect the crew. While these “space bugs” are similar to microorganisms found on Earth, the microgravity environment may cause these microbes to behave differently than on Earth. Therefore, scientists continue to investigate how these microorganisms may change in space in order to better protect the crew.

Some microbial changes during spaceflight are the results of the way microbes respond to their environment. These are temporary changes. Other changes can occur that are permanent. These are DNA mutations, which can occur due to radiation. Changes can also occur when pieces of DNA (often in the form of circular DNA called plasmids) are shared with one another. Mutations caused by both radiation and exchange of plasmids can cause a number of changes in microorganisms, including changes in the virulence of organisms.

A variety of techniques are used to measure changes in DNA. A common way is through a process called DNA gel electrophoresis. This technique separates DNA based on its length and ability to move through a gel.

Lab Procedure

On your TI-Nspire handheld open the file, *Space_Bugs*. Work through the entire activity and answer the questions embedded throughout the document.

Solution Key

Throughout this activity, students are provided information and questions within the TI-Nspire document, *Space_Bugs.tns.* A solution key, *Space_Bugs_Solutions.tns*, is also provided for the instructor to review with students using TI-Nspire software.

Mission (TI-Nspire page 1.2)

In this activity, you will be asked to analyze the basic composition of DNA. You will then look at how DNA is "cut up" with special molecular scissors (called *restriction enzymes*), so it can be analyzed. Finally, you will observe and evaluate the results of some simulated *DNA gel electrophoresis* trials.

Lab Activity and Questions (TI-Nspire pages 1.3-4.11)

DNA from all organisms has the same basic structure. There are only four building blocks of DNA molecules, called *nucleotides*: **A**denine, **T**hymine, **G**uanine, and **C**ytosine. The rungs of the DNA ladder are made of two of the four nucleotides called *base pairs*, and they are either T-A (or A-T) or G-C (or C-G). Therefore, in any sample of DNA, the amount of adenine equals the amount of thymine, and the amount of guanine equals the amount of cytosine. This is known as *Chargaff's Rule*; and in 1953, it helped Watson and Crick determine the *double-helix* structure of the DNA molecule, for which they won a Nobel Prize in 1962.

Staphylococcus aureus TW20 (*S. aureus*), generally referred to as staph, is commonly isolated from the nasal area of all humans, including astronauts. S. aureus is very common, and can cause a wide variety of diseases under the right circumstances, including boils, food poisoning, bone infections, and severe skin infections. Studies aboard spacecraft have shown that, despite all precautionary measures, S. aureus is still commonly passed between crew members.

1.6 The DNA of S. aureus consists of 32.78% G-C base pairs. What percentage of the S. aureus DNA consists of A-T base pairs?

67.22%

1.7 What percentage of the S. aureus DNA nucleotides is guanine?

16.39%

1.8 What percentage of the S. aureus DNA nucleotides is cytosine?

16.39%

1.9 What percentage of the S. aureus DNA nucleotides is adenine?

33.61%

1.10 What percentage of the S. aureus DNA nucleotides is thymine?

33.61%

1.11 The entire, circular chromosome of S. aureus consists of 29,585 base pairs. How many nucleotides comprise this chromosome?

59,170

1.12 How many of the S. aureus base pairs are A-T?

19,887

1.13 How many of the S. aureus base pairs are C-G?

9,698

1.14 How many thymine nucleotides are there in the S. aureus genome?

19,887

1.15 How many cytosine nucleotides are there in the S. aureus genome?

9,698

1.16 The human genome consists of about 3.15×10^9 base pairs, and 61.2% of these base pairs are

A-T. How many of each of the four DNA nucleotides are in the human genome?

Adenine = 9.64×10^8

Thymine = 9.64×10^8

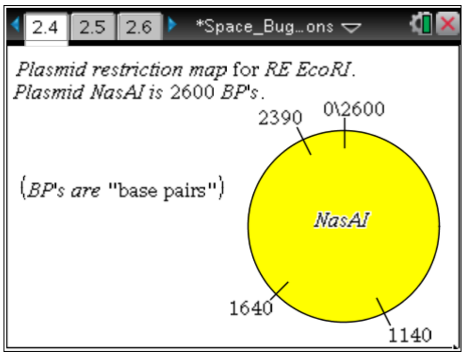
Cytosine = 6.11×10^8

Guanine = 6.11×10^8

Many bacteria produce special chemicals called *restriction enzymes* (REs), which are produced as a bacterial defense system to cut up foreign DNA from, for instance, a virus. REs cut DNA at specific locations called *restriction sites*. If DNA is exposed to a restriction enzyme, the DNA will be cut at a restriction site regardless of the organism (humans included).

In the laboratory, molecular biologists can use restriction enzymes to cut up DNA from two different organisms and then splice these pieces of DNA to one another, thus creating *recombinant DNA*. Once new DNA is placed into a host organism, the organism's genome will be changed, thus allowing it to make new proteins.

Page 2.4 (on the TI-Nspire handheld) shows a model of a *bacterial plasmid*, which is a small piece of DNA, separate from the main chromosome that some bacteria possess. Plasmids have become very useful to genetic researchers. Bacterial plasmids, which are proteins such as *insulin* and *human growth hormone*, are now made for human use.



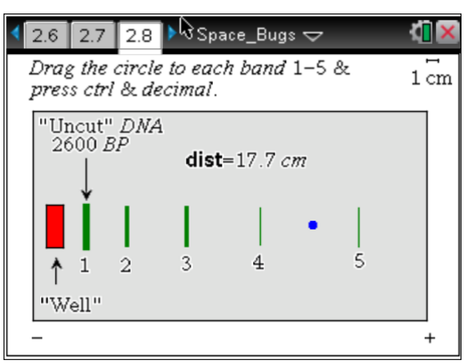
2.5 If the NasAI plasmid is digested with the restriction enzyme EcoRI, how many DNA fragments will be produced per plasmid?

4

2.6 If the NasAI plasmid is exposed to EcoRI, what will be the sizes of the fragments produced?

1140, 750, 500, 210

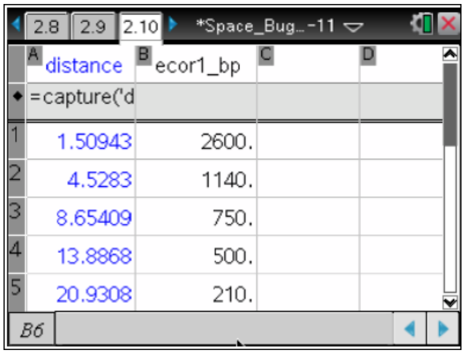
Page 2.8 shows a gel that was produced using EcoRI as the restriction enzyme. Find the distance of the DNA migrations by dragging the circle to each band numbered 1-5. *Do not drag it to the well.* When the circle is on each band, press **ctrl** and **decimal**. This will record the band distance and automatically record it in the spreadsheet and graph on the pages following.

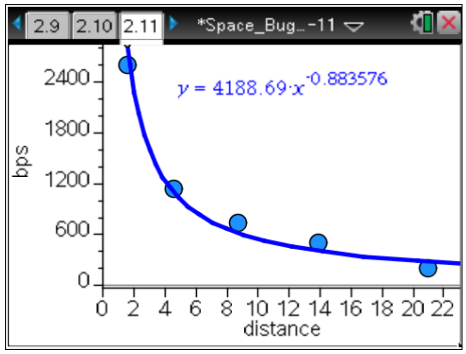


2.9 Why is the well into which the DNA is placed near the negative electrode?

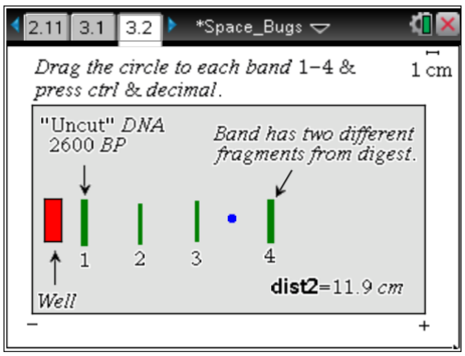
DNA is negatively charged and will move toward the positive electrode.

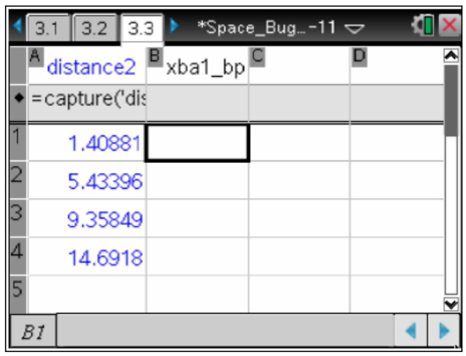
Teacher Note: The screenshots below show the spreadsheet and graph that were generated by the data collection on 2.8. Students will be using the equation of the regression line shown later in the activity to analyze two more gels.





The following page shows a gel that was produced using a different restriction enzyme, XBaI, on the NasAI plasmid. Follow the instructions to measure the distance of the DNA migrations. *Do not drag the circle to the well—only to the four bands.*

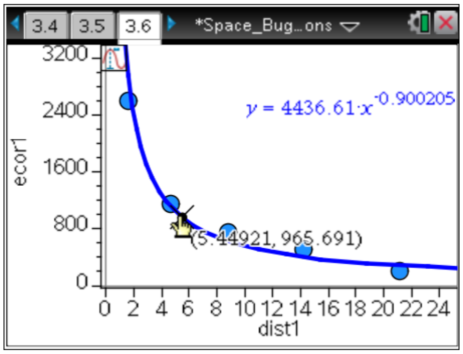


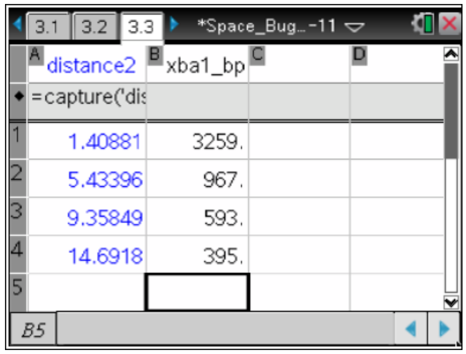


Use the distances that were recorded in the spreadsheet to predict the sizes of the DNA fragments in the XBaI gel on page 3.2. You will do this by using the regression model that you made for the EcoRI gel.

Go to the next page, click on the regression model, press **ctrl**, **menu**, and select **Graph Trace**. Move along the regression model by gently sliding your finger on the touchpad until you find the approximate distance (the *x*-value). Record the corresponding base pairs (the *y*-value) in the spreadsheet on page 3.3.

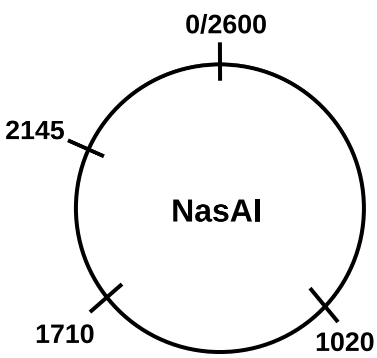
Alternatively, insert a calculator page and use the regression equation from the EcoRI graph to make your predictions.

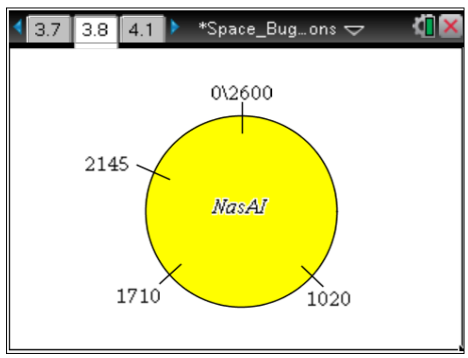


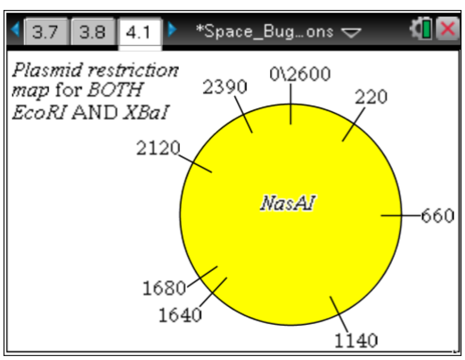


3.7 Using the information from the XBaI gel on page 3.2, draw a possible plasmid restriction map on your student handout for the NasAI plasmid when it is exposed to the restriction enzyme, XBaI, or insert a geometry page and draw it there.

*To insert a geometry page, press **ctrl** and **doc**, then select **Add Geometry**. To create a circle, press **menu** and select **Shapes > Circle**. To create segments, press **menu** and select **Points & Lines > Segment**. To add text, press **menu** and select **Actions > Text**.*



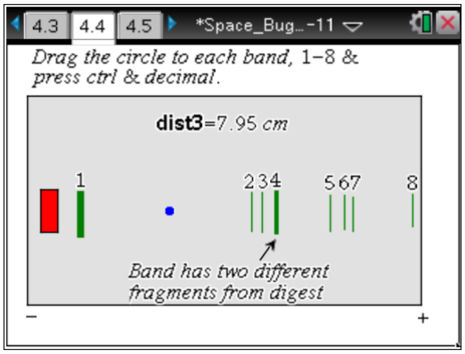


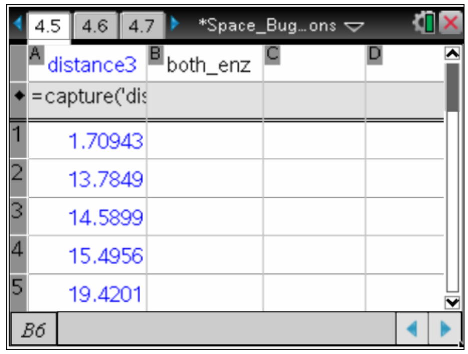


4.2 If the plasmid is digested with both EcoRI and XBaI, how many DNA fragments will be produced per plasmid?

8

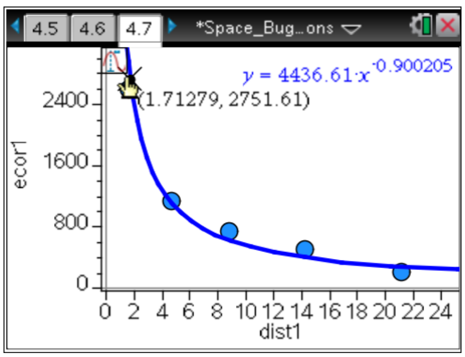
The following page shows a gel that was produced using both restriction enzymes, EcoRI and XBaI, on the NasAI plasmid. Measure the distance of the DNA migrations by dragging the circle to the bands numbered 1-8. *Do not drag the circle to the well—only to the eight bands.*

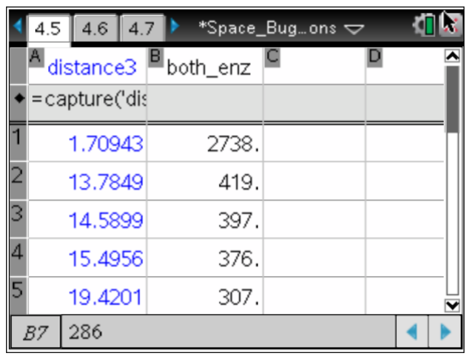




Use the distances that were recorded in the spreadsheet on page 4.5 to predict the sizes of the DNA fragments in the gel on page 4.4. Go to the graph on the next page, select Graph Trace, and move along the regression model until you find the approximate distance (the *x*-value). Record the corresponding base pairs in the spreadsheet.

Alternatively, insert a calculator page and use the regression equation from the EcoRI graph to make your predictions.





4.8 If the plasmid is exposed to both restriction enzymes, what will be the sizes of the fragments produced?

220, 440, 480, 500, 40, 440, 270, 210

4.9 Not counting the uncut DNA, the gel only has seven bands of DNA instead of eight. Explain.

Two of the fragment sizes are identical, so they show up as one band in the same location.

4.10 Explain why many of the DNA fragments in this gel are much smaller (migrated further) than in the other two gels.

Two restriction enzymes were used, so the DNA fragments were cut into smaller pieces.

4.11 Explain why the smaller DNA fragments end up furthest from the well.

Smaller fragments have an easier time getting pulled through the gel.

Contributors

This problem was developed by the Human Research Program Education and Outreach (HRPEO) team with the help of NASA subject matter experts and high school AP Biology instructors.

NASA Experts

Mark Ott, Ph.D. – Microbiology Laboratory, NASA Johnson Space Center, Houston, TX

Mayra Nelman – Immunology Laboratory, NASA Johnson Space Center, Houston, TX

Victoria Castro – Microbiology Laboratory, NASA Johnson Space Center, Houston, TX

AP Biology Instructor

Jeff Lukens – Texas Instruments T^3 (Teaching Teachers with Technology™) National Instructor, Roosevelt High School, Sioux Falls, SD

Rev B: 102312

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The TI-Nspire™ CX Navigator™ Science Classroom

TI PROFESSIONAL DEVELOPMENT

Objective

- Perform various TI-Nspire™ CX Navigator™ skills demonstrated in previous activities.

TI-Nspire™ Technology Skills:

- Opening and navigating a TI-Nspire™ document

About the Lesson

- Participants will role-play in this activity as a teacher and/or a student.
- The participant playing the role of the teacher will conduct a directed lesson using the features of the TI-Nspire™ CX Navigator™ System.
- The participant playing the role of the student will perform the tasks of a student for the lesson.
- Participants should then switch roles and repeat the process for another lesson.

Lesson Materials:

Equipment

- Computer with TI-Nspire™ CX Navigator™ Teacher Software (for a pair of participants) with two USB ports
- Two TI-Nspire™ CX learning handhelds per participant
- Standard A to Mini-B USB Cables

TI-Nspire™ Navigator™ Features

- Setting Up a Class
- Sending a Document
- Class Capture
- Live Presenter
- Quick Poll
- Portfolio Workspace
- Student Data

Roles

Working in pairs, assign one role as the teacher and one role as the student. The “teacher” will operate the computer, and the “student” will operate two TI-Nspire™ handhelds. Participants will have an opportunity to switch and experience both roles.

Instructions

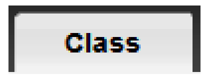
If a step below has **Teacher** in front of it, the participant operating the computer will perform the task. If the instruction has **Student** in front of it, the participant operating the TI-Nspire handhelds will perform the task.

Adding a Class

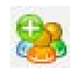
Version	TI-Nspire	CAS
v4.x		
v3.9		

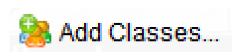
1. **Teacher:** Open the Teacher Software on the computer by double-clicking the Teacher Software icon on the desktop.
   - If necessary, close the Welcome Screen.

2. **Teacher:** If necessary, open the Class workspace by clicking on the **Class** tab.

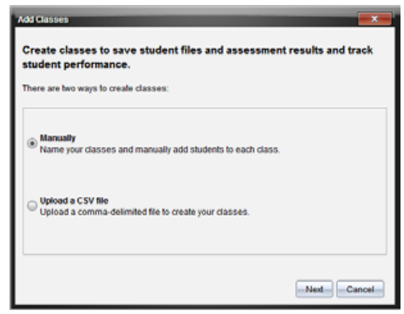


3. **Teacher:** Select the **Add Classes** icon from the tool bar, or select **Add Classes** from the **Class** menu.



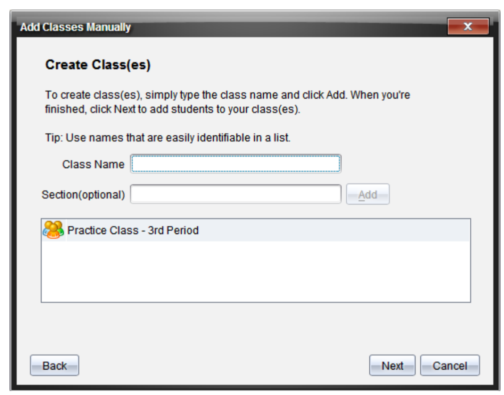


4. **Teacher:** Click on **NEXT** to enter the class and students manually.
   - The process for uploading a CSV file to create classes is located in a tip sheet. It can be discussed at a later time.

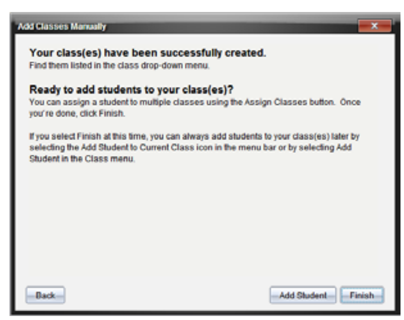


5. **Teacher:** Enter "Practice Class" as the class name and "3rd Period" as the section.
   - It is not necessary to complete the Section field. But it allows teachers to name classes by subject only (e.g. Algebra) and use the section field to distinguish between classes of the same subject (e.g. 3rd Period).

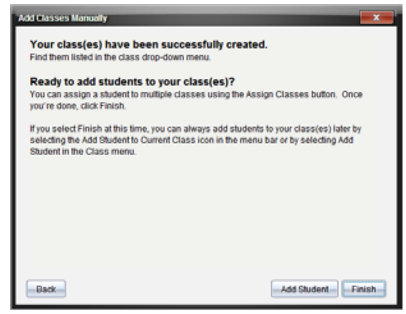
6. **Teacher:** Click on the **Add** button.



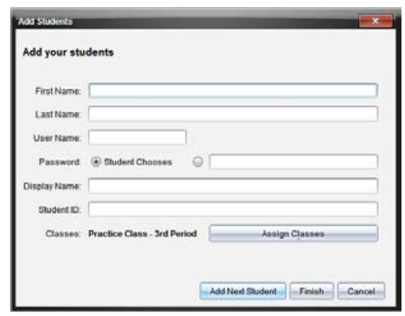
7. **Teacher:** Click **Next**.



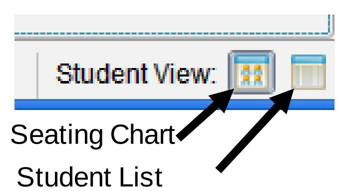
Adding Students



1. **Teacher:** To immediately add students to the class, click the **Add Student** button.
   - If the teacher closes the Class Wizard by clicking **Finish**, select the **Add Student** icon or select **Add Student** from the **Class** menu.

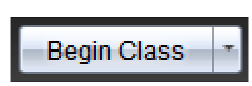


2. **Teacher:** For each student below, enter the first name, last name, and user name into the Add Students window. Select **Add Next Student** to add another student.
   - Jon, Smith, Jon
   - Deb, Jones, Deb
   - Marco, Polo, Marco
   - Sonja, Perez, Sonja
   - Raymone, Tyson, Raymone
3. **Teacher:** You can choose a password for each student, or each student can choose his or her own password when they log in to the class for the first time.
   - This will then be the student's password unless the teacher chooses to reset it.
   - By default, the Display Name is the student's first name. The Display Name can be edited as desired.
   - The Student ID is optional but sometimes important if you want to import grades into grade book software.
4. **Teacher:** After the last student's name is entered, click **Finish**.
5. **Teacher:** To switch the student view between **Seating Chart** and **Student List**, use the Student View icons in the lower right corner of the software.



Log in Students

1. **Teacher:** Begin the class by clicking **Begin Class**.
   - Each student's icon should change from light gray to light blue/yellow.



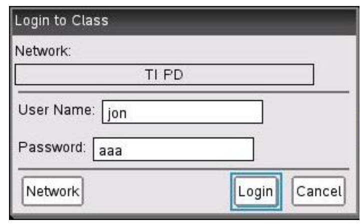
2. **Teacher:** Connect both of the TI-Nspire™ handhelds to your computer using USB cables. One end goes into your computer's USB port and the other into the TI-Nspire™ handheld.

The TI-Nspire™ CX Navigator™ Science Classroom

TI PROFESSIONAL DEVELOPMENT

Note: In your classroom, each student's handheld will not be connected to your computer in this way. They will each have their own wireless module that will communicate with your computer.

3. **Student:** Turn on each handheld.
4. **Student:** Log in a student on one of the handhelds.
   - The login window should pop up on the handheld's screen.
   - If it does not, press [⌂ on] to access the Home screen, select [5] for Settings and [5] for Login.



5. **Student:** Type **jon** as the username of one handheld, press ▼ on the Touchpad/Clickpad, type **abc** as the password, and press [enter].
   - You will see a message pop up on the handheld stating: "You are logged in as user: jon"
6. **Student:** Press to select the OK button.

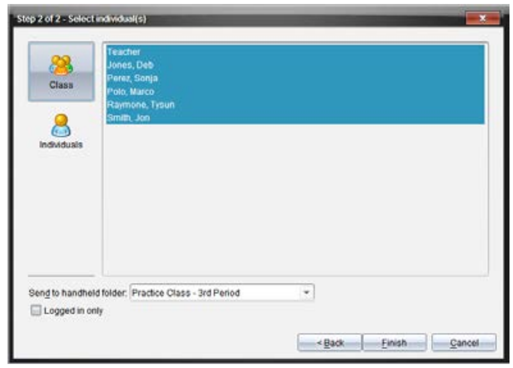
Note: The passwords used can be the same for all students or unique to each individual. Some teachers assign everyone the same password so that they do not have to reset any passwords. Some teachers allow students to pick their own passwords.

7. **Student:** Log in as **deb** on the other handheld.
   - If necessary, press [⌂ on] to access the Home screen, select [5] for Settings & Status and [5] for Login.
   - **Student:** Type **deb** as the username of another handheld, press ▼ on the Touchpad/Clickpad, type **abc** as her password, and press [enter].
   - You will see a message pop up on the handheld stating: "You are logged in as user: deb"
8. **Student:** Press to select the OK button.

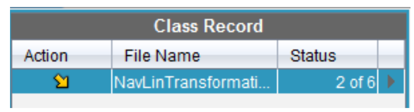
Send a Document

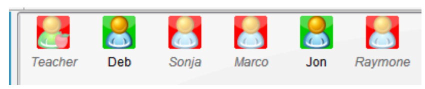
1. **Teacher:** Click **Send to Class**.
2. **Teacher:** Browse for the TI-Nspire™ document titled *Density_of_Metals.tns* provided for this activity in the location specified by your instructor. Click on the TI-Nspire™ document name so that it is highlighted.
   - Each person, when in the Teacher role, should use *Density_of_Metals.tns*.

3. **Teacher:** Click **Finish** to send the document to the handhelds.
   - You are able to send a document to specific individuals. However, the default is to send to the entire class. This is advisable because late students automatically get the document after they log in with minimal disruption.
   - You do not have to wait until the students log in before sending a TI-Nspire™ document. Documents can be sent any time after a class has been started.
   - On the handheld, all documents will be sent to a folder with the same name as the class (in this case, the Practice Class – 3rd Period folder).

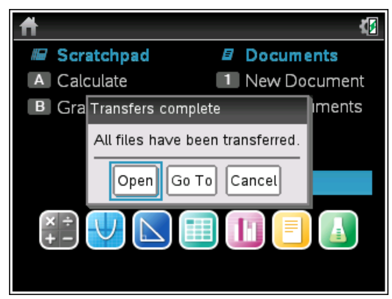


4. **Teacher:** Click on the 1st row in the Class Record. The row will turn blue, and you will see red and green student icons in the Classroom View.
   - A green icon indicates that the student has received the document; a red icon indicates that that student has not received the document.
   - Students with a red icon might be absent, or communication has been disrupted.
   - It is good practice to monitor the transfer of the documents sent to ensure that your students receive them.





5. **Student:** Students know they have received a document based on the “Transfers Complete” pop-up window.

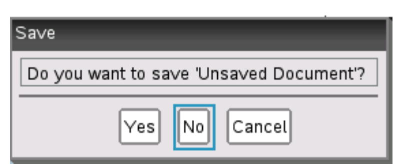


Open the Document

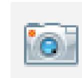
Remember: The participant in the **teacher** role should be looking at the computer screen and not the handhelds. The participant in the **student** role should be looking at the screen of their handheld and not the computer screen. This is to model the classroom experience.

1. **Student:** Pick **one** of the two handhelds and follow the Teacher’s instructions in step 2.

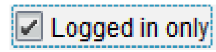
2. **Teacher:** Say: “Open the document that was just sent to your handheld. To do this, Press enter or del”
   - If the handheld had a document open prior to opening this one, you would be asked to choose whether to save the prior document. Select No by pressing ▶ .



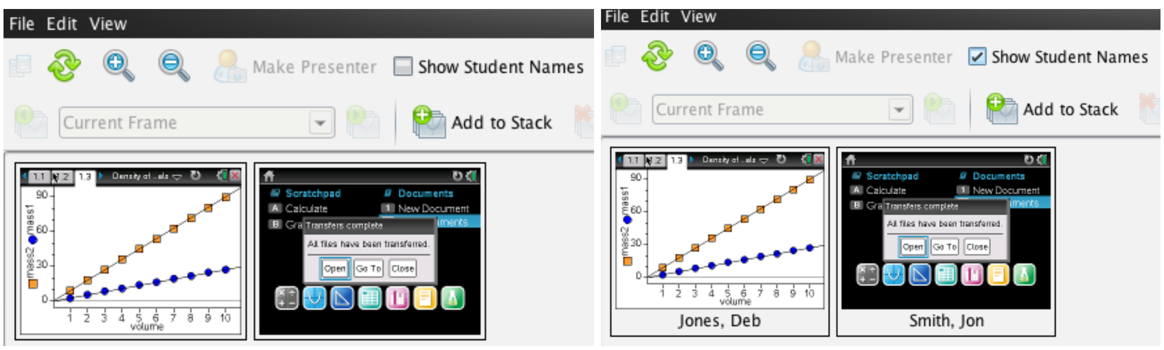
Class Capture and Live Presenter



1. **Teacher:** Without looking at the student handhelds, press the **Take Screen Capture** icon and select **Class Capture**.



2. **Teacher:** Click on the check box next to "Logged in only" to place a check mark inside. This will show screen captures for only those students that have logged in. Click **OK** to display the screens.
3. **Teacher:** If the student only opened the document on one handheld as requested, the participant playing the role of teacher will notice that one student in the class has not opened the document.
4. **Teacher:** Click on the check box beside Show Student Names, and observe the names appearing under the screenshots.



Pause and Think About:

i. *Are there scenarios where you want to see the name with the screenshot of each handheld?*
ii. *Can you think of a scenario where you would not want the names displayed?*
iii. *If you notice that a student has not yet followed your instructions, how could you get the student back on track?*

5. **Teacher:** Click on the one screen capture that does not have the first page of the document. It might be Jon's or Deb's handheld.
   - You want all students to properly process your verbal instructions. Class Capture can help you in this regard.

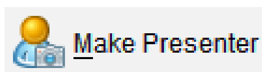
How do you get this student back on track?

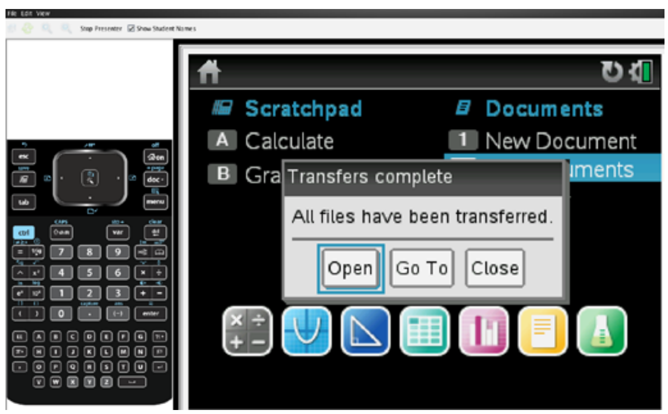
- One strategy makes use of the Show Student Names feature within Class Capture to identify students that are having difficulty. Students close to them can help them get back on track.
- Another strategy to get a student back on track is to make the student the Live Presenter and coach the student back. This is the strategy described below.

The TI-Nspire™ CX Navigator™ Science Classroom

TI PROFESSIONAL DEVELOPMENT

6. **Teacher:** Click on the Screen Capture of the student who is not on the appropriate screen, and click the **Make Presenter** button. You can now view a live feed of the handheld belonging to that student.
   - You will see the student's handheld on your computer screen.
   - The Live Presenter is a tool inside Class Capture that will show what the student is doing in real time. See Below. Note that you will see the handheld type used by the student according to the keypad they are using. This student is using TI-Nspire™ with Touchpad.

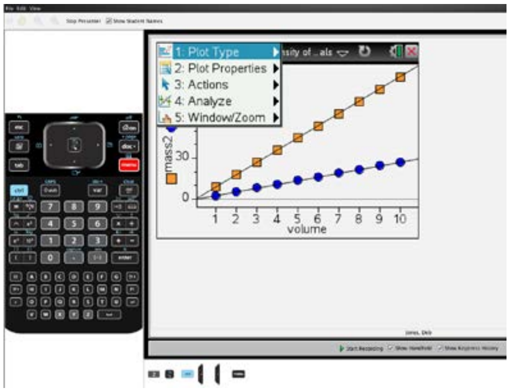


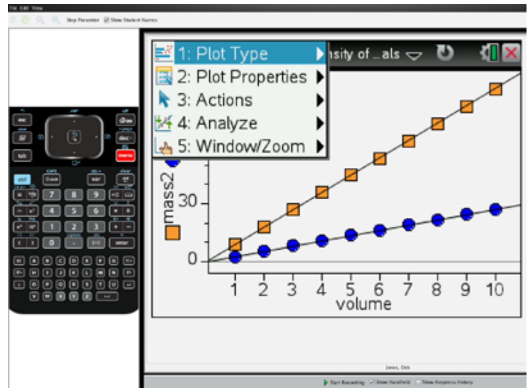


7. **Student:** Pick up the second handheld that has Deb logged into it, and follow the teacher's directions.

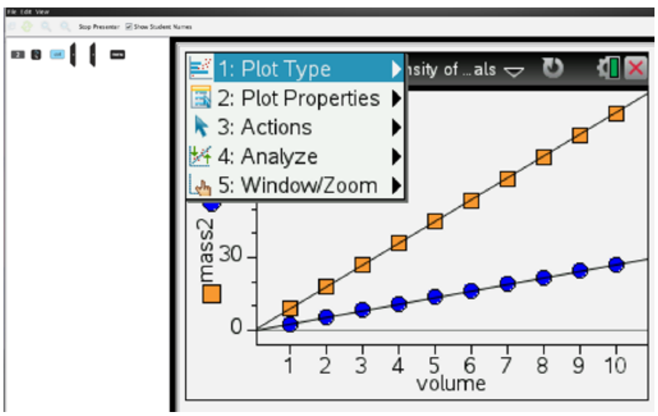
8. **Teacher:** Direct the student to press enter or [click] on the handheld to open the document that was sent to the class.

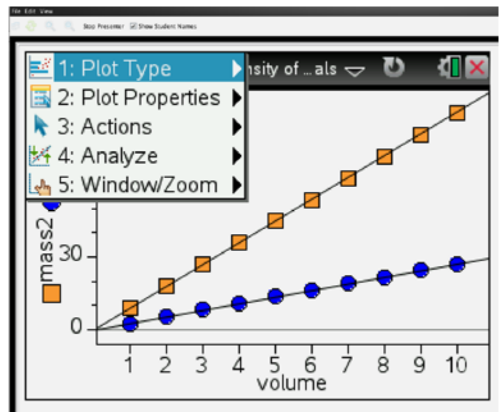
Note: The teacher can customize the layout of the presenter. Currently, the default is to show the Handheld and Key Press History. You can turn off either or both of these views to customize the Live Presenter. You will see the key press history and the screen changing in real time. Notice on your computer software that you will see the specific buttons the student pushes identified by red outlines.





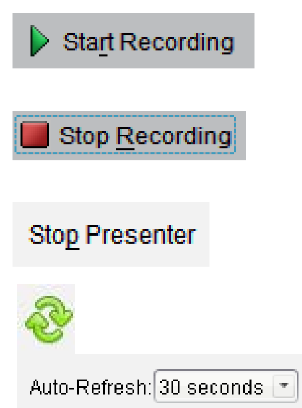
Show Handheld and Key Press History Show Handheld Only





Show Key Press View Only Neither Handheld Nor Key Press History

Note: One other important feature of Live Presenter is the ability to record keystrokes. Pressing **Start Recording** initiates the recording of an .avi video file. When you press **Stop Recording**, you will be prompted to save the .avi file in the Practice Class folder that exists on your computer.



9. **Teacher:** Once this student has opened the document, click on the **Stop Presenter** button.

10. **Teacher:** Direct the student to interact with the document using the accompanying Student Activity handout (if applicable).

11. **Student:** Interact as directed with the TI-Nspire document.

12. **Teacher:** While students are working, monitor their progress with the Class Capture. Refresh manually or set up Auto-Refresh as desired

Pause and Think About:

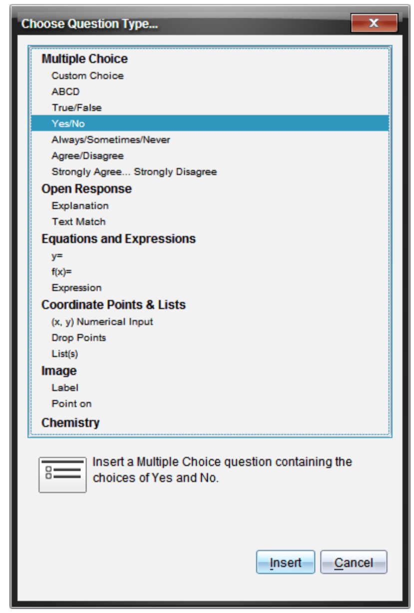
How could the use of Class Capture and Live Presenter change the way you can teach?

Quick Poll

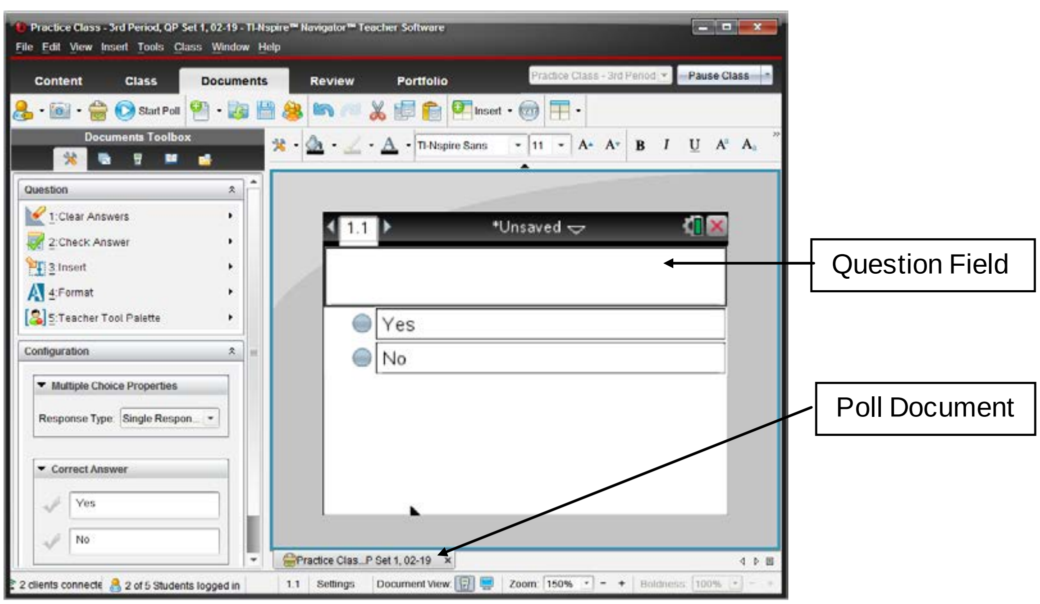
1. **Teacher**: Close the Class Capture feature of the software on your computer.

2. **Teacher**: Now, click the **Quick Poll** icon.

   - The Choose Question Type dialog box appears.
   - There are a variety of question types available:
     - Multiple Choice: Custom Choice, ABCD, True/False, Yes/No, Always/Sometimes/Never, Agree/Disagree, Strongly Agree… Strongly Disagree
     - Open Response: Explanation, Text Match
     - Equations and Expressions: y=, f(x)=, Expression
     - Coordinate Points & Lists: (x,y) Numerical Input, Drop Points, and List(s)
     - Image: Label, Point on
     - Chemistry



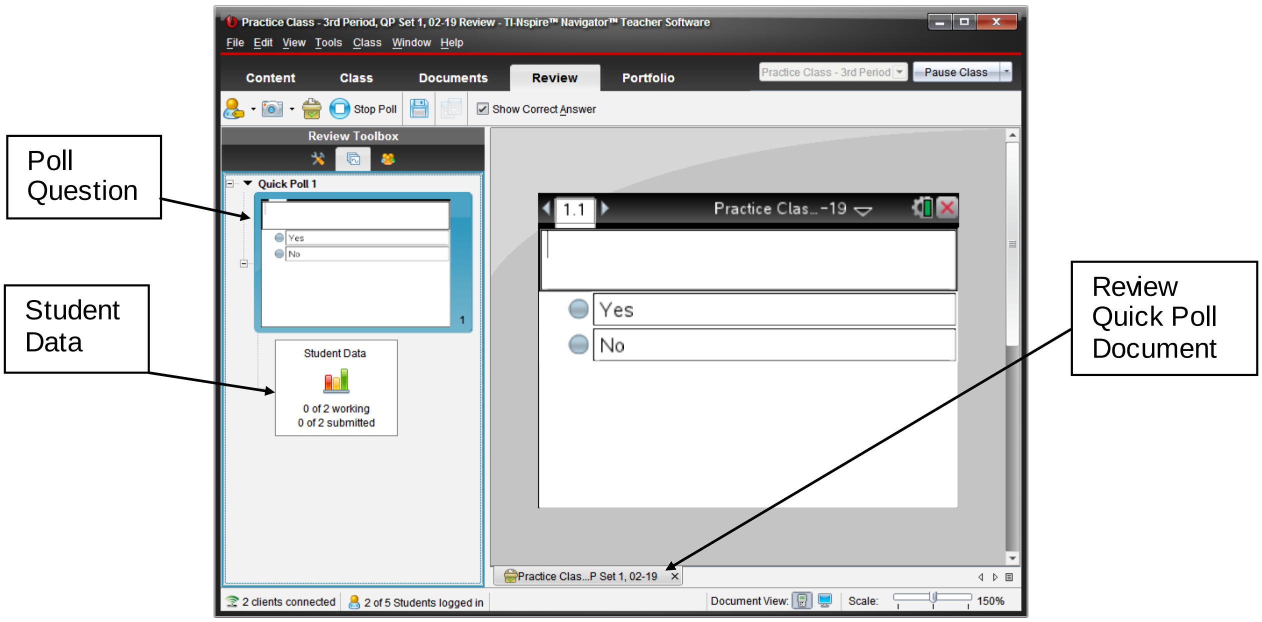
3. **Teacher**: Select the Multiple Choice - Yes/No question type and press **Insert**.
   - A document titled “Practice Class – 3rd Period, QP Set 1, DATE” opens in the Document workspace with a question page.
   - If desired, the question can be entered into the question field or it can be left blank and the question can be asked orally.



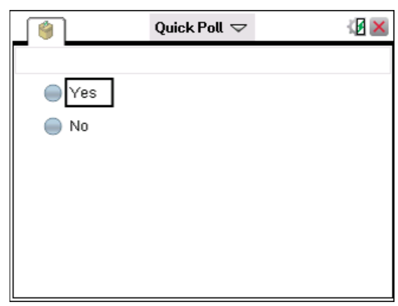
4. **Teacher:** Press the **Start Poll** button.

   - Assume that you are going to ask the following question orally to your class without the need for the question text.
   - Ask the student a yes/no question orally about the activity.

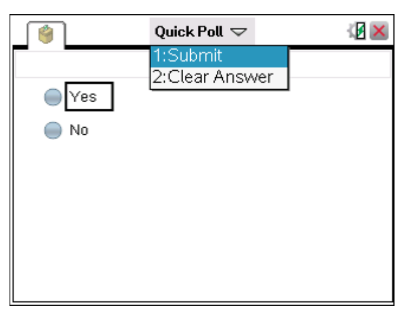
Note: Immediately after pressing the **Start Poll** button, the software opens to the Review workspace and creates a Review Poll document containing the Poll Question and Student Data.



5. **Teacher:** Monitor the number of incoming responses by watching the Student Data.
   - As the students begin to answer the poll, the numbers will change in real-time according to the number of students working on the question and the number of students who have submitted their answer.
   - Shown to the right is what a student sees on his or her handheld. All students have been sent the poll.

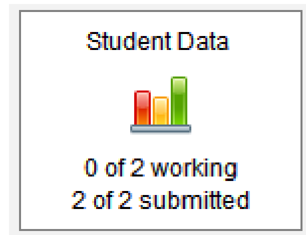


6. **Teacher**: If this is the first time a student has been asked to respond to a poll, you might have to give instructions for answering a poll and submitting an answer. Tell the student:
   - "To answer the question, use the arrow keys to move to the Yes or No answer. Press the click key to "color" in the answer bubble of your choice."
   - "To submit your answer, press the DOC button and select **1:Submit**.



- Alternatively, click on the down arrow to the right of the words **Quick Poll** at the top of the screen. Select **1:Submit**.
- On a Clickpad handheld, press ctrl home to open the Quick Poll pull-down menu.

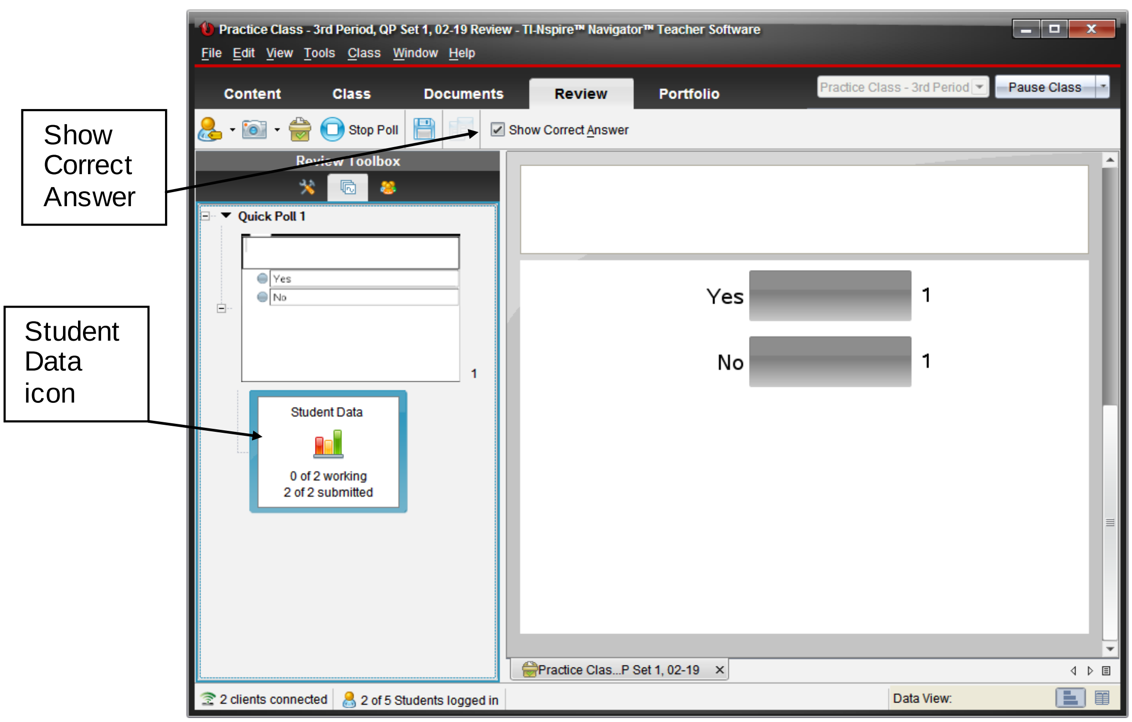
7. **Student**: Follow the teacher's instructions to send student responses from each handheld to the teacher's computer. On one of the handhelds, send Yes as the answer to the poll. On the other handheld, send No as the answer to the poll.



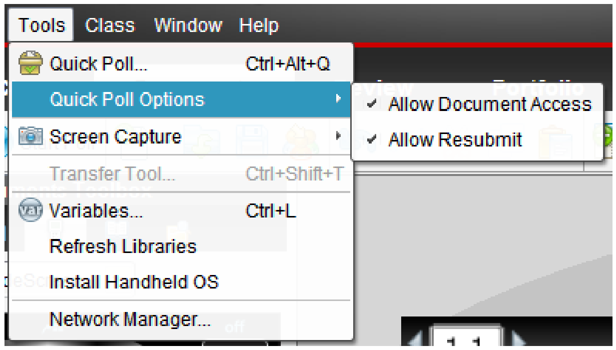
8. **Teacher**: Monitor the Student Data, and click the **Stop Poll** button once you have received an answer from each handheld.

   - As the students begin to answer the poll, the numbers will change in real-time according to the number of students working on the question and the number of students who have submitted their answer.

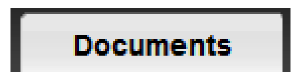
9. **Teacher**: Click the **Student Data** icon, and note that the incoming answers have been collected and organized for you.



Note: By default, the “Allow Resubmit” option is turned off. This option allows students to resubmit their answers until the poll is stopped. When the “Allow Resubmit” option is turned off, then the student has only one chance to respond to the question and the poll will disappear as soon as the student submits an answer.

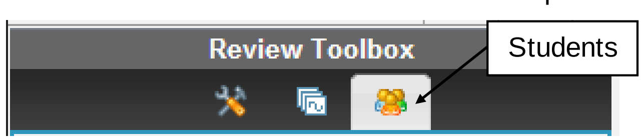


10. **Teacher:** The “Allow Resubmit” option is located in the Documents workspace under the **Tools > Quick Poll Options** menu. Return to the Documents workspace, and select **Allow Resubmit**.

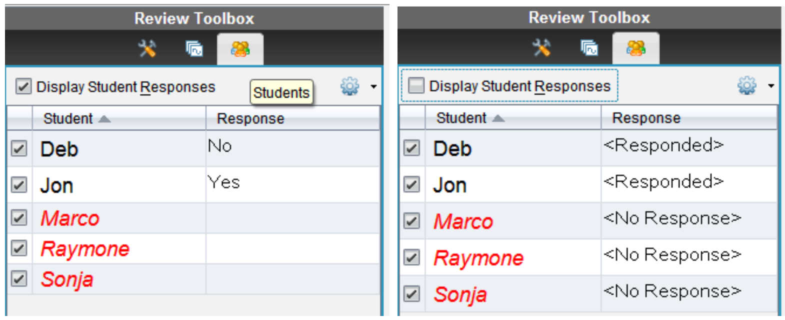


Pause and Think About:
When would you want students to Resubmit answers to a poll?
When would you not want students to Resubmit answers to a poll?

11. **Teacher**: Type the text of another appropriate yes/no question for the activity in the Quick Poll Question page that is already open.
12. **Teacher**: Press the **Start Poll** button.
13. **Student**: Select a response, and submit it for both handhelds.
    - The Quick Poll window remains open on the handhelds since the teacher selected the Allow Resubmit option.
14. **Student:** Change an answer on one handheld and resubmit.
15. **Teacher:** Monitor the Class Results, and click **Stop Poll** once you have received answers from all of your “students.”
16. **Teacher**: Click on the **Student Data** icon for Quick Poll 2 to see the student responses.
17. **Teacher**: Click on the **Students** icon under the Review Toolbox to see each student’s response. The students’ names that are in red have not answered the poll.



18. **Teacher**: Click on the check box beside **Display Student Responses**, and observe what happens. Notice all the responses are hidden, but the teacher knows who has responded.



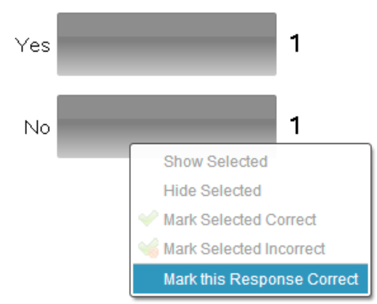
Pause and Think About:

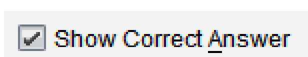
i) How could you use this feature in your classroom?

ii) Are there times when you want or don't want your students to see the responses?

iii) Is there pedagogical value in the information provided?

19. **Teacher**: In the Class Results display area, right-click on the bar representing the answer No, and select **Mark this Response Correct**.
    - The bar next to the word No will change to green to signify that it has been recorded as the correct answer if **Show Correct Answer** is selected.



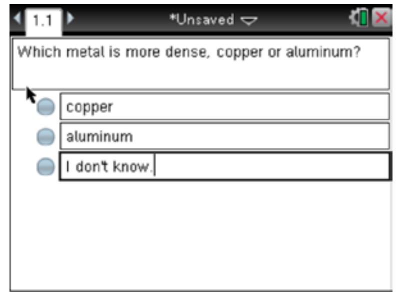


    - This will allow the teacher to record and track the correctness of each student's answer to the question posed.
    - If the correct answer to a question is never marked, the teacher can still gauge class understanding from the results, but the question will not be included in any scoring when the results are saved into the Student Portfolio.

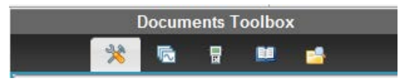
20. **Teacher**: Return to the Document workspace.
21. Turn off the "Allow Resubmit" option by pressing **Tools > Quick Poll Options**.
22. **Teacher:** Click the Quick Poll icon.

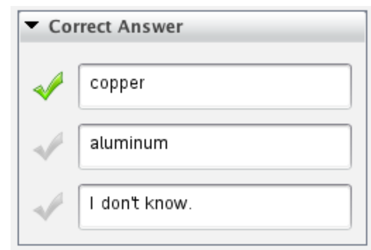
23. **Teacher**: Select the Multiple Choice - Custom Choice type of question, and press **Insert**.
24. **Teacher**: Click in the question field, and type an appropriate question for the activity.
25. **Teacher**: Click in the first answer field, and type the first answer choice.

26. **Teacher:** Using **Tab** or the down arrow, navigate to the second answer field. Type the second answer choice.
27. **Teacher:** Press **Enter** to open an additional answer field, and type in a third answer choice.
    - To remove an empty answer field, click in that field, and press **Backspace**.



Note: If this process is not being completed in front of students, the teacher could mark the correct answer when writing the question. Open the **Document Tools** in the Documents Toolbox and click on the checkmark in front of the correct answer.



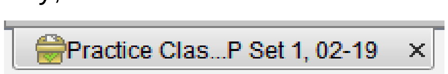


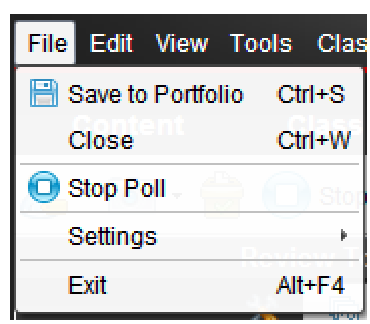
28. **Teacher:** Send the Quick Poll to the class by pressing **Start Poll**.
29. **Student:** Answer the Quick Poll question on both handhelds, and submit the responses.
30. **Teacher:** Monitor the incoming responses. If necessary, repeat instructions on how students submit a Quick Poll response.
31. **Teacher**: Click on the **Stop Poll** button after students have responded to the question.

Saving to the Portfolio

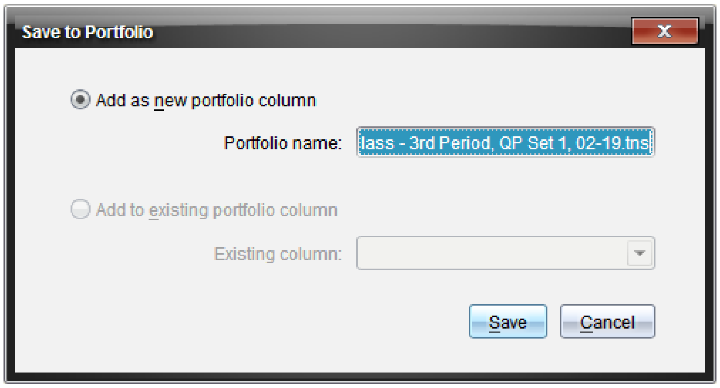
The Quick Poll questions and class results for a class session are compiled into one Review Document for up to 15 Quick Poll questions. If more than 15 Quick Poll questions are sent during a class session, another Review Document will open and compile the next 15 Quick Poll questions and results. These results can be saved into the Portfolio at any time during the class session. Saving the results will help the teacher monitor student progress over time and make diagnostic decisions regarding student performance.

1. **Teacher**: Click on the X to close the Review Document containing the Quick Poll questions and class results, and click **Save**. Alternatively, select **File > Save to Portfolio**.

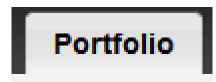


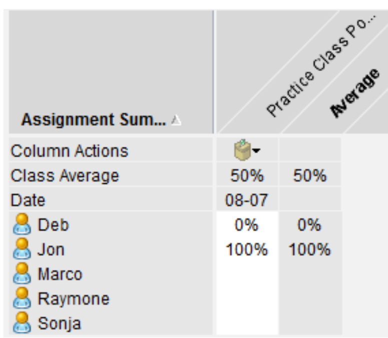


2. **Teacher:** If desired, change the name of the portfolio column, and click **Save**.

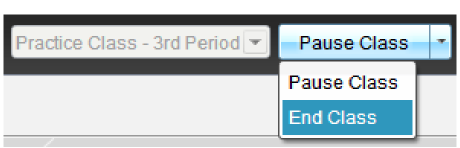


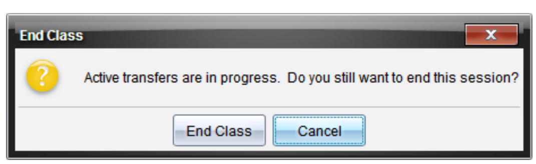
3. **Teacher:** To view the portfolio, go to the Portfolio workspace. The Assignment Summary displays the results in a gradebook type display.
    - The portfolio will be discussed in depth in a later activity in the workshop.





4. **Teacher:** To end the class, select **End Class** from the pull-down menu next to the Class Name.
    - If a pop-up window indicates 'Active transfers are in progress," press **End Class**. The alert indicates that the TI-Nspire document sent to the class is still available for those who have not yet logged in to the class session.





Switch Roles

Now switch roles and repeat the activity. When creating a new class, be sure to use a different class name and select that class name before starting the class.

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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 onto a flat surface, count them, and 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.

Materials

- 2 lb. bag of M&M's®
- Paper towels
- Small paper cups

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

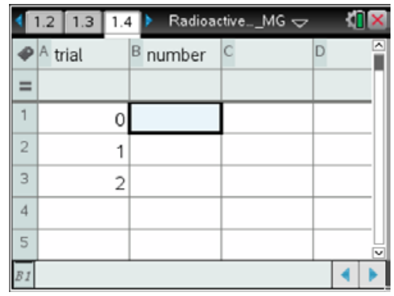
Radioactive_Decay_Student.doc

TI-Nspire document

Radioactive_Decay_MG.tns

Discussion Points and Possible Answers

Move to pages 1.2, 1.3, and 1.4.



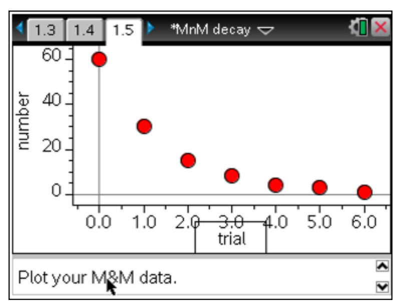
1. Acquire a half cup of M&M®s from your teacher.
2. Pour the M&Ms onto a flat surface, count them, and enter the count on the spreadsheet on Page 1.4.
3. Place the M&M's back in the cup, shake, and pour all of them out again.
4. Remove the candies that landed M-side up, and count the remaining M&Ms (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.

> **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 = ½; 3 sides = 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

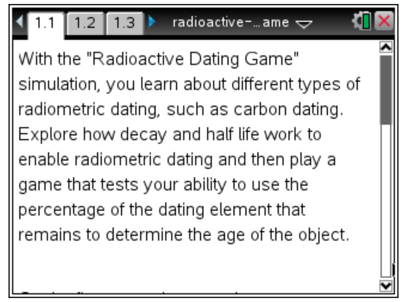
Middle Grades Student Activity

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.

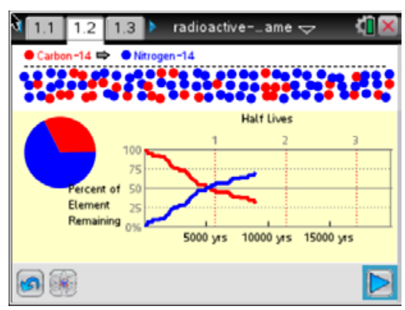
Carbon-14 is a radioactive isotope. It decomposes into another element and releases radioactivity in the process. This decomposition occurs at a known rate, so scientists can use the amount of the element/isotope remaining to determine how old something is. This known rate is called half-life, and here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

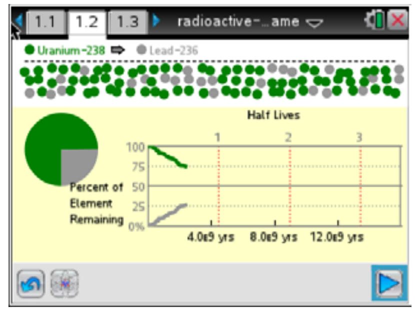
1. Run the simulation for Carbon-14 by selecting the play button. Observe how long it takes for Cabon-14 to decompose into Nitrogen-14. Then analyze the patterns you see. Select to change from Carbon-14 to Uranium-238. Observe how long it takes for Uranium-238 to decompose into Lead-236.



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?

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



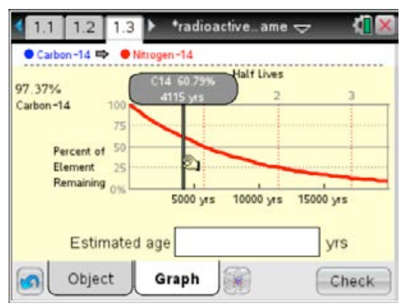
Q3. Why do you think the intersecting line for the decomposition of Uranium-238 into Lead-236 is not exactly at the 1st half-life line?

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 select 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 and drag it. Observe how the percent remaining changes as the age increases from left to right.
   Note: Select to change from Carbon-14 to Uranium-238.



Tech Tip: To move the gray bar, tap to drag it to the left or right across the screen. It is best to grab the bar at its base so you do not obstruct the data above it.

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?

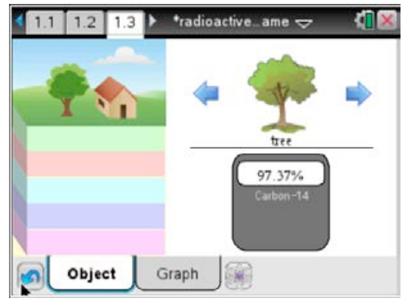
Radioactive Dating

Middle Grades Student Activity

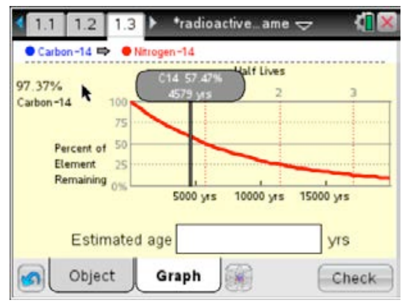
Name ______________

Class ______________

On page 1.3, select Object.



5. Play the Radioactive Dating game. Select 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 select 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 select 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. Select Check and the appearance of the green face means your answer is correct. The red face means your answer is incorrect.

Tech Tip: To enter the estimated age, tap inside the box next to Estimated age. The keyboard will appear. Select the button **".?123"** to the left or right of the space bar to enter a numerical quantity. After you have entered the value, select "return." Then, select Check to check your answer.

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?

Radioactive Dating

Middle Grades Student Activity

Name _______________

Class _______________

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

Radioactive Dating

MIDDLE GRADES SCIENCE NSPIRED

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
- decompose
- Carbon–14
- Uranium–238
- radioactivity
- radioactive dating
- half-life
- archeological site

About the Lesson

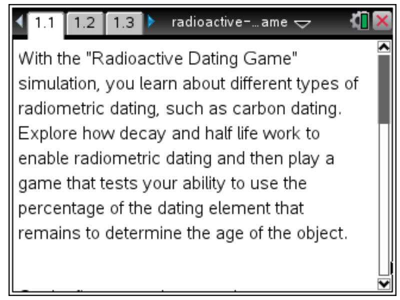
- This lesson involves students using TI-Nspire technology to simulate radioactive dating at an archeological site.
- As a result, students will:
  - Reinforce understanding of the atom and its parts.
  - Learn how the amount of radioactive emissions given off by certain isotopes as they decompose can 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 Class Capture.
- Use Live Presenter to allow students to show how they manipulate variables that effect results.

Activity Materials

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



Tech Tips:

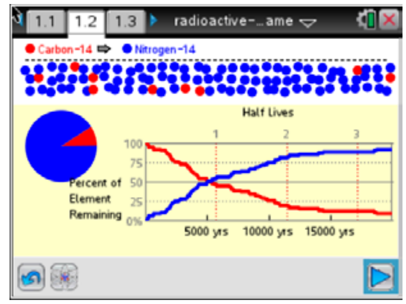
- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- 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

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

Discussion Points and Possible Answers

Move to page 1.2.



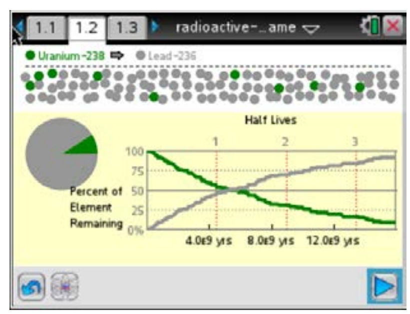
1. On this page students run the simulation for Carbon-14. They should observe how long it takes for the isotopes Carbon-14 and Uranium-238 to decompose and then analyze the patterns they see.

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 select 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.

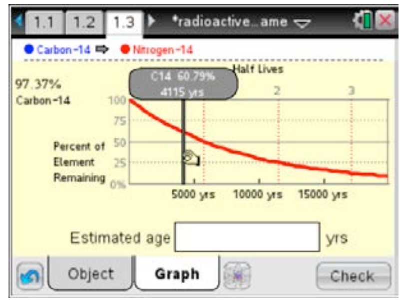
Q4. What do you notice about the difference in decomposition rates between Carbon-14 and Uranium-238?

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

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 select Graph.



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

Tech Tip: Students can select to grab the bar and 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.

Tech Tip: Students should tap to grab and drag the bar to the left or right across the screen. It is best to grab the bar at its base so they do not obstruct the data above it.

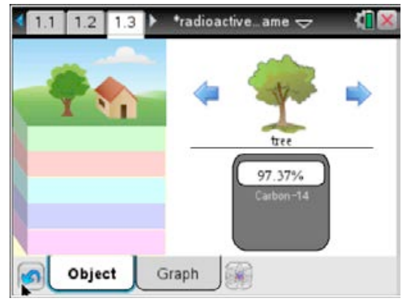
Q6. How does the age of Carbon-14 differ from the age of Uranium-238 after they have both decomposed about 50% (the first half-life)? 50% of the first 50% (the second half-life) and 50% of the previous 50% (the third half-life)?

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

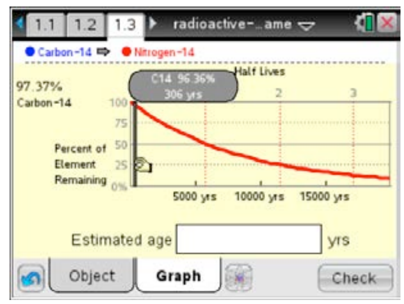
Q7. What is similar about the decomposition of both elements? What is different?

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.

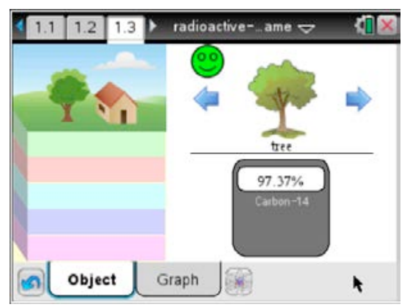
On page 1.3, select Object.



5. Students should play the Radioactive Dating game by first selecting 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 select to change from one isotope to the other.



7. Students should record the percentage of the isotope remaining the object. Then they select **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 select Check they will know whether or not their answer is correct by the appearance of the green (correct) or red (incorrect) face.

Tech Tip: To enter the estimated age, students should tap inside the box next to Estimated age. Then they can select the button **".?123"** to the left or right of the space bar to enter a numerical quantity. After they have entered the value, they can select "return" and select Check to check their answer.

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.

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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The Temperature's Rising or Falling
Student Activity

Name ______________

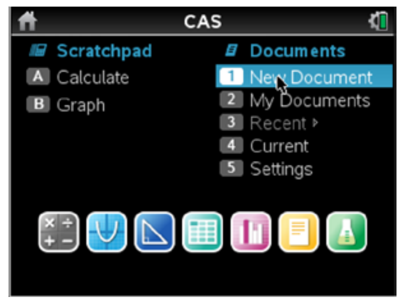
Class ______________

Activity Overview

In this activity, you will examine how temperature varies with time in various situations.

Materials

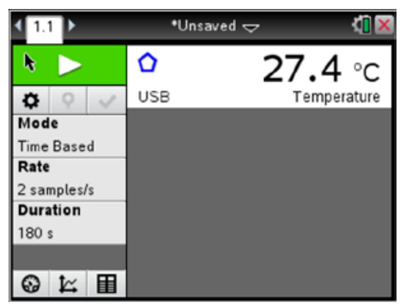
- TI-Nspire™ CX or TI-Nspire™ CX CAS handheld
- Vernier EasyTemp® USB temperature sensor or Vernier EasyLink® USB sensor interface and Vernier Stainless Steel Temperature probe
- Water of various temperatures and/or ice
- Hair dryer or other heat source (optional)
- Cups



Step 1:

Turn on the TI-Nspire™ CX handheld and create a new document by selecting New Document from the Home page.

- If asked to save the current document, select "Yes" or "No" based upon whether you have used this document and want it for future reference.



Step 2:

Once you have the new document open, plug the EasyTemp sensor into the mini-USB port of the TI-Nspire handheld.

- If you are using the Stainless Steel Temperature probe with the EasyLink adapter, plug the probe into the EasyLink and then plug the EasyLink into the handheld mini-USB port.
- The Vernier DataQuest™ application should launch automatically. If not, select it from the Menu.

Step 3:

Discuss the following with your partner.

- What is the current temperature? What are the units?

- How often will a data point be collected using the current settings?

- How long will the experiment last once data collection begins?

- How do you think you can make changes to the settings?

The Temperature's Rising or Falling

Student Activity

Name ____________

Class ____________

Step 4:

Come up with a plan to vary the temperature of the sensor over time.

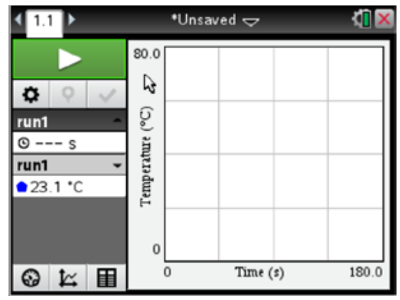
- Write it down. Include at least 3 different changes (increase, decrease, etc.) and how you plan to create the changes.
- Make a prediction of what the graph will look like for these temperature variations.
- Sketch your prediction in the space to the right, labeling the axes including units.

Step 5:

a. Prepare to collect the data for your plan. Obtain the materials that will allow you to make the temperature changes.

b. To collect the data, click the green Start button ▶ in the upper left corner of the screen.

c. Perform the experiment that you designed. Make a sketch of the resulting graph on the grid space provided to the right.



Step 6:

Compare your graph with your prediction. Write an analysis of how the data points shown on the graph compare with your prediction.

Step 7:

Exchange handhelds with another group. Try to determine how they collected their data and have the other group determine your methods.

- Be as specific as possible when describing their plan.
- You can click on the temperature vs time graph and move along it using the arrow keys. The temperature at any selected time will appear on the left side of the screen.

Step 8:

If time permits, collect another set of data using a different plan. Are your predictions closer to the actual data collected this time? Why?

The Temperature's Rising or Falling

STEM Objectives

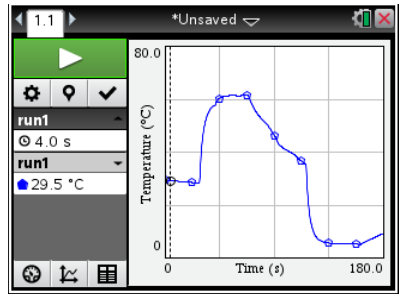
- Students will learn the basics of collecting temperature data and then carry out a plan to vary temperatures over time, comparing their data with their predictions.
- Students will plan and carry out investigations.
- Students will analyze and interpret data.
- Students will use appropriate tools strategically.
- Students will reason abstractly and quantitatively with the Vernier® DataQuest™ application.

About the Lesson

- This lesson involves examining how temperature varies with time.
- As a result, students will:
  - Design a plan.
  - Predict the outcome through a graph.
  - Test their predictions.

Materials

- TI-Nspire™ CX or TI-Nspire™ CX CAS handheld
- Vernier EasyTemp® USB temperature sensor or Vernier EasyLink® USB sensor interface and Vernier Stainless Steel Temperature probe
- Water of various temperatures and/or ice
- Hair dryer or other heat source (optional)
- Cups



TI-Nspire™ Technology Skills:

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

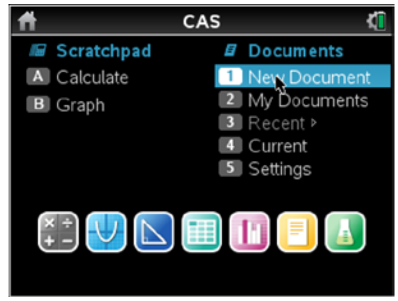
Tech Tips:

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

Lesson Files:
Student Activity

- Temperatures_Rising_Student.pdf
- Temperatures_Rising_Student.doc

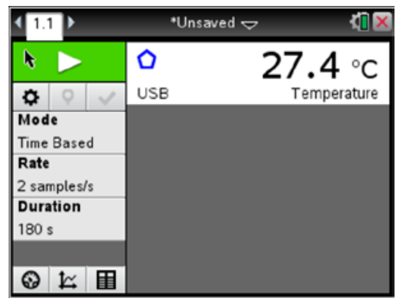
Discussion Points and Possible Answers



Step 1:

Turn on the TI-Nspire CX handheld and create a new document by selecting New Document from the Home page.

- If asked to save the current document, select "Yes" or "No" based upon whether you have used this document and want it for future reference.



Step 2:

Once you have the new document open, plug the EasyTemp sensor into the mini-USB port of the TI-Nspire handheld.

- If you are using the Stainless Steel Temperature probe with the EasyLink adapter, plug the probe into the EasyLink and then plug the EasyLink into the handheld mini-USB port.
- The Vernier DataQuest™ application should launch automatically. If not, select it from the Menu.

Step 3:

Discuss the following with your partner.

- What is the current temperature? What are the units?

  Answer: Temperature values will vary but units are ˚C.

- How often will a data point be collected using the current settings?

  Answer: 2 readings every second

- How long will the experiment last once data collection begins?

  Answer: 180 seconds

- How do you think you can make changes to the settings?

  Answer: Click the gear icon below the green start key or use the Menu and Experiment Set Up.

> **Tech Tip:** These readings are based on the default settings of the probe. If these readings are different, the student may want to reset the settings by selecting **Menu > Experiment > New Experiment**.

Step 4:

Come up with a plan to vary the temperature of the sensor over time.

- Write it down. Include at least 3 different changes (increase, decrease, etc.) and how you plan to create the changes.
- Make a prediction of what the graph will look like for these temperature variations.
- Sketch your prediction in the space to the right, labeling the axes including units.

Predictions will vary but should increase or decrease as indicated in the plan.

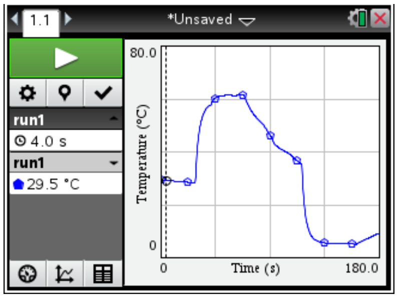
Sample Answer: Encourage students to be specific and think about how long each part of their plan will last. Collect Data for 25 seconds at room temperature > put temperature probe into hot water for 30 seconds > remove the probe and let cool for 20 seconds > blow on the probe for 20 seconds > place the probe in ice water for 50 seconds > remove the probe and let it heat back up.

Step 5:

a. Prepare to collect the data for your plan. Obtain the materials that will allow you to make the temperature changes.

b. To collect the data, click the green Start button in the upper left corner of the screen.

c. Perform the experiment that you designed. Make a sketch of the resulting graph on the grid space provided to the right.



Sample Answer: Sample data shown to the right.

Step 6:

Compare your graph with your prediction. Write an analysis of how the data points shown on the graph compare with your prediction.

Sample Answer: Students should be encouraged to discuss differences in detail. In many cases, students make graphs linear. They should know or discover that with temperature data, the graph will generally not be linear, especially as the temperature reaches a point where it is going to level out.

Step 7:
Exchange handhelds with another group. Try to determine how they collected their data and have the other group can determine your methods.

- Be as specific as possible when describing the plan.
- You can click on the temperature vs time graph and move along it using the arrow keys. The temperature at any selected time will appear on the left side of the screen.

  Sample Answer: The idea here is for students to get the ideas of how various actions impact the graph. The answers do not need to be correct but should be plausible based upon the graph the students receive.

Step 8:
If time permits, collect another set of data using a different plan. Are your predictions closer to the actual data collected this time? Why?

Sample Answer: Student answers will vary.

> **Teacher Tip:** You might want the students to keep the first run by clicking on the checkmark below the play button.

DataQuest
13

Transpiration

Water is transported in plants, from the roots to the leaves, following a decreasing water potential gradient. *Transpiration*, or loss of water from the leaves, helps to create a lower osmotic potential in the leaf. The resulting transpirational pull is responsible for the movement of water from the xylem to the mesophyll cells into the air spaces in the leaves. The rate of evaporation of water from the air spaces of the leaf to the outside air depends on the water potential gradient between the leaf and the outside air.

Various environmental factors, including those conditions which directly influence the opening and closing of the stomata, will affect a plant's transpiration rate. This experiment will measure transpiration rates under different conditions of light, humidity, temperature, and air movement. The data will be collected by measuring pressure changes as the plant takes up water into the stem.

OBJECTIVES

In this experiment, you will

- Observe how transpiration relates to the overall process of water transport in plants.
- Use a handheld interface and a Gas Pressure Sensor to measure the rate of transpiration.
- Determine the effect of light intensity, humidity, wind, and temperature on the rate of transpiration of a plant cutting.

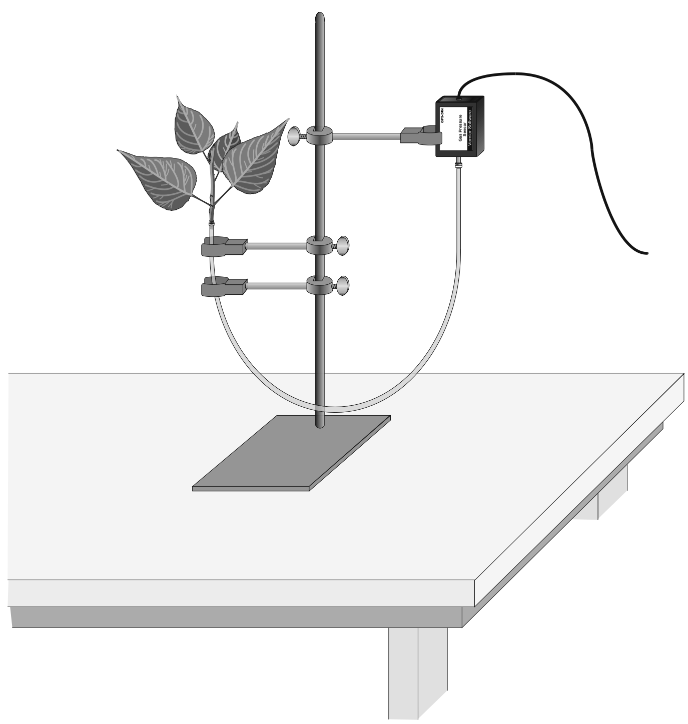


Figure 1

MATERIALS

TI-Nspire handheld **or**
computer and TI-Nspire software

100 watt light source
metric ruler

data-collection interface
Vernier Gas Pressure Sensor
utility clamps
ring stand
plant cuttings
plastic tubing clamps
dropper or Beral pipette
razor blade or scalpel
masking tape
plastic gallon size bag with twist tie
heater, small electric
fan with slow speed
aerosol spray container or plant mister
plastic syringe
graph paper

PROCEDURE

1. Position the ring stand, utility clamps, and Gas Pressure Sensor as shown in Figure 1.
2. Prepare the plastic tubing.
   a. Connect the plastic syringe to one end of a 36–42 cm piece of plastic tubing.
   b. Place the other end of the tubing into water and use the syringe to draw water up into the tubing until it is full. Tap the tubing to expel any air bubbles that form inside the tube.
   c. Slip a plastic tubing clamp onto the tubing as shown in Figure 2.
   d. Bend the tubing into a U shape with both ends up. Remove the syringe, leaving the tubing full of water.

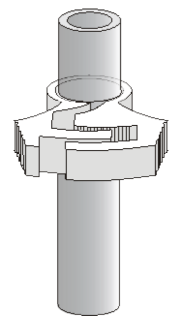


Figure 2

3. Select a plant which has a stem roughly the same diameter as the opening of the plastic tubing. Using a scalpel or razor blade, carefully cut the plant one inch above the soil. Place the plant under water against a hard surface and make a new cut at a 45° angle near the base of the stem.
4. Connect the plant to the tubing.
   a. The plastic tubing has a white plastic connector at one end that allows you to connect it to the valve on the Gas Pressure Sensor. Raise the end of the tubing with the connector until you see water beginning to drip out of the other end.
   b. Carefully push the cut stem of the plant down into the end of the tubing where the water is dripping out. Be careful not to allow any air bubbles to form between the cut portion of the stem and the water in the tube.
   c. Push the plant down as far as it will go without damaging the plant. At least one centimeter of the plant stem should fit into the tubing. If the stem is too large for the tubing, cut the stem at a higher point where it is smaller.
   d. Squeeze the tubing clamp shut as tight as possible as shown in Figure 3.

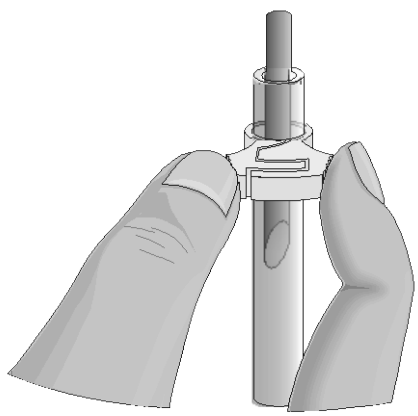


Figure 3

5. When the tubing clamp is shut tight, invert your plant cutting to check for any leaks. If water does leak out, turn the plant right-side up and try tightening the clamp further.

Important: Be sure the tubing is filled completely with water. The water column must be flush with the stem. There should be no air visible at the base of the stem. If water moves down the tube away from the stem after it has been inserted, check for a leak in the system.

6. Connect the plastic tubing to the sensor valve. **Caution**: Do not allow water to enter the valve of the Gas Pressure Sensor.

7. Secure the plant in an upright position with the utility clamps as shown in Figure 1. It should be positioned so that the cut stem is about 8 cm below the water level at the other end of the tubing, as shown in Figure 1.

8. Place a mark on the tube at the starting water level to allow you to refill the tube to the proper level when you repeat data collection.

9. Place your plant setup in an area where the wind, humidity, and temperature are reasonably constant. This will be your control setup.

10. Allow the system 5 minutes to adjust to the environment. While the system is adjusting, continue with this procedure to complete setting up the sensor and data-collection parameters.

11. Connect the Gas Pressure Sensor to the data-collection interface. Connect the interface to the TI-Nspire handheld or computer.

12. Choose New Experiment from the Experiment menu. Choose Collection Setup from the Experiment menu. Enter **0.25** as the rate in samples per second and **900** as the experiment duration in seconds (15 minutes). The number of points collected should be 226. Select OK.

13. Check the base of the plant stem in the water tube to make sure that no air bubbles or air pockets have formed that will prevent the plant from taking up water. If an air pocket has formed, refit the plant in the tubing before initiating data collection in Step 14.

14. After the plant has equilibrated for 5 minutes, start data collection (▶). Data will be collected for 900 seconds. If necessary, you can stop data collection early (■).

15. When data collection has stopped, perform a linear regression to calculate the rate of transpiration.

    a. Examine the graph and identify the most linear region.
    b. Select the linear region of the data.
    c. Choose Curve Fit ►Linear from the Analyze menu. The linear-regression statistics for these two data columns are displayed for the equation in the form

    $$y = mx + b$$

    where x is time, y is pressure, m is the slope, and b is the y-intercept.
    d. Enter the absolute value of the slope, m, as the rate of transpiration in Table 1.

16. Design an experiment to simulate *one* of the following environmental conditions, as assigned by your teacher:
    - the effect of light intensity
    - the effect of the wind blowing on the plant
    - the effect of humidity
    - the effect of temperature
    - the effect of another self-identified environmental variable

    Be sure to address the following questions in your design:
    - What is the essential question being addressed?
    - What assumptions are made about the system being measured?
    - Can those assumptions be easily verified?
    - Will the measurements provide the necessary data to answer the question under study?
17. After checking your procedure with your teacher, obtain the materials needed for the experiment and perform the tests. Be sure to Store Data button (✔) before each new trial. Record your values in Table 1.
18. Identify the environmental condition you tested in the blank provided in Table 1.

PROCESSING THE DATA

1. Determine the surface area of all the leaves on your plant cutting by the following method:
   a. Cut all the leaves (not stems) off your plant and determine their mass using a balance.
   b. Estimate the total leaf surface area in cm^2 for your plant by cutting out a section of leaf 5 cm x 5 cm.
   c. Determine the mass for this leaf section and divide by 25 cm^2 to find the mass of l cm^2 of leaf.
   d. Divide the total mass of the leaves by the mass of l cm^2 to find the total leaf surface area.
   e. Record the calculated surface area in Table 1.
2. Divide the slope by the surface area for each test and record in the *rate/area* column of Table 1. These rate values should be expressed as $kPa/s/cm^2$.
3. Subtract the control (rate/area) value from the experimental value. Record this adjusted rate in the last column of Table 1.
4. Record the adjusted rate for your experimental test on the board to share with the class. Record the class results in Table 2 for each of the environmental conditions tested. If a condition was tested by more than one group, take the average of the values and record in Table 2.
5. Make a bar graph that shows the effect of different environmental conditions on the transpiration of water in plant cuttings. Using the data in Table 2 plot the adjusted rate for each test on the y-axis and the test label on the x-axis.
   a. Insert a new problem in the document, then Insert a new DataQuest App into the problem. Click on the Table View tab (▦) to view the Table.
   b. Double click on the *X* column to access the column options. Enter **Test** for the column name. Change the Display Precision to 0 decimal places. Select OK.

c. Double click on the *Y* column to access the column options. Enter **Rate** for the column name. Enter **kPa/s/cm^2** as the units. Select OK.

d. Insert a Data and Statistics application into the problem.

e. Move the cursor over the Click to Add Variable label in the lower center of the screen and access the contextual menu. (ctrl menu on a handheld or right-click on a computer.)

f. Choose the Add X Variable with Summary List option.

g. Choose run1.Test as the X List and run1.Rate as the Summary List, then Select OK.

DATA

Table 1

Test	Slope (kPa/s)	Surface area (cm^2)	Rate/area (kPa/s/cm^2)	Adjusted rate (kPa/s/cm^2)
Experimental				
Control				

Table 2 - Class Data

Test	Adjusted rate (kPa/s/cm^2)
Light	
Humidity	
Wind	
Temperature	

QUESTIONS

1. How was the rate of transpiration affected in each of the experimental situations as compared to the control?

2. Which variable resulted in the greatest rate of water loss? Explain why this factor might increase water loss when compared to the others.

3. What adaptations enable plants to increase or decrease water loss? How might each affect transpiration?

EXTENSIONS

1. Using a compound microscope, identify the vascular tissues of a plant stem. Describe the function of each tissue type identified.
   a. Obtain a section of stem from the plant you used during the transpiration experiment.
   b. Using a nut-and-bolt microtome, carefully cut 6 cross sections of the plant stem. The cross sections should be cut as thin as possible.
   c. Place each of the cross sections in a dish or cup of 50% ethanol solution for 5 minutes.
   d. Remove the cross sections from the alcohol and place them in a dish containing toludine blue O stain for 5 minutes.
   e. Rinse the cross sections with distilled water and mount them on a microscope slide with a drop of 50% glycerin. Place a cover slip on the slide and examine the cross sections using a compound microscope.
   f. On a separate sheet of paper, make a drawing of the cross sections. Identify and label the cell and tissue types described by your teacher.
2. Test cuttings from a variety of different plant species. How does each compare?
3. Count the number of stoma/cm^2 for each of the plants in Extension 1. How does this relate to the plant's ability to transpire water?
4. Design an experiment to test for the variables in Question 3.

Experiment
13

TEACHER INFORMATION

Transpiration

1. Editable Microsoft Word versions of the student pages and pre-configured TI-Nspire files can be found on the CD that accompanies this book. See *Appendix A* for more information.

2. You should leave water out overnight in a beaker or cup to allow any excess dissolved air to escape. This will ensure that no air bubbles form in the tube at the cut end of the stem. If air bubbles form, it may be necessary to restart your experiment. If bubbles do form, remove the plant and tubing from the two utility clamps and allow the plant to hang towards the ground with the other end of the tubing pointing up. Carefully tap on the sides of the tubing to loosen any bubbles—they will float to the water's surface at the other end. Once all bubbles are removed, check the plant's seal at the tube. Secure your plant in the tubing and restart the data collection.

3. There is not always an immediate change in the transpiration rate. Allow the plant to spend a few extra minutes under a particular condition before initiating data collection. This will give the plant the necessary time to adjust. When the transpiration rate changes drastically, the stomata will close, decreasing the transpiration rate. If the length of data collection is extended, you will be able to see on the graph when the stomata have closed and the rate slows down.

4. Many plants work well for this experiment. Plants that have been used include tomato, strawberry, bean, geranium, cyclamen, and even honeysuckle. For best results, we recommend using plants with numerous leaves. Tomato plants work very well and have been used to collect the sample data for this activity. One possible extension of this experiment would be to have the students use different plant species under similar conditions and evaluate how different plants have adapted to prevent water loss.

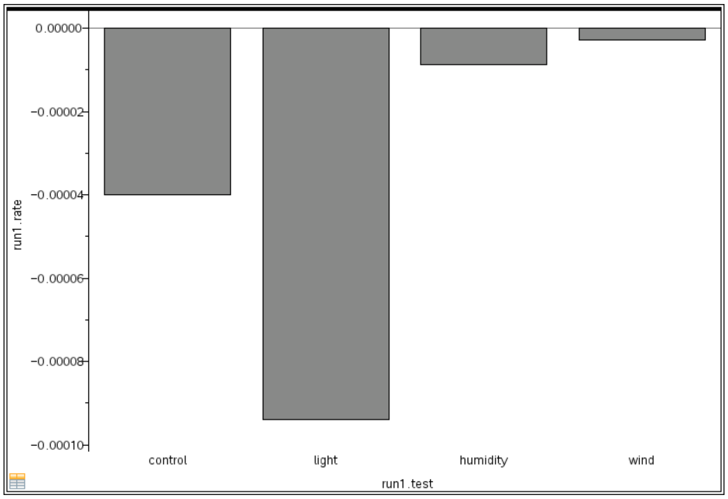
5. The thick-wall plastic tubing that comes with the Gas Pressure Sensor is well suited for this lab. The inner diameter of the tubing is 3 mm and may be too small for some plant specimens. Science supply companies carry thick-wall plastic tubing, with a larger inner diameter, that will work well on larger plant stems. They also sell tubing connectors that will allow you to connect the larger tubing to the tubing provided with the Gas Pressure Sensor.

6. Emphasize to your students the importance of providing an airtight fit with all plastic-tubing connections.

7. The plastic tubing clamps (order code PTC) used in the student procedure may be purchased in packages of 100 from Vernier Software & Technology.

SAMPLE RESULTS

Test	Adjusted rate ($kPa/s/cm^2$)
Control	-4.0×10^{-5}
Light	-9.4×10^{-5}
Humidity	$-.87 \times 10^{-5}$
Wind	$-.27 \times 10^{-5}$



ANSWERS TO QUESTIONS

1. It is typically predicted that the light and wind will increase the rate of transpiration. This may not be apparent until after correction for surface area differences. Sometimes the wind, if too strong, may cause the leaves to droop or fold up, and in this case they may transpire less. Stomates may close to counter the dehydration. If this happens, discuss the nature of science experimentation, e.g., the expected may not always be the result. Usually, after correction for surface area, the high humidity plant will transpire less than a control. A student may question whether the light increased the temperature of the leaf. If the light was too close to the plant, temperature may indeed be a variable without a control.

2. Answers will vary—usually the light will produce the greatest rate of water loss. High light intensity increases water loss due to increased photosynthesis. Wind removes water vapor from the surface of the leaf more rapidly. It may increase the evaporation rate by increasing the gradient between water in the leaf air spaces and water vapor in the air.

3. Plants can increase or decrease water loss by
   - closing the stomata during water stress.
   - reducing the number of stomata.
   - waxy cuticles.
   - fleshy, thick leaves.
   - hairy surfaces.
   - reducing the overall leaf surface area.

Zombie Apocalypse

Student Activity

Name ________________

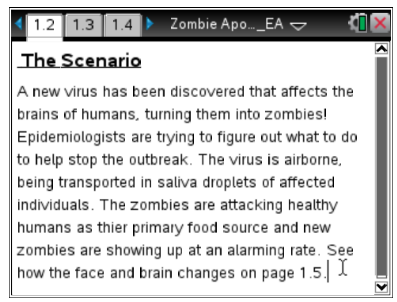
Class ________________

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

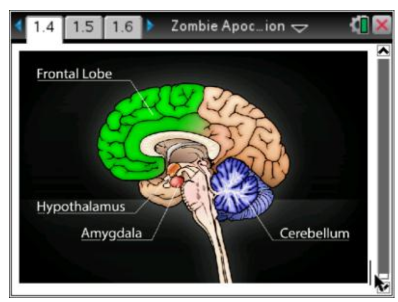
In this activity you will explore the spread of a fictional virus that turns normal humans into angry, hungry zombies. Although zombies aren't real, they are a fun way to learn about how a disease can spread and how populations can suffer the effects of REAL viruses, like influenza. You will also learn a little about the human brain and certain areas of the brain that, if affected, would cause a person to become a zombie again, if such a thing were real. Explore the activity and remember, although zombies aren't real, viruses and diseases certainly are. Knowing how populations become infected is important to understand if we want to control the spread of diseases.

Move to pages 1.2 - 1.6

1. Read the scenario of the zombie virus epidemic on page 1.2. Page 1.3 describes the method by which the virus infects humans and explains the resulting symptoms in the human brain.

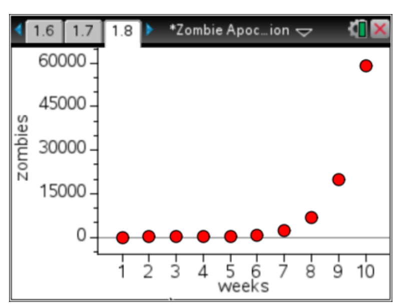


2. Review the parts of the brain on page 1.4. These are the structures that are affected by the zombie virus. Read about the symptoms of this fictional disease on page 1.5. Go to page 1.6 and step through the progression of the disease. The normal human becomes 'zombified' over time as the virus works on specific areas of the brain. Can you think of some real diseases that affect the brain?



Move to pages 1.7 - 1.8

3. Read about the background of the zombie crisis on page 1.7. Advance to page 1.8 and look at the graph. Look at both axes. Notice the pattern of the data. What predictions can you make based on this data?



Zombie Apocalypse

Student Activity

Name ______________

Class ______________

Move to pages 1.9 – 1.17. Answer the following questions here or in the .tns file.

Q1. The greatest rate of infection occurred between week _____ and week _____.

Q2a. What is the approximate infection rate between week 1 and week 6?

Q2b. Now read page 1.11 and use the graph on page 1.12-
What is the approximate infection rate between week 1 and week 6?

Q3. Take a look at the graph on page 1.15 and predict what the number of zombies will be after the 25th week.

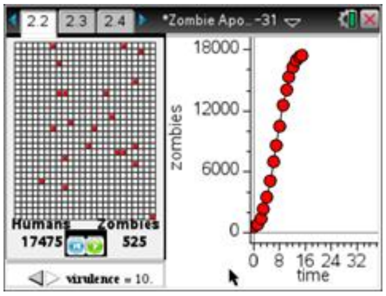
Q4. Explain what you believe will be happening with the rate of zombie production after 30 weeks.

Move to page 1.18.

4. The rate of infection of any disease will eventually decrease because of many different factors. For this activity, the main factors are lack of food (healthy humans) and lack of additional targets to infect (again, healthy humans). For other epidemics or diseases those factors may include the development of a vaccine or the elimination of a vector (the source that carries and distributes the pathogen) such as mosquitos, rats, or other organisms. Historically, factors such as sanitation have helped to control the rate of disease spread. What other factors can you think of?

Move to pages 2.1 – 2.3

5. "Virulence" is a measure of how effectively a disease-causing agent can spread through a population. Using the simulation on page 2.2, explore how changing the virulence of the zombie virus changes how quickly a human population can become infected.



Zombie Apocalypse

Student Activity

Name ________________

Class ________________

6. On page 2.3, notice that both zombie and human populations are plotted on the graph. Even when you change the virulence in the simulation you should see a relationship between the numbers of humans and zombies.

Move to pages 2.4 – 2.12. Answer the following questions here or in the .tns file.

Q5. In the graph, "time" is the independent variable, but there is no actual UNIT of time indicated. What do you think would be an appropriate unit of time for the spread of the Zombie Virus?

Q6. Estimate the point at which the number of zombies and the number of humans are equal? What variable would affect this point?

Q7. Based on the graph of humans and zombies from the previous page, which do you think is the relationship between the two populations?

A. Inverse
B. Direct
C. There appears to be no relationship

Q8. What effect did changing the virulence have on the rate of Zombie Virus infection?

A. As virulence increased, the rate decreased
B. As virulence increased, the rate increased
C. As virulence increased, the rate did not change

Q9. Although the Zombie Virus isn't a real concern for us YET, name another disease that you think has a pretty high degree of virulence.

Q10. What if a new "strain" of the Zombie Virus appeared that was almost the same as the original virus, except that it did not affect the cerebellum? Predict what the result would be.

Q11. What if the virus changed again, and neither cerebellum nor the frontal lobe were affected? Predict the results.

Zombie Apocalypse – How Disease Spreads through a Population

TEACHER NOTES

Science Objectives

- Students will investigate the spread of a disease through a population, using zombies as a model.
- Students will learn or review the basic functions of various parts of the human brain.
- Students will investigate and discuss factors dealing with immunity and vaccines.

Vocabulary

- Epidemiologist
- Cerebellum
- Hypothalamus
- Frontal Lobe
- Amygdala
- Infection
- Vaccine
- Virus
- Virulence

About the Lesson

- This lesson introduces the concept of a disease spreading through a human population using fictional zombies as the agent of infection.
- Teaching time: one 45 minute class period
- As a result, students will:
  - Interpret graphs to make predictions.
  - Use simulations to understand the symptoms of a fictional disease and see how the disease moves through a population.

TI-Nspire™ Navigator™

- Send out the *Zombie_Apocalypse.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 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

- Zombie_Apocalypse_Student.pdf

TI-Nspire document

- Zombie_Apocalypse.tns

Background

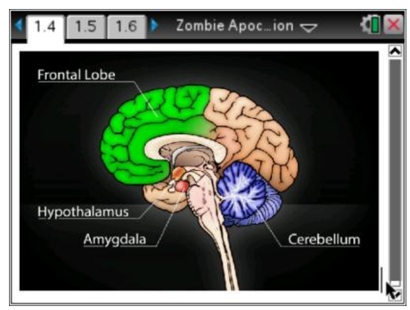
There are highly stylized images of zombies in this file. If you have students who have concerns with this activity, you may choose to delete the page with the zombie images. Explain to students that although zombies do NOT exist, they serve as a fun, pop cultural model that allows us to talk about disease and the spread of disease. Many television shows and movies have zombies as a part of the storyline, so they will serve as a way to engage students as they are introduced to the concepts of disease and the patterns and parameters that are characteristic of the spread of disease.

This particular activity starts by giving students the scenario of a virus spreading through a population. It goes on to describe the symptoms of the infection and wraps up with an animated simulation of the disease spreading through a population demonstrating an associated graph generating a characteristic ‘s’ curve.

It is likely that students will question the mechanism of transmission. This activity depicts the zombie virus being transmitted through airborne saliva droplets from coughing and/or sneezing. Movies and television programs have treated the zombie “infection” in different ways. Students will ask if zombies get infected from bites from other zombies. Those kinds of questions are great opportunities to discuss how the spread of the disease would be different from the airborne model this activity portrays.

Move to pages 1.2 - 1.6.

1. Students will read the above scenario whereby a newly discovered virus has been infecting humans, causing them to exhibit zombie-like symptoms. There are four areas of the brain which the virus affects –



- The Cerebellum: Balance and Coordination
- The Hypothalamus: Appetite
- The Frontal Lobe: Intelligence and Problem Solving
- The Amygdala: Anger and Rage

The Resulting Symptoms

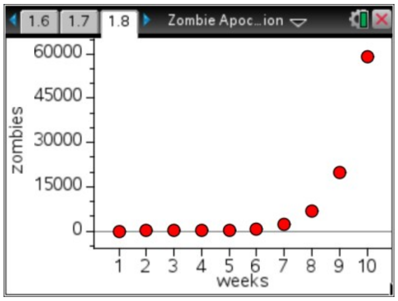
- **Affected Cerebellum**: Zombies clumsily shuffle forward.
- **Affected Hypothalamus**: Zombies have insatiable appetites.
- **Affected Frontal Lobe**: Zombies are poor problem solvers.
- **Affected Amygdala**: Zombies aren't nice. They are full of rage.

Zombie Apocalypse – How Disease Spreads through a Population

TEACHER NOTES

2. After students review the parts of the brain on page 1.4, ask students: *Can you think of some real diseases that affect the brain?* **Sample answers: Multiple Sclerosis, Parkinson's disease, Alzheimers disease, Epilepsy**

Move to pages 1.7 – 1.8.



3. Page 1.8 uses a Data & Statistics page, which students may use to see the rates of infection in the first months after the onset of the disease. Notice this graph appears to have an exponential pattern.

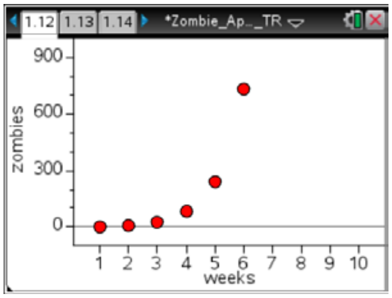
For discussion, ask students:

- *What predictions can you make based on this data?* **Sample answers: It appears that after week 7, the number of zombies is increasing at a very fast rate. Or the numbers of zombies seems to increase exponentially**
- *How long they believe this pattern will continue?* **Answers will vary**, this is an opinion question.
- *What factors will affect the pattern?* **Sample answers: the number of humans infected or the number of humans available as a food source.**

Move to pages 1.9- 1.18. Answer questions Q1 – Q4 here or in the .tns file.

Q1. The greatest rate of infection occurred between week _____and week _____.
Answer: Between week 9 and week 10.

Q2a. What is the approximate infection rate between week 1 and week 6?
Answer: Relatively low; the graph makes it look like zero.



Q2b. Now read page 1.11 and use the graph on page 1.12- What is the approximate infection rate between week 1 and week 6?
Answer: If you hover over the points, you can see the ordered pairs for each point.

Using (1, 3) and (6, 732), the average rate of growth is

$$\frac{732 - 3}{6 - 1} = \frac{729}{5} = 145.8 \text{ zombies per week.}$$

It is suggested that you accept answers between 100 and 200 zombies per week, if students just look at the graph and approximate the rate of change

Zombie Apocalypse – How Disease Spreads through a Population

TEACHER NOTES

Q3. Take a look at the graph on page 1.15 and predict what the number of zombies will be after the 25th week.

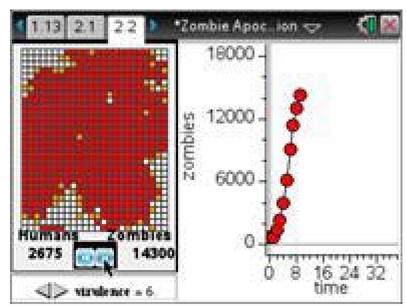
Answer: This is hard to determine from the graph, however a reasonable answer would be well into the millions—if the exponential model continued to hold true.

Q4. Explain what you believe will be happening with the rate of zombie production after 30 weeks.

Answer: The rate should slow considerably because of fewer people available to infect. This is not an obvious answer to most students.

4. The rate of infection of any disease will eventually decrease because of many different factors. For this activity, the main factors are lack of food (healthy humans) and lack of additional targets to infect (again, healthy humans). For other epidemics or diseases those factors may include the development of a vaccine or the elimination of a vector (the source that carries and distributes the pathogen) such as mosquitos, rats, or other organisms. Historically, factors such as sanitation have helped to control the rate of disease spread. What other factors can you think of?

Move to pages 2.1 – 2.3.



5. Pages 2.1 to 2.3 introduce students to the idea that the zombification rate is limited by certain factors such as food source, virulence (the measure of how effectively a disease-causing agent can spread through a population) and natural resistance to the virus in some humans. Students will use a simulation which offers a visual of the spread of the zombie virus. An associated graph is produced alongside the simulation. The following page, 2.3, shows the inverse relationship between humans and zombies as the disease progresses through the population. Ask students to discuss the other factors that could affect the limitations of a disease and why the relationship between the numbers of humans and zombies is inverse. Discuss why the virus doesn't wipe out all humans in the simulation (natural resistance and low susceptibility).

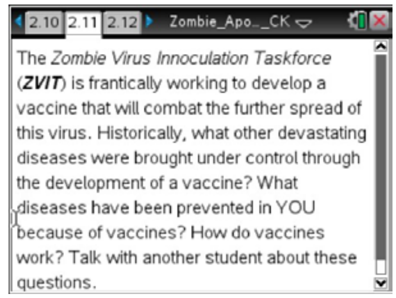
NOTE: *The last two pages of the teacher notes include sample screen shots for virulences from 1 through 10. Use these for comparison purposes.*
It is suggested that each student in a group do the simulation with a different virulence number. One should use a virulence number of 1, another use 10, and then some between 1 and 10. Have them compare and contrast their different graphs on pages 2.2 and 2.3.

Zombie Apocalypse – How Disease Spreads through a Population

TEACHER NOTES

Tech Tip: Students should select the button to reset the simulation and run it again with a different virulence.

Move to pages 2.4 – 2.12.



6. Students will answer questions about the simulation and the impact of the adjustments they made to the level of virulence. Students should notice that as virulence increases the rate of infection increases until there are no longer susceptible humans to infect. Ask students why some humans become infected with the virus and some do not. There is natural immunity to viruses and bacteria. Biodiversity serves as a mechanism to ensure the survival of a species. This includes resistance to disease. Use pages 2.11 – 2.12 to wrap-up the activity with a discussion on diseases and vaccines that are real, and relevant to students.

Q5. In the graph, "time" is the independent variable, but there is no actual UNIT of time indicated. What do you think would be an appropriate unit of time for the spread of the Zombie Virus?

Answer: Weeks or months would be a good answer.

Q6. Estimate the point at which the number of zombies and the number of humans are equal? What variable would affect this point?

Answer: With the virulence set at 2, the numbers of each would be equal at 11 weeks. (answers may vary)

Q7. Based on the graph of humans and zombies from the previous page, which do you think is the relationship between the two populations?

A. Inverse

B. Direct

C. There appears to be no relationship

Q8. What effect did changing the virulence have on the rate of Zombie Virus infection?

A. As virulence increased, the rate decreased

B. As virulence increased, the rate increased

C. As virulence increased, the rate did not change

Q9. Although the Zombie Virus isn't a real concern for us YET, name another disease that you think has a pretty high degree of virulence.

Answers: Diseases such as influenza, common cold, chicken pox, etc.

Q10. What if a new "strain" of the Zombie Virus appeared that was almost the same as the original virus, except that it did not affect the cerebellum? Predict what the result would be.

Answer: The zombies would have more muscle coordination and may be able to better catch their prey!

Q11. What if the virus changed again, and neither cerebellum nor the frontal lobe were affected? Predict the results.

Answer: Now, in addition to being more physically coordinated, they would also be able to think and reason much more clearly. Not a good scenario for the 'non-zombied' humans!

TI-Nspire Navigator Opportunities

Make a student the Live Presenter to demonstrate their zombie population simulation graphs.

Wrap Up

Students will have various results depending upon the virulence setting they used. Have students compare their graphs and discuss why the results are different.

Assessment

- Students will answer questions throughout the lesson to ensure understanding of the process of disease spread.

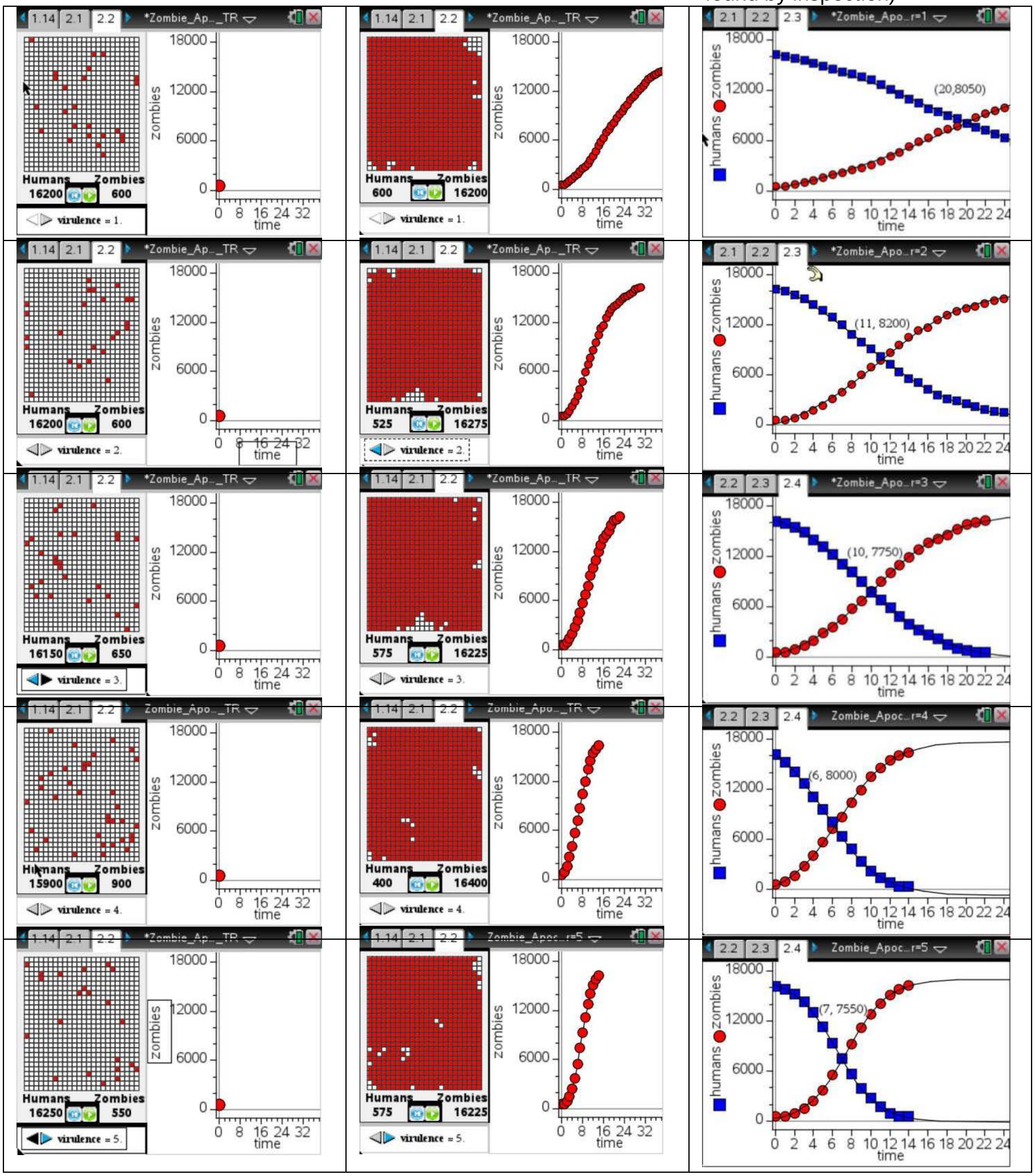
The next two pages contain sample screen shots for virulences from 1 through 10. Use these for comparison purposes.

Zombie Apocalypse – How Disease Spreads through a Population

TEACHER NOTES

Sample Data- *Screen shots with different virulences:1 through 5.*

Start simulation | **End simulation** | **Humans** versus **Zombies** (point of intersection found by inspection)

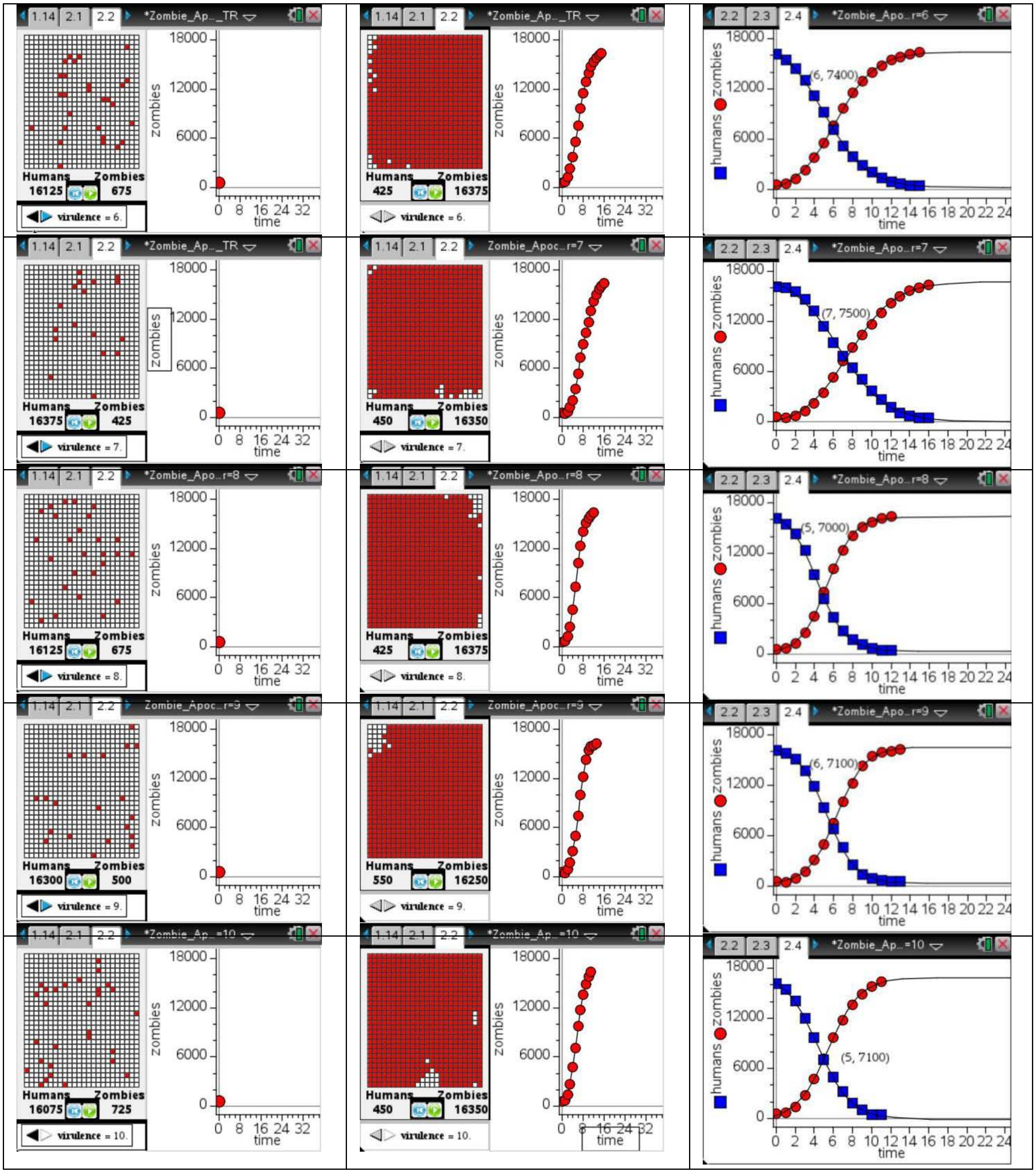


Zombie Apocalypse –
How Disease Spreads through a Population

TEACHER NOTES

Sample Data- *Screen shots with different virulences: 6 through 10.*

Start simulation | **End simulation** | **Humans** versus **Zombies** *(point of intersection)*



Online Resources

TI PROFESSIONAL DEVELOPMENT

Activity Overview

In this activity, you will explore resources available at education.ti.com. You will browse for activities at Math Nspired or Science Nspired. 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 > Activities**. Select **Math Nspired** or **Science Nspired**, which can also be accessed directly at mathnspired.com and sciencenspired.com. Select a subject on the left.

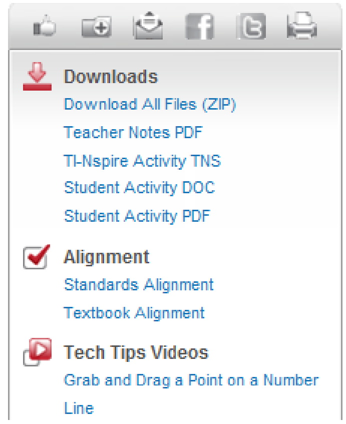
Step 2:

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

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

Step 3:

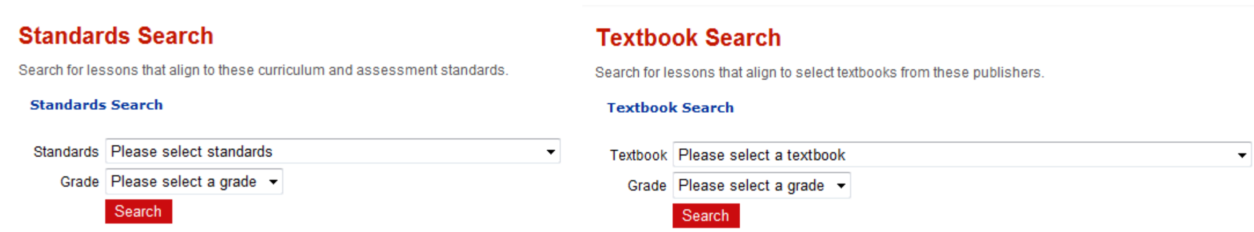
Select an activity from the list. The activity page shows objectives, relevant vocabulary, and additional information. A video offers a preview of the lesson, and related lessons are recommended below.



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

Step 4:

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



Step 6:

Click the **Solutions** tab and select Common Core State Standards or Science Tools. Content and activities, technology resources, and information on professional development opportunities are provided.

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, the TI-Nspire™ Navigator™ System, and the TI-Nspire™ App for iPad®.

The Upcoming page contains links to upcoming, free PD webinars. The On-Demand page contains recordings of past webinars, and associated webinar documents are available for download.

Step 8:

Explore each of the following pages by clicking the appropriate tab: Products, Downloads, Activities, Professional Development, Solutions, Support, and Where to buy.

The Content Workspace

TI PROFESSIONAL DEVELOPMENT

Activity Overview

In this activity, you will explore the Content Workspace of the TI-Nspire™ CX Teacher Software. You will browse web content, manage computer content, and transfer a document to a connected handheld.

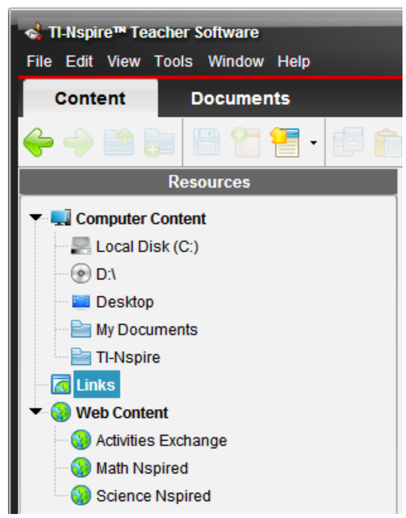
Materials

- TI-Nspire™ CX or TI-Nspire™ CX CAS Teacher Software with internet connection
- TI-Nspire™ CX handheld and standard-A to mini-B USB cable

Computer Content, Links, and Web Content

Step 1:

Open the TI-Nspire™ CX Teacher Software. If the Welcome Screen appears when the software is opened, go to the Content Workspace by clicking View Content. Otherwise, go to the Content Workspace by clicking the **Content** tab.



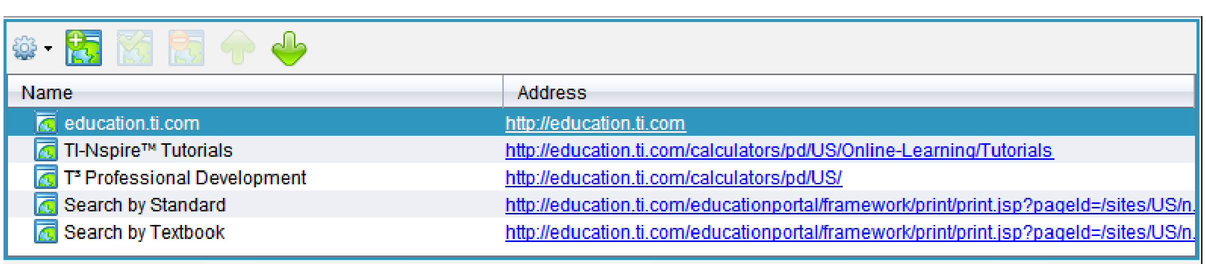
Step 2:

The Resources panel contains three types of resources: Computer Content, Links, and Web Content. If a handheld is connected to the computer, a fourth resource, Connected Handhelds, appears. Select Links.

Note: Each resource can be collapsed by clicking ▼ and expanded by clicking ▶.

Step 3:

The Content Workspace offers access to online resources through links to various websites. A list of links appears in the Content window**.** When a link is clicked, a Web browser is launched. Links can be added, edited, and removed by clicking the **Add Link**, **Edit Link**, and **Remove Link** icons.

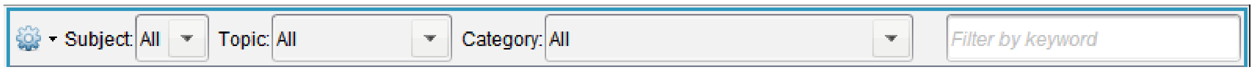


The Content Workspace

TI PROFESSIONAL DEVELOPMENT

Step 4:

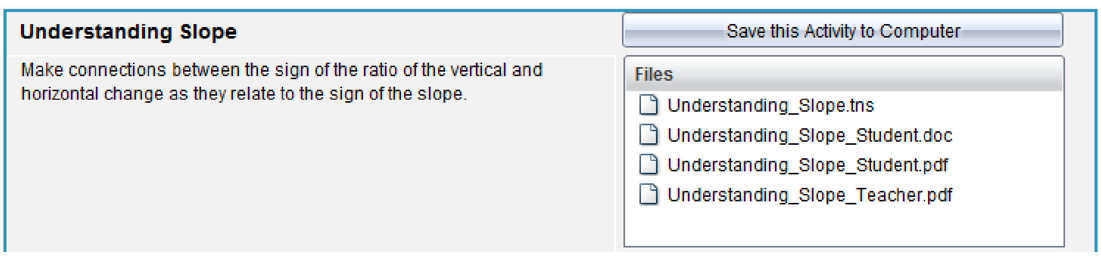
The Content Workspace offers the ability to search for lessons available online at Math Nspired or Science Nspired. In the Resources panel, go to Web Content and select **Math Nspired** or **Science Nspired**. The Content pane toolbar contains cascading fields for Subject, Topic, and Category. Activities can also be located using the **Filter by keyword** field.



Step 5:

Once a lesson is located, details about the activity appear in the Preview pane. The activity might appear as a lesson bundle, which consists of multiple files and can contain multiple file types. If the activity is a lesson bundle, the Files window appears and lists the individual files in the lesson bundle.

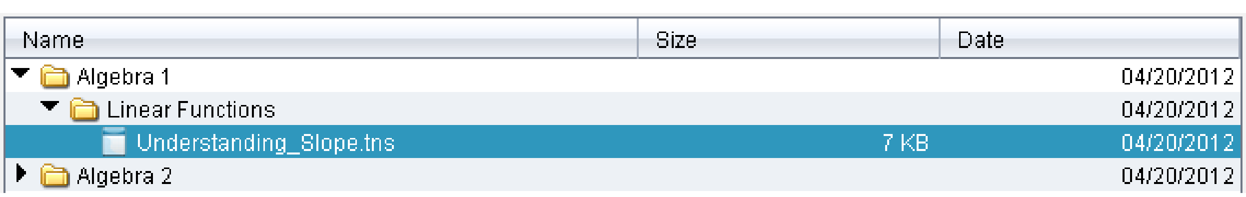
Save the lesson bundle to your Desktop by clicking **Save this Activity to Computer**. To save an individual file, right-click it and select **Save to Computer**.



Step 6:

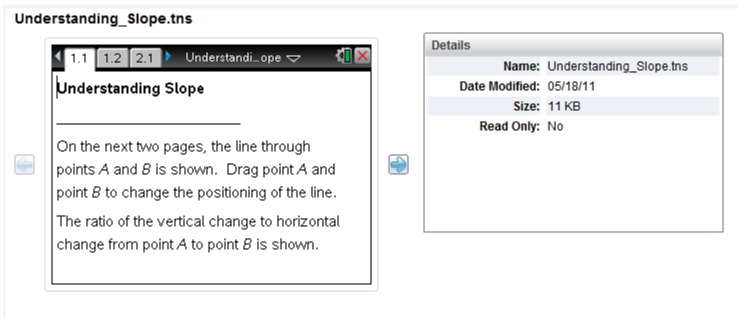
In the Resources panel, go to Computer Content**.** Here, you have the ability to view the documents and folders available on the Desktop, in the My Documents folder, and in the TI-Nspire folder.

The Content pane toolbar provides tools needed to locate folders and files. The **Look in** field contains the path of the current folder or file. To move up a level in the folder hierarchy, click . To create a new folder, click . To search for a document containing a specific word, use the keyword field.



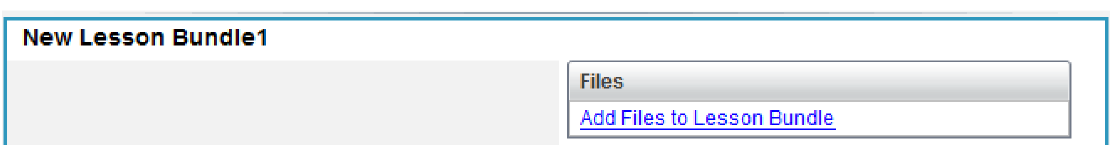
Step 7:

When a TI-Nspire™ document is selected, the first page of the document appears in the Preview pane. If the document has multiple pages, the forward arrow can be used to preview additional pages. To open a TI-Nspire™ document in the Teacher Software, double-click it.



Step 8:

To create a lesson bundle, click the **Create a New Lesson Bundle** icon on the Content Workspace toolbar. Click **Add Files to Lesson Bundle** and a dialogue box appears that allows you to browse local content. Select a file and click **Add**. Once a TI-Nspire document is added to the lesson bundle, click the name of the document and the first page appears in the preview pane.

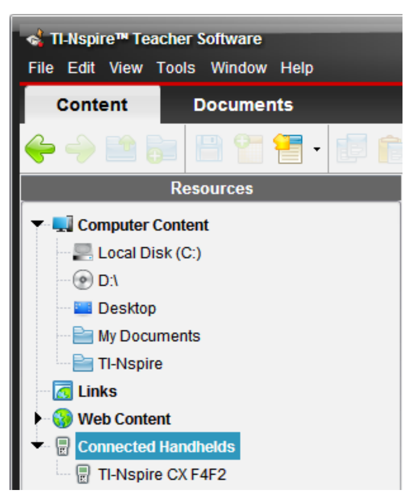


Transferring Documents to Connected Handhelds

Step 9:

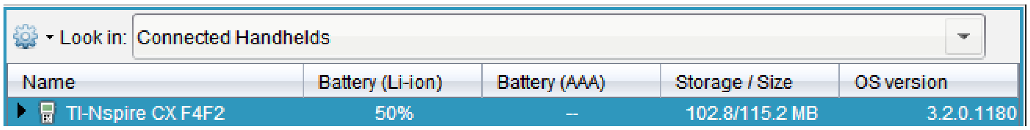
Connect a TI-Nspire™ handheld to the computer using the USB connection cable. In the Resources panel, click **Connected Handhelds**.

Note: Multiple handhelds can be connected to the computer using multiple USB ports, USB hubs, or the TI-Nspire™ CX Docking Station. If multiple handhelds are connected to the computer, then multiple handhelds appear in the list of Connected Handhelds.



Step 10:

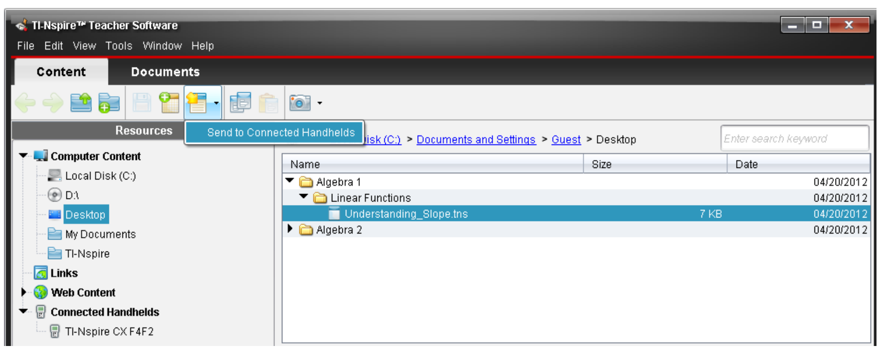
The connected handheld appears in the Content window, along with battery, storage, and OS information. To view the documents on a connected handheld, right-click it and select Open. The handheld can also be renamed, its screen can be captured, and the OS can be checked and updated.



Step 11:

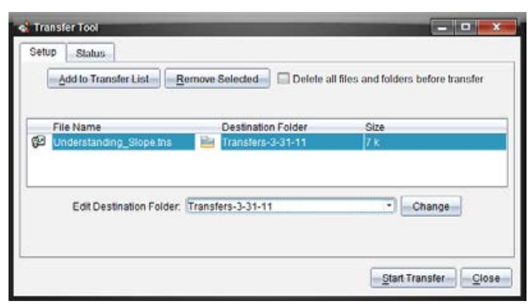
Locate a TI-Nspire document on your computer by browsing Computer Content in the Resources panel. Send the document by dragging and dropping it to the connected handheld. The document can also be sent by right-clicking the document name and selecting **Send to Connected Handhelds**.

Note: When sending multiple documents, locate the first document in the Content Window and select **Send to Connected Handhelds**.



Step 12:

Upon selecting **Send to Connected Handhelds**, the Transfer Tool window appears. To add an additional document, select **Add to Transfer List** and locate the additional document. To remove a document, select the document and click **Remove Selected**.



To change the destination folder, select the document and go to the Edit Destination Folder field. To identify an existing folder, select it from the drop-down menu and click Change. To create a new folder, type its name into the field and click Change. To send the document to the handheld, click **Start Transfer**. Once the Status tab indicates that the transfer is complete, click **Stop Transfer**.

Barometric Pressure

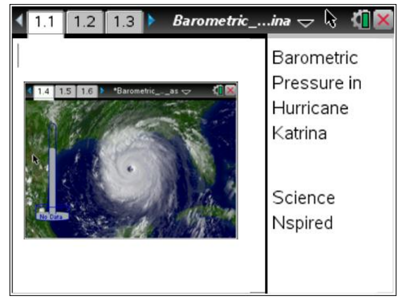
Student Activity

Name ______________________

Class ______________________

Open the TI-Nspire document
Barometric_Presssure_in_Hurricane_Katrina.tns.

In this simulation, you will examine parts of a hurricane. You will discover how barometric pressure changes in relation to a hurricane.



Move to pages 1.2. Read the background information for this activity.

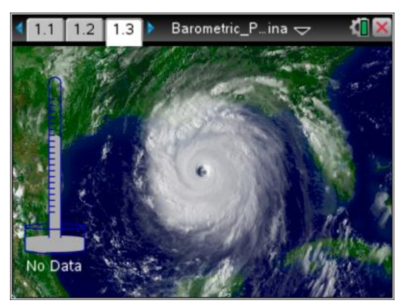
Hurricane Katrina was the deadliest and most destructive Atlantic hurricane of the 2005 Atlantic hurricane season. It is the costliest natural disaster, as well as one of the five deadliest hurricanes, in the history of the United States. Among recorded Atlantic hurricanes, it was the sixth strongest overall. At least 1,836 people died in the actual hurricane and in the subsequent floods.

Air molecules are so tiny you cannot see them, but they still have weight and take up space. The force put on you by the weight of air molecules is called air pressure. Another name for air pressure is **barometric pressure**. The space between air molecules can vary, so the barometric pressure can also vary. In high pressure air, the air molecules are closer together than in low pressure air. Weather forecasters measure air pressure with a barometer. Barometric pressure is measured in **millibars**.

Part 1: Exploring Barometric Pressure and Parts of a Hurricane

Move to page 1.3.
Read the directions for the simulation.

1. Slowly move the cursor across the image near the center of the hurricane until you see the cursor change from to a plus sign +. Notice that there is a barometer on the left side of the screen. Move the cursor in a straight line from left to right across the entire screen and observe the barometer.



Tech Tip: To observe the pressure measurements around the eye of the hurricane, press your finger to the eye of the hurricane and drag it left and right.

Barometric Pressure

Student Activity

Name ________________

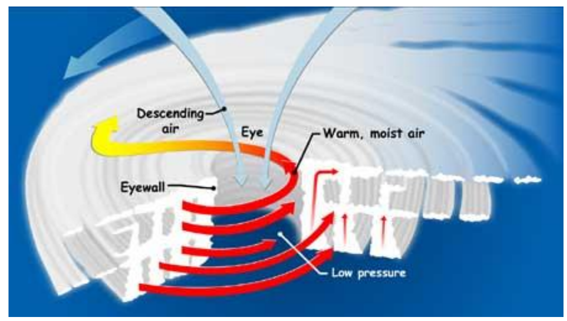
Class ________________

Tech Tip: To access the Directions again, select menu or **Document Tools ( ) > Hurricane Katrina > Directions.**

Tech Tip: To access the Directions again, select > **Hurricane Katrina > Directions.**

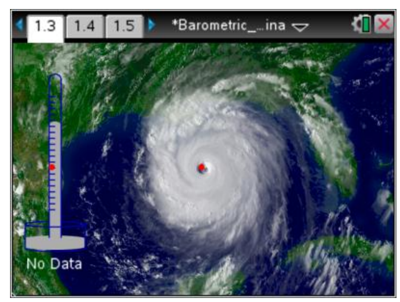
Q1. Describe what happens to the barometer as you move the cursor across the screen.

2. Observe the structure of a hurricane in the diagram to the right. The **eye** is a circular area at the center of a hurricane. Just outside the eye is the **eyewall**, where the hurricane's most intense rain and wind are found.



[http://spaceplace.nasa.gov/hurricanes/]

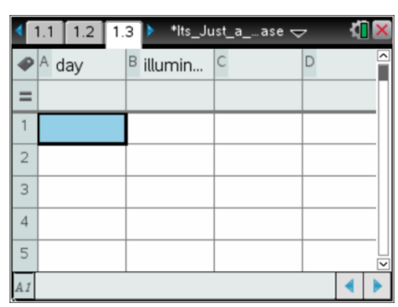
3. Select esc to clear data points that may have previously been selected. Move the cursor to the eye of the hurricane and select it using . Then, move the cursor to the edge of the coast and select it.



Tech Tip: To select data points, drag your finger across the screen and lift it to select a point. To clear data points, select > **Hurricane Katrina > Erase Measurements.**

Move to page 1.4.

4. A chart shows the data you collected from the points you selected. The distance is measured in kilometers from an unknown location on land.

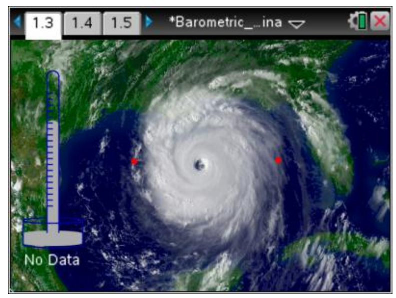


Q2. Complete the table shown below.

Location of Data Point	Distance (km) From Unknown Location
Eye of Hurricane	
Coast	

Q3. True or False: Based on your data, the eye of Hurricane Katrina is more than 1,500 kilometers away from the coast.

5. Clear the data points that have previously been placed. This will also clear the spreadsheet and the scatter plot on pages 1.3 and 1.5.



Q4. Notice that Hurricane Katrina has a circular shape. Collect two data points at the outer edges of the hurricane to find its diameter. Complete the table shown below here on this activity sheet.

Location of Data Point	Distance (km) From Unknown Location
Right Side	
Left Side	

Q5. Based on your data, what is the approximate diameter of Hurricane Katrina?

A. 60 kilometers
B. 550 kilometers
C. 800 kilometers
D. 1,250 kilometers

Barometric Pressure

Student Activity

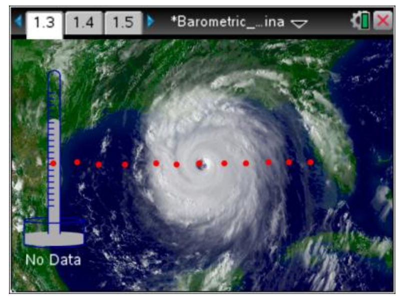
Name ________________

Class ________________

Part 2: Analyzing Barometric Pressure

6. You've seen what happens to the barometer when you moved the cursor across the screen. Now you will collect more data and analyze what happens to the barometric pressure. Clear the data points that have been collected.

7. Move the cursor horizontally across the screen and collect 12 data points in a straight line. Start on land and move east, out into the Atlantic Ocean and across Hurricane Katrina. Be sure to collect data from the coast, the outer edges of the hurricane, and the eye of the hurricane.

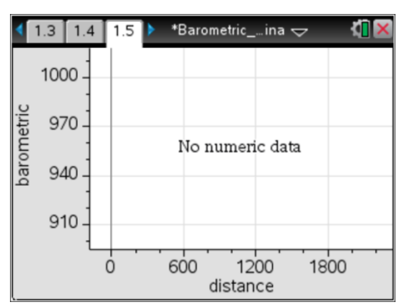


Q6. Go to page 1.4 that shows the spreadsheet with data you collected. Copy your data from the spreadsheet to complete the table shown below.

Data Point	Distance (km)	Barometric Pressure (mb)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

Move to page 1.5.

Q7. Look at the line graph. Describe the line graph. Where is barometric pressure highest on the graph? Where is barometric pressure lowest on the graph? In what part of the hurricane is barometric pressure lowest?



Barometric Pressure

Student Activity

Name ______________

Class ______________

How do hurricanes work? Hurricanes form when warm, moist air over the ocean rises up from the surface, causing an area of lower barometric pressure below it. Higher pressure air from surrounding areas then pushes into the low pressure area, warming it and making it rise too. As the warm air rises, the surrounding air keeps rushing in to take its place. The warm air cools as it rises, and the moisture in the air condenses to form clouds. This cycle of rising, swirling, and cooling air creates a system of clouds and wind that grows, fed by heat and moisture from the ocean.

Q8. What causes strong winds in a hurricane?

As the hurricane rotates faster and faster, an eye forms in the center. The lower the barometric pressure in the eye of the hurricane, the more intense the storm is considered.

Q9. Based on your data, what was the barometric pressure in the eye of Hurricane Katrina?

Q10. Suppose the eye of Hurricane X had a barometric pressure of 975 millibars. Which hurricane was more intense? Why?

Part 3: Classifying a Hurricane

Hurricanes are classified according to their central pressure, wind speed, and potential to cause damage. Central pressure is the pressure in the eye of the hurricane. The table below shows the Saffir/Simpson Hurricane Scale, which is used to classify hurricanes.

SAFFIR/SIMPSON HURRICANE SCALE			
Category	**Central Pressure (mb)**	**Winds (mph)**	**Damage**
1	>980	74-95	Minimal
2	965-979	96-110	Moderate
3	945-964	111-130	Extensive
4	920-944	131-155	Extreme
5	<920	155+	Catastrophic

Name ______________

Class ______________

Q11. Use the data you found in Question 9 for the central pressure of Hurricane Katrina to classify it on the Saffir/Simpson Hurricane Scale. What category is Hurricane Katrina? Explain.

Q12. Based on the Saffir/Simpson Hurricane Scale, what category is Hurricane X?

Q13. Based on the Saffir/Simpson Hurricane Scale, did Hurricane X cause more or less damage than Hurricane Katrina? Explain.

Barometric Pressure

TEACHER NOTES

MIDDLE GRADES SCIENCE NSPIRED

Science Objectives

- Students will examine and describe parts of a hurricane.
- Students will discover how barometric pressure changes in relation to a hurricane.

Vocabulary

- barometric pressure
- millibars
- eye of a hurricane
- eyewall

About the Lesson

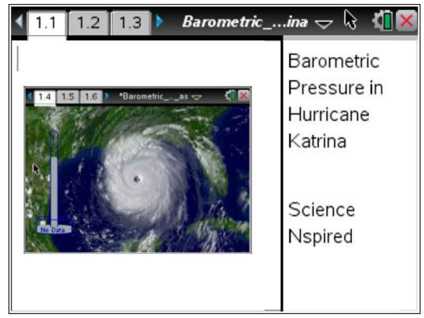
- This lesson is a simulation of barometric pressure measured across different points in relation to Hurricane Katrina. This provides an opportunity for students to gather data and explore parts of a hurricane and how barometric pressure changes in relation to the hurricane.
- As a result, students will:
  - Measure the distance of the eye of Hurricane Katrina from the coast and measure the diameter of the hurricane.
  - Collect data on barometric pressure across different points of an aerial view of Hurricane Katrina.
  - Use collected data to classify Hurricane Katrina on the Saffir/Simpson Hurricane Scale.

TI-Nspire™ Navigator™

- Send out the *Barometric_Pressure_in_Hurricane_Katrina.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

- Barometric_Pressure_in_Hurricane_Katrina_Student.doc
- Barometric_Pressure_in_Hurricane_Katrina_Student.pdf

TI-Nspire document

- Barometric_Pressure_in_Hurricane_Katrina.tns

Discussion Points and Possible Answers

Move to pages 1.2.

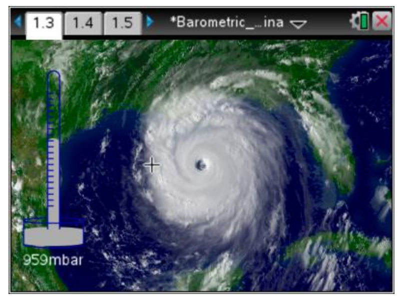
Have students read the background information for the activity on their student activity sheets and/or on their devices.

Part 1: Exploring Barometric Pressure and Parts of a Hurricane

In this part of the lesson students explore barometric pressure and parts of a hurricane.

Move to page 1.3.

Have students read the directions for the simulation. Make sure students note where the barometer is located on the screen.



1. Students will be moving the cursor across the screen using the left ◀ and ▶ right arrows. Make sure students can see that the cursor changes from an arrow to + (a plus sign) when it is on an area of the screen where data is available. Make sure students can observe that the barometer level can move up and down depending on where the cursor is located. They are not collecting data at this time.

Tech Tip: To observe the barometer levels, students should press their finger to the screen and drag it across the hurricane.

TI-Nspire Navigator Opportunities

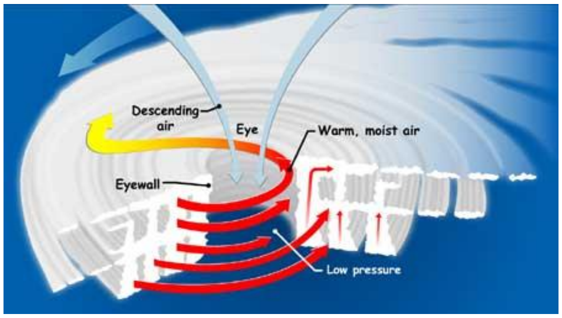
Allow students to volunteer to be the Live Presenter and demonstrate areas on the screen where the cursor changes.

Students should have an intuitive understanding that the barometric pressure rises and falls depending on where the cursor is located on the screen. From their observations, students should conclude that the barometric pressure does not rise and fall randomly, but in a pattern.

Q1. Describe what happens to the barometer as you move the cursor across the screen.

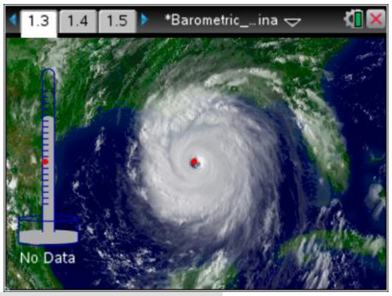
<u>**Answer**</u>: The barometer changed levels as the cursor was dragged across the screen from left to right. It started at a high level, then dropped as it got closer to the center of the hurricane, then it rose again.

2. Allow students time to look at the diagram to the right showing the structure of a hurricane. Make sure students understand where the land, coast, and the eye of a hurricane are located on the screen.



[http://spaceplace.nasa.gov/hurricanes/]

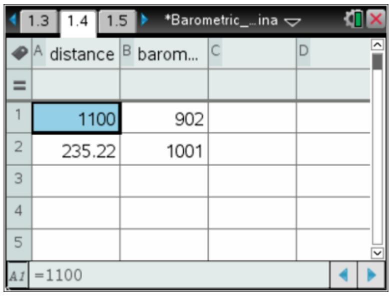
3. Students will be selecting areas of the screen to collect data points. Students need to move the cursor to the eye of the hurricane and select it using [icon]. Then, they should move the cursor to the edge of the coast and select it.



Tech Tip: To record data points, have students lift their fingers from the screen when the barometer changes.

Move to page 1.4.

4. Data will vary from student to student and is dependent on where they placed their cursor. All students should see the same general patterns.



Q2. Complete the table shown below.

Sample answer:

Location of Data Point	Distance (km) From Unknown Location
Eye of Hurricane	**1100**
Coast	**269.22**

Q3. True or False: Based on your data, the eye of Hurricane Katrina is more than 1,500 kilometers away from the coast.

Answer: False

5. At any point, students can select esc to remove data points that have previously been placed. This will also clear the spreadsheet and the scatter plot on pages 1.5 and 1.6.

Tech Tip: To clear data points, have students select > **Hurricane Katrina > Erase Measurements.**

Q4. Notice that Hurricane Katrina has a circular shape. Move the cursor and collect two data points at the outer edges of the hurricane to find its diameter. Complete the table shown below.

Sample answer:

Location of Data Point	Distance (km) From Unknown Location
Right Side	**1556.601**
Left Side	**754.088**

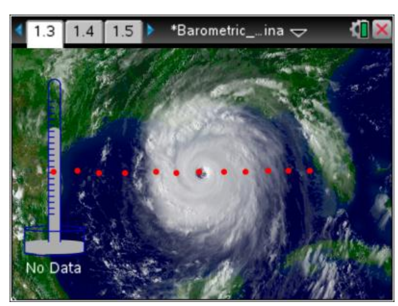
Q5. Based on your data, what is the approximate diameter of Hurricane Katrina?

A. 60 kilometers
B. 550 kilometers
C. 800 kilometers
D. 1250 kilometers

Answer: C

Part 2: Analyzing Barometric Pressure

6. Make sure to remind students that the barometer changes as the cursor is moved across the screen. Students will be collecting data from 12 points of the screen image. Students may have an intuitive understanding that barometric pressure is lowest in the central area of the hurricane, but now they will collect data to demonstrate this.



7. Students will be collecting collect data starting from inland and moving east. Make sure they use a systematic approach, spacing data points as evenly as possible. Also make sure they collect data from key points including the coast, the outer edges of the hurricane, and the eye of the hurricane.

Allow students time to analyze the line graph on page 1.6 resulting from the data collected. If they did not collect a key data point, allow them to clear their data and start over. Allow students time to read the information on the student activity sheet about how hurricanes form. Review any parts that the students do not understand.

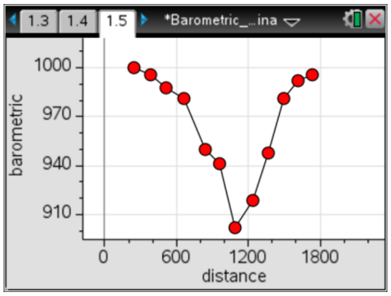
Q6. Go to page 1.4 that shows the spreadsheet with data you collected. Copy your data from the spreadsheet to complete the table shown below.

Sample answer:

Data Point	Distance (km)	Barometric Pressure (mb)
1	76.1006	1007
2	221.384	1001
3	408.176	996
4	574.214	986
5	726.415	968
6	830.139	950
7	961.635	941
8	1093.08	902
9	1224.53	919
10	1335.22	930
11	1487.42	981
12	1667.3	994

Move to page 1.5.

Q7. Look at the line graph. Describe the line graph. Where is barometric pressure highest on the graph? Where is barometric pressure lowest on the graph? In what part of the hurricane is barometric pressure lowest?



Answer: The line graph is a V-shape. Barometric pressure is highest at the beginning and the end of the graph. Barometric pressure is lowest in the middle of the graph. Barometric pressure is lowest in the eye of the hurricane.

Teacher Tip: Student graphs will vary based on data.

How do hurricanes work?

Allow students time to read the information about how hurricanes work on the student activity sheet. Go over any parts that the students do not understand.

Q8. What causes strong winds in a hurricane?

Answer: Winds are the result of high pressure air rushing into the area of low pressure at the center of the hurricane.

Q9. Based on your data, what was the barometric pressure in the eye of Hurricane Katrina?

Sample answer: 902 mb

Q10. Suppose the eye of Hurricane X had a barometric pressure of 975 millibars. Which hurricane was more intense? Why?

Sample answer: Hurricane Katrina was more intense because its eye had a lower barometric pressure.

Part 3: Classifying a Hurricane

From parts 1 and 2, students should now have a formal understanding of how barometric pressure is related to hurricanes. Central pressure is the pressure in the eye of the hurricane. Students should understand that the lower the central pressure of a hurricane, the more intense it is. Go over the Saffir/Simpson Hurricane Scale. Explain any terms students do not understand.

SAFFIR/SIMPSON HURRICANE SCALE

Category	Central Pressure (mb)	Winds (mph)	Damage
1	>980	74-95	Minimal
2	965-979	96-110	Moderate
3	945-964	111-130	Extensive
4	920-944	131-155	Extreme
5	<920	155+	Catastrophic

Q11. Use the data you found in Question 9 for the central pressure of Hurricane Katrina to classify it on the Saffir/Simpson Hurricane Scale. What category was Hurricane Katrina? Explain.

Answer: Hurricane Katrina was category 5 because it had a central air pressure of less than 980 mb.

Q12. Based on the Saffir/Simpson Hurricane Scale, what category is Hurricane X?

Answer: Hurricane X was category 2 because it had a central air pressure between 965 and 979 mb.

Q13. Based on the Saffir/Simpson Hurricane Scale, did Hurricane X cause more or less damage than Hurricane Katrina? Explain.

Answer: Hurricane Katrina caused more damage than Hurricane X because a category 5 hurricane causes catastrophic damage, but a category 2 hurricane causes moderate damage.

TI-Nspire Navigator Opportunities

Use Quick Poll to check for understanding during the course of the activity.

Wrap Up

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

Assessment

- Analysis questions are written into the student worksheet.

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Day At the Beach
Student Activity

Name ______________
Class ______________

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

In this data-gathering activity, you will explore the temperature differences in two sets of sand, one dry and one wet. You'll gather the data, display it in a spreadsheet, and then graph it. You will then analyze the data and graph and draw conclusions about the temperature differences.

Background:

When you've been at the beach, you have likely noticed that in the middle of a hot day, dry sand can be uncomfortably hot on bare feet. On the other hand, wet sand is cooler and easy to walk on with bare feet. Why is there a difference?

In each case—wet sand vs. dry sand—sunlight is absorbed as heat. In the case of the dry sand, the heat is retained in the sand itself. You can feel that heat as you walk on the dry sand.

In the case of the wet sand, the particles of sand are mixed with droplets of water. Each of those substances reacts to heat differently. In the case of the sand particles, they absorb heat. In the case of the water droplets, they, too absorb heat. But if water absorbs enough heat energy, it evaporates. When water evaporates, it turns into a gas and floats into the air. These gas molecules carry away the heat that was previously absorbed by the sand-water mixture.

Set Up:

1. Place 500 ml of dry sand into each of the two aluminum trays.

2. Add enough water to one pan to thoroughly dampen the sand. Use room temperature water to keep the initial temperatures of the sand in the two containers the same. It is important that the starting temperatures of the wet and dry sand be as close as possible.

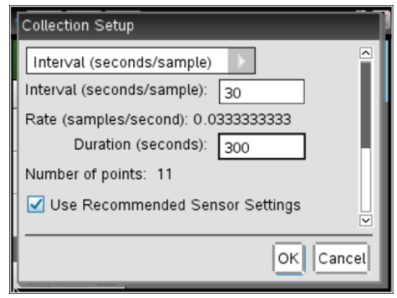
Day At the Beach
Student Activity

Name ______________
Class ______________

3. Heat lamps with clamps designed for labs are optimal; however, student desk lamps with flexible necks and 60-/100-watt bulbs work fine. Keep the distance from the heat source constant for both trials.

4. Connect the Temperature Probe to the data-collection interface. Connect the interface to the TI-Nspire handheld or computer. (If you are using an EasyTemp or Go!Temp, you do not need a data-collection interface.)

5. Choose **Menu > Experiment > New Experiment**. Choose **Menu > Experiment > Collection Setup**. Then choose **Interval (seconds/sample)** from the drop down menu. Enter **30** as the interval (seconds/sample) and **300** as the experiment duration in seconds (5 minutes) and select OK.



DATA COLLECTION:

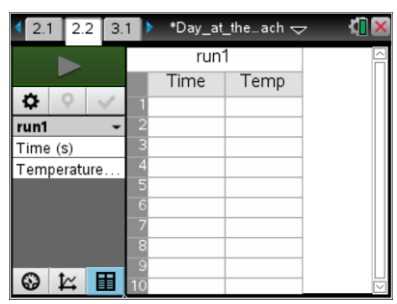
6. Bury the end of the temperature sensor 0.5 cm below the surface of the dry sand.

7. Place the heat lamp 20 cm above the tray of sand.

8. When you are ready to begin, start the data collection by pressing ▶. At the end of each 30 second interval, a data point is plotted on the graph.

9. Continue to hold the sensor in the dry sand. After 11 data samples are collected from the sensor and plotted, the line graph is displayed.

10. Click the data table tab ▦ to see each data point and record the values in the table on the next page. Sketch the graph to the right of the table on the next page.



11. Repeat steps 6–10 for the tray of wet sand. Sketch both graphs on the same set of axes.

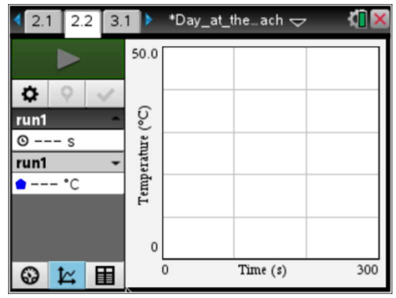
Day At the Beach
Student Activity

Name ______________
Class ______________

In this adventure, you will compare the heating rates of wet sand and dry sand.

Choose the data table tab on page 2.2. Record the information below.

Time (seconds)	Temperature of Dry Sand (°C)	Temperature of Wet Sand (°C)
0		
30		
60		
90		
120		
150		
180		
210		
240		
270		
300		



Move to pages 3.1 – 4.1. Answer questions 1 - 6 here and/or in the .tns file.

Q1. What do the slopes of the lines on the graph represent?

Q2. What do the differences in the two slopes indicate about the heating rates of the wet and dry sand?

Q3. What does the *y*-intercept represent?

Q4. Compare the temperatures of the wet and dry sand at the same time intervals. How does water affect the heating of the sand?

Q5. Compare the change in temperature for the dry sand and wet sand.

Dry sand: starting temperature (____°C) – ending temperature (____°C) = (____°C)

Wet sand: starting temperature (____°C) – ending temperature (____°C) = (____°C)

Q6. ________ sand heats faster in the sun than ________ sand.

A. Wet; dry B. Dry; wet

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Science Objectives

- Determine the heating rates of wet sand and dry sand
- Describe the effect of evaporation on heating rates

Vocabulary

- evaporation
- heat
- temperature
- mass

About the Lesson

- In this data-gathering activity, students will explore the temperature differences in two sets of sand, one dry and one wet. They will gather the data, display it in a spreadsheet, and then graph it. Then students will analyze the data and graph and draw conclusions about the temperature differences.

TI-Nspire™ Navigator™

- Send out the *Day_At_The_Beach.tns* file.
- Monitor student progress using Screen Capture.
- Use Live Presenter to allow students to show how to set up the lab.

Activity Materials

- *Day_At_The_Beach.tns*
- TI-Nspire™ Technology
- Temperature Probe
- Two small aluminum trays
- 1000 ml sand
- Water
- Heat lamp

TI-Nspire™ Technology Skills:

- Open a document
- Set up a data collection

Tech Tip:

Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:

Student Activity

- Day_At_The_Beach.doc
- Day_At_The_Beach.pdf

TI-Nspire document

- Day_At_The_Beach.tns

Discussion Points and Possible Answers

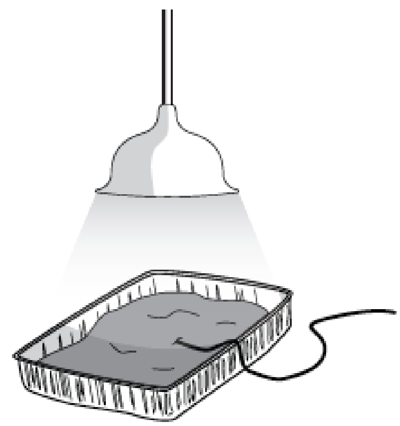
Many vacationers end up on a beach. On hot summer days, dry sand can get so hot it hurts to walk on it. But the wet sand near the water feels cool and refreshing.

Evaporation occurs when water changes from a liquid to a gas. This requires an input of energy, usually heat energy. As heat energy necessary for evaporation is transferred to the water molecules, the matter from which the heat energy is derived is cooled.

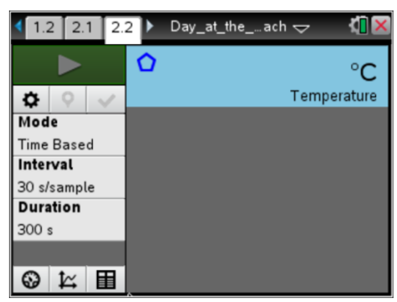
Allow students to read the background information on the activity sheet before continuing with the lab.

Set Up:

1. Students are to place 500 ml of dry sand into each of the two aluminum trays.

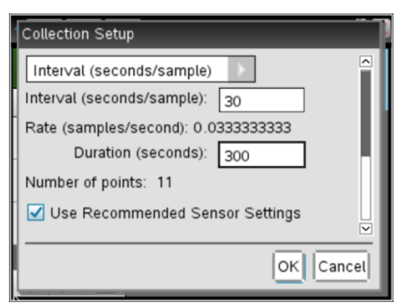


2. Make sure students add enough water to one pan to thoroughly dampen the sand. They need to use room temperature water to keep the initial temperatures of the sand in the two containers the same. It is important that the starting temperatures of the wet and dry sand be as close as possible.



3. Heat lamps with clamps designed for labs are optimal; however, student desk lamps with flexible necks and 60-/100-watt bulbs work fine. Make sure that students keep the distance from the heat source constant for both trials.

4. Students connect the Temperature Probe to the data-collection interface. Connect the interface to the TI-Nspire handheld or computer. (If they are using an EasyTemp or Go!Temp, they do not need a data-collection interface.)



5. Students are to choose **Menu > Experiment > New Experiment**. Choose **Menu > Experiment > Collection Setup**. Then they choose **Interval (seconds/sample)** from the drop down menu. Enter **30** as the interval (seconds/sample) and **300** as the experiment duration in seconds (5 minutes) and select OK.

<u>**Note**</u>: The .tns file has already set up the experiment for students.

Day at the Beach

TEACHER NOTES

MIDDLE GRADES SCIENCE NSPIRED

DATA COLLECTION:

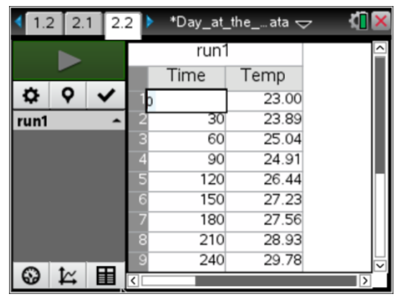
6. Now students bury the end of the temperature sensor 0.5 cm below the surface of the dry sand.

7. Students place the heat lamp 20 cm above the tray of sand.

8. When students are ready to begin, they can start the data collection by pressing ▶. At the end of each 30 second interval, a data point is plotted on the graph.

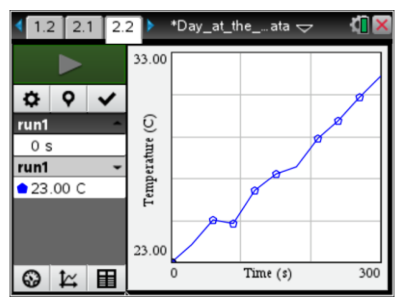
9. Students should continue to hold the sensor in the dry sand. After 11 data samples are collected from the sensor and plotted, the line graph is displayed.

10. Students can click the data table tab ▦ to see each data point and record the values in the table on the activity sheet. They can sketch the graph to the right of the table on their activity sheet.



11. Finally, students will repeat steps 1 – 5 for the tray of wet sand. They can sketch both graphs on the graph to the right of the table on their activity sheet.

Time (seconds)	Temperature of Dry Sand (°C)	Temperature of Wet Sand (°C)
0	*23*	*23*
30	*23.89*	*23.27*
60	*25.04*	*23.44*
90	*24.97*	*23.91*
120	*26.44*	*24.05*
150	*27.23*	*24.57*
180	*27.56*	*24.66*
210	*28.93*	*25.02*
240	*29.78*	*25.22*
270	*30.91*	*25.31*
300	*31.93*	*25.72*



After entering their data, students can move to pages 3.1 – 4.1 and answer questions 1 - 6 on the activity sheet, in the tns. file, or both.

Q1. What do the slopes of the lines on the graph represent?

Answer: The slopes of the lines on the graph represent the rate of heating of the sand.

Q2. What do the differences in the two slopes indicate about the heating rates of the wet and dry sand?

Answer: The positive slope indicates that the temperatures of the sand increase with time. The steeper slope of the dry sand indicates that the rate of heating is faster than the wet sand with the less steep slope.

Q3. What does the *y*-intercept represent?

Answer: The *y*-intercept represents the initial temperatures of the trays of sand.

Q4. Compare the temperatures of the wet and dry sand at the same time intervals. How does water affect the heating of the sand?

Answer: Water keeps the temperature of the sand cooler for longer.

Q5. Compare the change in temperature for the dry sand and wet sand.

Dry sand: starting temperature (____°C) – ending temperature (____°C) = (____°C)

Wet sand: starting temperature (____°C) – ending temperature (____°C) = (____°C)

Answer: Answers will vary. Answers using sample data: Dry sand 9.8°C, Wet sand 3°C

Q6. _______ sand heats faster in the sun than _______ sand.

Answer: B. Dry; wet

TI-Nspire Navigator Opportunities

Make a student a Live Presenter to illustrate temperatures changes. Throughout the lab, discuss the activity 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. Save grades to Portfolio. Discuss activity questions using Review.

Assessment

- Formative assessment will consist of questions embedded in the .tns file. 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.

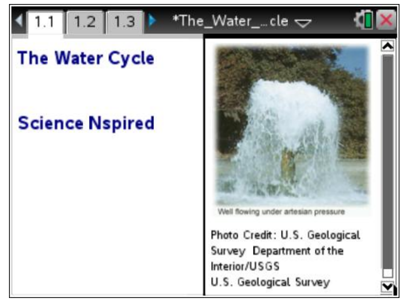
The Water Cycle

Student Activity

Name ________________

Class ________________

Open the TI-Nspire document *The_Water_Cycle.tns*



More commonly known as the water cycle, the hydrologic cycle is the interaction of the **atmosphere** (air), **hydrosphere** (water), and **lithosphere** (land). Water can be stored for long periods in the ground or on the surface, before being recirculated within the earth system to support life on Earth. Throughout the hydrologic cycle, water may exist in any of its three states: solid, liquid, or gas.

Would an increase in the average global atmospheric temperature have an effect on the hydrologic cycle?

Move to pages 1.2 – 1.4. Answer questions 1 - 3 below and/or on your device.

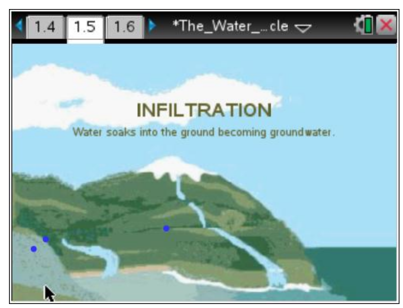
Q1. Water stored in the ground is part of the hydrologic (water) cycle. True or False?

Q2. **Condensation** is when air turns into a liquid. True or False?

Q3. There is less water on Earth now than there was 500 years ago. True or False?

Move to page 1.5.

Read the directions for the simulation.



1. Use the touchpad or mouse to move the cursor over the picture and find FIVE of the **phases** of the hydrologic cycle. Watch the movement of the water in its different states. Be sure to read the descriptions and think about in which state(s) water might be present during each phase of the cycle.

Tech Tip: To observe the five phases of the hydrologic cycle, tap various parts of the screen to reveal the text.

Tech Tip: To access the Directions again, select menu or **Document Tools ( ) > The Water Cycle > Directions**.

Tech Tip: To access the Directions again, select > **Directions**.

The Water Cycle

Student Activity

Name ______________

Class ______________

2. NOTE: Transpiration is not represented in this simulation. About 10 percent of the moisture found in the atmosphere is released by plants through transpiration. Transpiration is the process in which water is taken up by the roots of plants and then released as water vapor through small pores on the underside of leaves.

The symbols for the states of water are:

- Blue solid circles = liquid water
- Open circles with white outlines = water vapor
- Open circles with blue outlines = water vapor changing state into tiny water droplets
- Short dashes = water in a liquid and/or solid state

Move to pages 1.6 – 1.11. Answer questions 4 - 9 below and/or on your device.

Q4. In which state or states does water exist during **precipitation**?

A. solid only B. liquid only C. gas only D. liquid or solid E. solid, liquid, and gas

Q5. In which state or states does water exist if it has been **condensed**?

A. solid only B. liquid only C. gas only D. liquid or solid E. solid, liquid, and gas

Q6. Clouds are made of ________.

A. liquid B. gas C. condensed air

Q7. Into which state or states is water changing during **evaporation**?

A. solid only B. liquid only C. gas only D. liquid or solid E. solid, liquid, and gas

Q8. In which state or states does water exist during **infiltration**?

A. solid only B. liquid only C. gas only D. liquid or solid E. solid, liquid, and gas

Q9. Can water exist as a solid in the atmosphere? Yes or No?

The Water Cycle

Student Activity

Name ______________

Class ______________

Move to pages 2.1 – 2.3. Answer questions 10 and 11 below and/or on your device.

Q10. If the average global atmospheric temperature increases, what do you predict will happen to sea level?

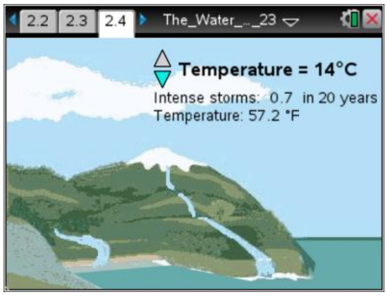
A. The sea level will rise.
B. The sea level will fall.
C. No change in sea level will occur.

Q11. Predict what might happen to the severity of storms as the average global atmospheric temperature increases.

A. Storms would become more severe.
B. Storms would become less severe.
C. There would be no change in storm severity.

Move to page 2.4.

Read the directions for the simulation.



The EPA (Environmental Protection Agency) uses climate models to predict future changes in our global average temperatures. This simulation uses the 20th century average of 14.8°C (58.6°F) with a 6°C (11°F) increase over the next 100 years.

2. In this simulation, use the slider to change the average global atmospheric temperature. Observe the changes in the sea level and in the number of heavy precipitation (storm) events as the global average temperature changes.

Move to pages 2.5 – 2.9. Answer questions 12 – 16 below and/or on your device.

Q12. What happens to the sea level as the average global atmospheric temperature increases?

Q13. Which of the following is the most plausible hypothesis for the increase in sea level?

A. There is an increase in the amount of precipitation.
B. The ice, snow, and permafrost stored in the hydrologic cycle are melting.
C. Storms are more severe and occur more frequently.

Name ______________

Class ______________

Q14. Based on this simulation, what is predicted to happen to the number of intense storms as the average global atmospheric temperature increases?

A. The number of intense storms will increase.
B. The number of intense storms will decrease.
C. The number of intense storms will stay the same.

Q15. What do you think is happening to the rate of evaporation and condensation as the average global atmospheric temperature increases?

Science Objectives

- Students will discover that the hydrologic cycle is an interaction among the atmosphere, the hydrosphere, and the lithosphere.
- Students will identify which of the three states of water exist in the different phases of the hydrologic cycle.
- Students will change the average global atmospheric temperature to observe resultant effects on sea level and the number of heavy precipitation (storm) events.

Vocabulary

- hydrosphere
- lithosphere
- atmosphere
- condensation
- evaporation
- precipitation
- infiltration
- runoff
- phases

About the Lesson

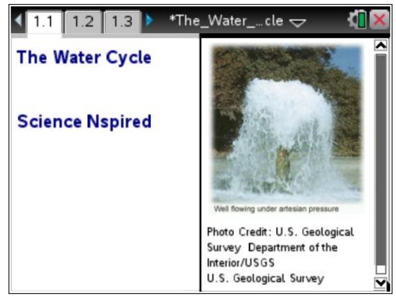
- Students will use an interactive model of the hydrologic cycle to observe which states of water exist in each phase.
- Students will change average global atmospheric temperature using a slider to observe the effects on sea level and storm events.
- As a result, students will:
- Be able to identify which states of water could be present in five phases of the hydrologic cycle.
- Understand that the amount of water in the hydrologic cycle remains constant.
- Understand the consequences of global warming on sea level and storm events.

TI-Nspire™ Navigator™

- Send out the *The_Water_Cycle.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 Files:

Student Activity

- The_Water_Cycle_Student.doc
- The_Water_Cycle_Student.pdf

TI-Nspire document

- The_Water_Cycle.tns

Discussion Points and Possible Answers

Have students read the background information stated on their activity sheet.

Move to pages 1.2 – 1.4.

Have students answer questions 1 - 3 on the device, the activity sheet, or both.

Q1. Water stored in the ground is part of the hydrologic (water) cycle. True or False?

Answer: true

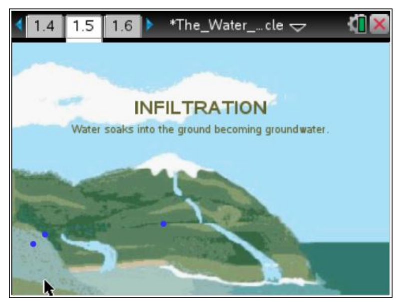
Q2. **Condensation** is when air turns into a liquid. True or False?

Answer: false

Q3. There is less water on Earth now than there was 500 years ago. True or False?

Answer: false

Move to page 1.5.



1. Using the touchpad or mouse, students will tap or move the cursor over the picture to see 5 **phases** of the hydrologic cycle. They should watch the movement of the water in its different states, read the descriptions, and think about in which states water might be present during each phase of the cycle.

States of water:

- Blue solid circles = liquid water
- Open circles with white outlines = gas
- Open circles with blue outlines = water vapor changing state into tiny water droplets
- Short dashes = water in liquid and/or solid form

NOTE: Transpiration, while an integral part of the cycle, is not represented in this simulation.

Tech Tip: To observe the five phases of the hydrologic cycle, have students tap various parts of the screen to reveal the text.

Tech Tip: To access the Directions again, have students select menu or **Document Tools ( ) > The Water Cycle > Directions**.

Tech Tip: To access the Directions again, have students select > **Directions**.

Move to pages 1.6 – 1.11.

Have students answer questions 4 - 9 on the device, the activity sheet, or both.

Q4. In which state or states does water exist during **precipitation**?

Answer: D. liquid or solid

Q5. In which state or states does water exist if it has been **condensed**?

Answer: C. gas only

Q6. Clouds are made of ___________.

Answer: A. liquid

Q7. Into which state or states is water changing during **evaporation**?

Answer: C. gas only

Q8. In which state or states does water exist during **infiltration**?

Answer: B. liquid only

Q9. Can water exist as a solid in the atmosphere?

Answer: Yes

Move to pages 2.1 – 2.3.

Have students answer questions 10 and 11 on the device, the activity sheet, or both.

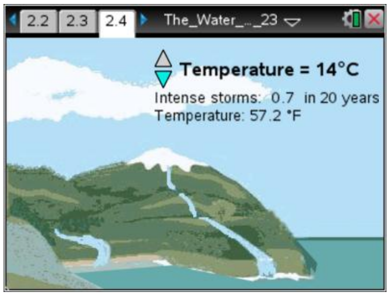
Q10. If the average global atmospheric temperature increases, what do you predict will happen to sea level?

Answer: A. The sea level will rise.

Q11. Predict what might happen to the severity of storms as the average global atmospheric temperature increases.

Answer: A. Storms would become more severe.

Move to page 2.4.



2. Have students read the directions for the simulation on page 2.4. In this simulation, students will change the average global atmospheric temperature to observe the effect on sea level and severity/occurrence of storms.

   This simulation uses the 20th Century average of 14.8°C (58.6°F) with an EPA predicted 6°C (11°F) increase over the next 100 years.

Move to pages 2.5 – 2.9.

Have students answer questions 12 - 16 on the device, the activity sheet, or both.

Q12. What happens to the sea level as the average global atmospheric temperature increases?

Sample Answer: The sea level increases.

Q13. Which of the following is a plausible hypothesis for the increase in sea level?

Answer: B. The ice, snow, and permafrost stored in the hydrologic cycle are melting.

Q14. Based on this simulation, what is predicted to happen to the number of intense storms as the global average temperature increases?

Answer: A. Increase in number

Q15. What do you think is happening to the rate of evaporation and condensation as the average global atmospheric temperature increases?

Sample Answer: The rates of both are increasing which in turn increases the frequency and severity of precipitation events.

TI-Nspire Navigator Opportunities

Make a student a Live Presenter during a whole class review of the stages in the hydrologic cycle. Use Class capture to monitor students' progress through the lesson. Use quick poll to send formative assessment questions during the lesson.

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. 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 or a performance assessment where students diagram, label and explain how water moves in the hydrologic cycle. Use of the RAFT (Role, Audience, Format, Topic) strategy: Have students write journal entries from the perspective of a water drop traveling with her friends on a trip through the hydrologic cycle.

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How Does It Stack?

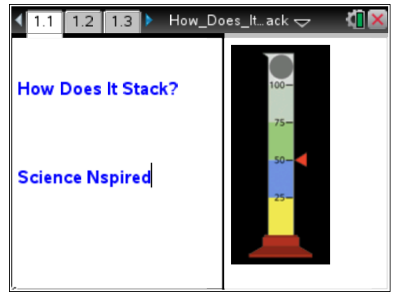
Student Activity

Name ______________

Class ______________

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

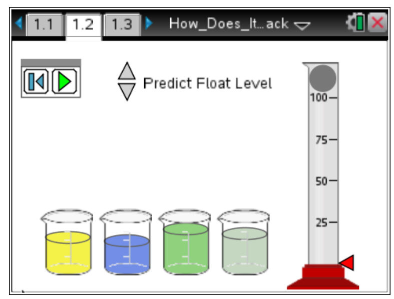
Have you ever wondered why ice floats in water? Do you know why a mixture of oil and vinegar eventually separates? Have you wondered why a rock sinks in water, while polystyrene foam floats? In this activity, you'll use a simulation to explore these questions.



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

Move to pages 1.2 – 1.3.

1. Each beaker has a different mass and volume of a solution. You may need to reveal the information, depending on the technology you are using. **IMPORTANT: If you click or tap on the beaker, the liquid will be "poured" into the cylinder, forcing you to reset and start over.**



Tech Tip: To reveal the mass and volume, hover over the beakers. Be careful not to "select" them, as the liquid will be poured into the cylinder. If this happens, you will need to reset, and start over.

Tech Tip: Selecting the button will reset the simulation and ALL the masses and volumes of ALL the liquids in the beakers change. You will need to start over.

Container 1	Container 2	Container 3	Container 4
Mass: ____________	Mass: ____________	Mass: ____________	Mass: ____________
Volume: __________	Volume: __________	Volume: __________	Volume: __________

How Does It Stack?

Student Activity

Name _______________

Class _______________

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

What is the formula for calculating density? ______________________________

Tech Tip: Press [scratchpad] to use Scratchpad instead of moving between pages 1.2 and 1.3 to perform calculations.

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

3. Once you have determined the densities, return to page 1.2 and click on the beaker containing the solution that will settle to the very bottom of the cylinder. Then, continue to "pour" the liquid from each beaker into the cylinder in the order in which they will settle. If you are correct, indicate the order of how the liquids settled- 1 being at the top, 4 being at the bottom.
   ***If you select an incorrect order, you will receive a Goat. Reset [reset] the page and try again. Use the multiple trials space at end to record new data. Go back to step #1.*

4. Hover the cursor (or it may already be evident) over the solid ball to reveal mass and volume.

   Mass: ______________________ Volume: ______________________

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

   Density of Solid Ball: ______________________

6. Use the arrows beside "Predict Level" to move the red arrow next to the graduated cylinder to show where you predict the ball will float in the cylinder. **Be careful with this prediction—if you are wrong, you will have to start over!**

7. Click the play button [play] to watch the ball fall through the density column. If you correctly predicted the location of the ball, you will receive a Gold Star.
   ***If you did not predict the correct location of the ball, you will receive a Goat. Press the Reset button [reset] and try again until you receive the Gold Star. You will need to start all over again, and use the space at end for multiple trials. Go back to step #1.*

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

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

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

How Does It Stack?

Student Activity

Name ______________

Class ______________

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

A. sink

B. float

C. rise to the top

D. be suspended midway in the liquids

Q3. Density is __________.

A. how heavy an object is

B. the size of an object

C. $D = \frac{V}{m}$

D. how closely packed the matter is

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

A. doubles

B. decreases by one half

C. is unchanged

D. decreases by one fourth

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

A. doubles

B. decreases by one half

C. is unchanged

D. decreases by one fourth

If you make a mistake, and receive "The Goat", you will need to start over. Use the following space to record your data for multiple trials. If you need more space, use the back of your paper for more trials.

Try #2:

Container 1	Container 2	Container 3	Container 4
Mass: ____________	Mass: ____________	Mass: ____________	Mass: ____________
Volume: __________	Volume: __________	Volume: __________	Volume: __________
Density: __________	Density: __________	Density: __________	Density: __________
Order___	Order___	Order___	Order___
Solid Ball:			
Mass: ___________		Density of the Ball: __________	
Volume:__________			

Try #3

Container 1	Container 2	Container 3	Container 4
Mass: ____________	Mass: ____________	Mass: ____________	Mass: ____________
Volume: __________	Volume: __________	Volume: __________	Volume: __________
Density: __________	Density: __________	Density: __________	Density: __________
Order___	Order___	Order___	Order___
Solid Ball:			
Mass: ___________		Density of the Ball: __________	
Volume:__________			

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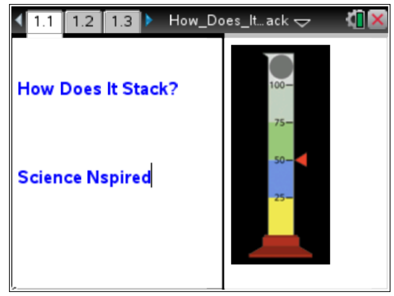
How Does It Stack?

SCIENCE NSPIRED

TEACHER NOTES



Science Objectives

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

Vocabulary

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

About the Lesson

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

Using TI-Nspire™ Navigator™

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

Activity Materials

- Compatible TI Technologies: TI- Nspire™ CX Handhelds, TI-Nspire™ Apps 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

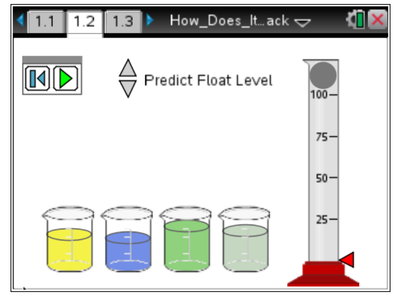
- How_Does_It_Stack_Student.doc
- How_Does_It_Stack_Student.pdf

TI-Nspire document

- How_Does_It_Stack.tns

Discussion Points and Possible Answers

Move to pages 1.2 – 1.3.



1. Students will hover over each beaker to obtain mass and volume data.
   a. IMPORTANT: If students click/tap on the beaker the liquid will be "poured" into the cylinder and they will have to reset the page to remove the liquid from the cylinder.

> **Tech Tip:** The directions presented to students are slightly different on this platform. The mass and volume data is also displayed automatically.

> **Tech Tip:** Selecting the button will reset the simulation and ALL the masses and volumes of ALL the liquids in the beakers change. The students will basically have to start over again.

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

2. Students will use the calculator page 1.3 to calculate the density of each solution.
   Guide students to use dimensional analysis if they cannot remember the formula for density. The units of g/mL are units of mass divided by weight, so the formula is: $\text{density} = \dfrac{\text{mass}}{\text{volume}}$.
3. Next the student will back to page 1.2 and click on the solutions in the order they would be poured into the graduated cylinder—**most dense first and least dense last. They are asked to record the order of the solutions—1 to 4 (most dense/bottom).**
   If the student is not successful, he/she will get a "Goat" and will have to reset the page to start over. Be sure they understand with each mistake, they will have to go back to step #1.
4. The student will then hover over the solid ball to get its mass and volume.
5. Students return to page 1.3 or use Scratchpad to calculate the solid ball's density.
6. Students then predict on page 1.2 where the solid will settle in the column. Be sure students understand which buttons are "predict" and which are "reset/play."
7. Students click the play button to test their predictions. If the prediction is incorrect, the student will have to reset the simulation and try again until they get a gold star.

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

TI-Nspire Navigator Opportunities

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

Move to pages 2.1 – 2.5.

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

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

Answer: C. be the bottom layer

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

Answer: A. sink

Q3. Density is _____________.

Answer: D. how closely packed the matter is

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

Answer: A. doubles

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

Answer: C. is unchanged

TI-Nspire Navigator Opportunities

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

Wrap Up

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

Assessment

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

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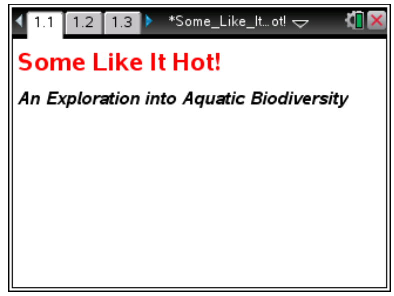
Some Like It Hot!

Student Activity

Name ________________

Class ________________



Open the TI-Nspire document *Some_Like_It_Hot!.tns.*

You may often hear of classrooms, schools, or towns having a certain amount of “diversity.” Used in this way, “diversity” refers to variety within a single species: OURS!

Even though students in your classroom, school, or town might seem to be really diverse on the surface, they are all human, just like you.

Outside of your school’s walls, there are lots of different species of organisms living with and among each other. Some are breathing the same air; some are using the same carbon dioxide; and some are competing for the same food, water, and space.

Even with all of this competition, species manage to survive. In fact, the health and stability of an environment depend on having a large variety of organisms living among one another. In this activity, you will examine some of the factors influencing the **biodiversity** of an ecosystem.

Move to Page 1.2 and read the background information for this activity.
Biotic factors (organisms) are impacted by the abiotic, or nonliving, factors in their environments. This is true for both terrestrial and aquatic environments. The abiotic factors in any environment have a huge impact on the biodiversity of that area. In general, the more "favorable" the abiotic conditions, the greater the biodiversity.

Move to pages 1.3 – 1.5. Answer questions 1-3 below and/or in the .tns file.

Q1. Give two examples of abiotic factors in an environment.

Q2. Which of the following does not belong?

A. Snow

B. Snow leopard

C. Snow monkey

D. Snowberry bush

Q3. The tropical rain forest would be expected to have a greater biodiversity than the Arctic tundra.

A. Agree

B. Disagree

Move to page 1.6.

2. On page 1.6, you will see a model of a lake ecosystem. Carefully read the directions that are covering the picture of the lake. When you understand what your task is, select ☒ and make the adjustments that the directions recommend. Pay close attention to what happens as the temperature and pH of the lake are changed. You will be asked about this later in the activity!

> **Tech Tip:** To access the Directions again, select menu or **Document Tools ( ) > Some Like it Hot > Directions.**

> **Tech Tip:** To access the Directions again, select > **Some Like it Hot > Directions.**

Move to pages 1.7 – 1.8. Answer questions 4 and 5 below and/or in your .tns file.

Q4. What are the variables that you can regulate in the simulation? (Select all that apply.)

A. pH

B. Population

C. Species

D. Temperature

Q5. Which of the following are "biotic" factors in the simulation? (Select all that apply.)

A. Fish

B. Gas bubbles

C. Plants

D. Water

Move to pages 1.9 and 1.10. Answer question 6 below and/or in your .tns file.

3. Read the content information about pH on page 1.9.

Q6. What do you think we call a solution that has a pH of exactly 7?

Move to pages 1.11 and 1.12.

4. On page 1.11, you will read about the meaning of biodiversity. After reading the information on this page, move to page 1.12. On this page, you will be instructed to return to the simulation on page 1.6 and review what happens when the pH and temperature of the water are changed.

Move to pages 1.13 – 1.17. Answer questions 7-11 below and/or in your .tns file.

Q7. How do temperature and pH affect each other?

A. As temperature goes up, pH goes up.

B. As temperature goes up, pH goes down.

C. As temperature goes down, pH goes up.

D. Temperature and pH do not affect each other.

Q8. In general, there is a greater diversity of fish when the water is warmer.

A. Agree

B. Disagree

Q9. As the water becomes more acidic, the diversity of fish decreases.

A. True

B. False

Q10. 20°C is the same as about 68°F. Your body temperature is about 98.6°F. Predict what your body temperature is in °C.

My body temperature is about _____ °C.

Q11. Now go back to the simulation and change the temperature of the water so that it is the same as your body temperature. What do you observe?

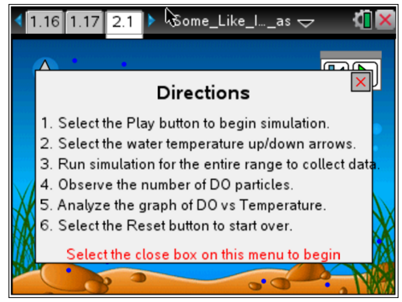
Some Like It Hot!

Student Activity

Name ______________

Class ______________

Move to page 2.1 for the simulation on dissolved oxygen.



5. This next simulation deals with the relationship between water temperature and the levels of dissolved oxygen in the water. As in the first simulation, read the directions in the pop-up window. When you are ready to run the simulation, close the directions box by selecting ☒. You will then vary the water temperature and collect data on dissolved oxygen levels.

Move to pages 2.2 – 2.8. Answer questions 12-18 below and/or in your .tns file..

Q12. What happened to the amount of dissolved oxygen as you increased the temperature of the water?

Q13. What happened to the amount of dissolved oxygen as you decreased the temperature of the water?

Q14. Which term do you think best describes the relationship between water temperature and dissolved oxygen levels?

A. Direct B. Inverse

Q15. Fish such as salmon and trout need a lot of oxygen to survive. Which water temperature do you think would be best for these fish?

A. 40°C

B. 30°C

C. 20°C

D. 10°C

Q16. In which of the following environments would you expect to find the most salmon and trout?

A. in warm, coastal ocean waters

B. in mountain rivers and streams

C. in lakes in the southern United States

Q17. Catfish have a lower oxygen requirement than many freshwater fish. In which state do you think catfish would thrive?

A. Alabama

B. New York

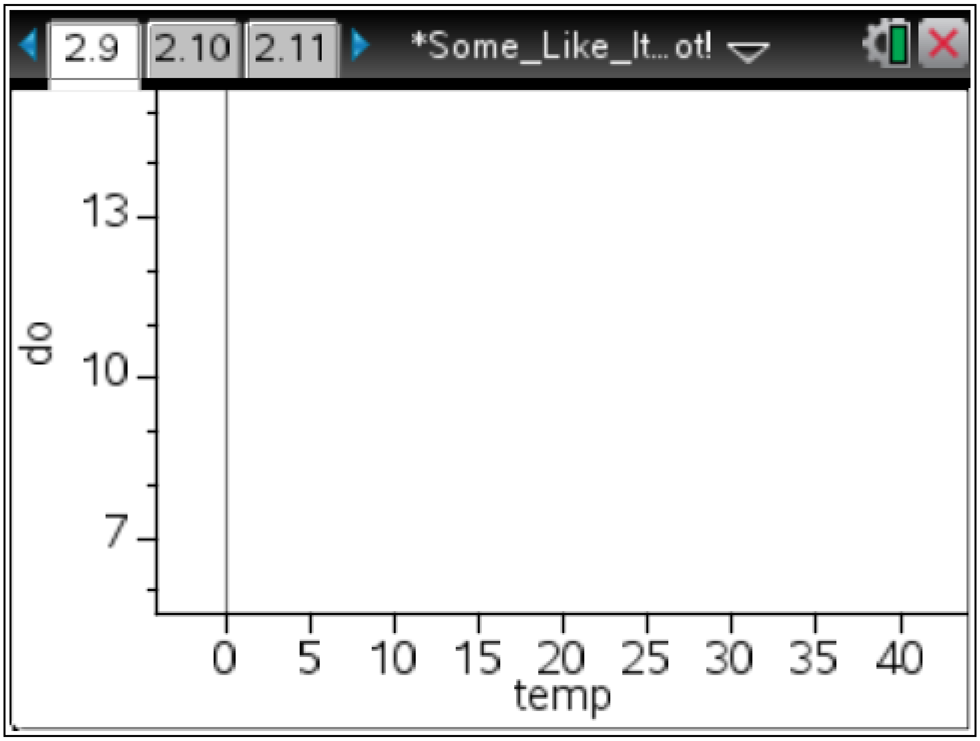
C. Montana

D. Alaska

Q18. Why do you think it would be difficult to have salmon and catfish together in the same aquarium?

Move to page 2.9.

6. On page 2.9, there is a graph of the data that was collected automatically as you made changes to the water temperature in the simulation. Plot the data below as it appears in the graph on your .tns file.



Some Like It Hot!

Student Activity

Name _______________

Class _______________

Tech Tip: To modify the scale of the *x* and *y*-axes, place two fingers on the screen and then drag your fingers away from each other or towards each other parallel to the axis.

Move to pages 2.10 – 2.11. Answer questions 19 and 20 below and/or in your .tns file.

Q19. Which words could be placed in the blanks below to make the statement true? (Select all that apply).

As water temperature goes _____, the dissolved oxygen level goes _____.

A. up; up

B. up; down

C. down; up

D. down; down

Q20. Predict what would happen if the water continued to get warmer and warmer.

A. The dissolved oxygen levels would continue to drop.

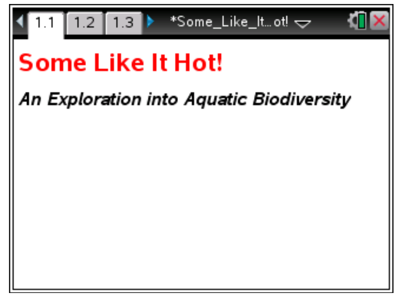
B. The dissolved oxygen levels would eventually start to increase.

C. The dissolved oxygen levels would eventually be less than zero: negative values.

Move to page 2.12.

7. The final page of the activity shows you the actual data that was collected as you made changes to the temperature of the water in the dissolved oxygen simulation.

Some Like It Hot!



Science Objectives

- Students will simulate adjusting the pH of a lake and draw conclusions about the relationship between pH and biodiversity.
- Students will simulate adjusting the temperature of a lake and draw conclusions about the relationship between water temperature and dissolved oxygen levels in the lake.

Vocabulary

- pH
- aquatic
- biotic
- acid
- base
- abiotic
- terrestrial
- biodiversity
- dissolved oxygen

About the Lesson

In this activity, students will observe model environments, adjust abiotic variables in those environments, observe the results of those adjustments, and then draw conclusions about the effects of the abiotic world on the biotic world.

- As a result, students will:
  - Learn the fundamental meaning of “biotic” and “abiotic” factors and how they impact one another to determine biodiversity.
  - Form a basic understanding of pH and how it affects biodiversity of an aquatic ecosystem.
  - Develop an understanding of the relationship between water temperature and dissolved oxygen levels.

TI-Nspire™ Navigator™

- Send out the *Some_Like_It_Hot.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to have students demonstrate how to negotiate the simulations and to spotlight student answers.
- Collect student responses from assessment items that are embedded throughout the document.

Activity Materials

- Compatible TI Technologies: TI- Nspire™ CX Handhelds, TI-Nspire™ Apps 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

- Some_Like_It_Hot_Student.doc
- Some_Like_It_Hot_Student.pdf

TI-Nspire document

- Some_Like_It_Hot! .tns

Discussion Points and Possible Answers

Have students read the background information stated on their activity sheet.

Move to page 1.2.

1. After opening the document, students should read the background information on page 1.2.

Move to pages 1.3 – 1.5.

Have students answer questions 1-3 on either the device, on the activity sheet, or both.
These three questions assess the students' background knowledge of biotic factors, abiotic factors and biodiversity. It is recommended that these questions be used for discussion purposes after the students answer them.

Q1. Give two examples of abiotic factors in an environment.

Suggested Answers: water, air, climate, rain, snow, rocks, oxygen, carbon dioxide, etc.

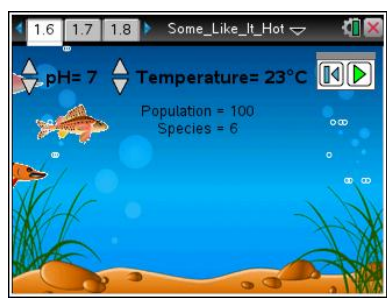
Q2. Which of the following does not belong?

Answer: A. Snow (This is the only abiotic factor in the list.)

Q3. The tropical rain forest would be expected to have a greater biodiversity than the Arctic tundra.

Answer: A. Agree

Move to page 1.6.



2. On page 1.6 are some instructions for the student about the simulation of the aquatic ecosystem. After reading the directions on the page that overlays the lake, the students should close the instruction window by selecting ☒.

   In order to see the impact of changing pH and temperature on the biodiversity of the lake, students should only adjust ONE variable at a time. For example, guide the students to work through the entire range of the pH scale, making observations of the effects of changing the pH. Then, the pH should be reset to 7 and the temperature should be changed. Remind students that if both variables are changed at the same time, it's difficult to determine which is impacting the ecosystem.

Tech Tip: To access the Directions again, select menu or **Document Tools ( ) > Some Like it Hot > Directions.**

Tech Tip: To access the Directions again, select > **Some Like it Hot > Directions.**

Move to pages 1.7 – 1.8.

Have students answer questions 4 and 5 on the device, the activity sheet, or both.

Q4. What are the variables that you can regulate in the simulation? (Select all that apply.)

Answers: A. pH and D. Temperature

Q5. Which of the following are "biotic" factors in the simulation? (Select all that apply.)

Answers: A. Fish and C. Plants

Move to pages 1.9 and 1.10.

Have students answer question 6 on the device, the activity sheet, or both.

3. Have students read the content information about pH on page 1.9. The concept of pH may be new to students, so it is recommended that the teacher take some time to discuss it.

Q6. What do you think we call a solution that has a pH of exactly 7?

Suggested Answer: Neutral

Move to pages 1.11 and 1.12.

4. On page 1.11, the students will read about the meaning of biodiversity. After reading the information on this page, they should move to page 1.12. On this page, they will be instructed to return to the simulation on page 1.6 and review what happens when the pH and temperature of the water are changed.

Move to page 1.13 – 1.17.

Have students answer questions 7-11 on the device, the activity sheet, or both.

Q7. How do temperature and pH affect each other?

Answer: D. Temperature and pH do not affect each other.

Q8. In general, there is a greater diversity of fish when the water is warmer.

Answer: B. Disagree

Q9. As the water becomes more acidic, the diversity of fish decreases.

Answer: A. True

Q10. 20^{o}C is the same as about 68^{o}F. Your body temperature is about 98.6^{o}F. Predict what your body temperature is in ^{o}C.

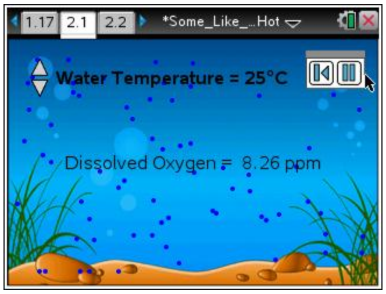
My body temperature is about _____ ^{o}C.

Acceptable Range of Answers: 35–40^{o}C.

Q11. Now go back to the simulation and change the temperature of the water so that it is the same as your body temperature. What do you observe?

Sample Answer: The number of fish decreases dramatically at 35°C and 36°C. No fish survive at 37°C and above.

Move to page 2.1 for the simulation on dissolved oxygen.



5. After finishing the first simulation and all of the questions, the students should move to the second simulation, which deals with the relationship between water temperature and the levels of dissolved oxygen in the water. The process for the students will be the same as in the first simulation.

Move to pages 2.2 – 2.8.

Have students answer questions 12-18 on the device, the activity sheet, or both.

Q12. What happened to the amount of dissolved oxygen as you increased the temperature of the water?

Answer: The amount of dissolved oxygen decreased when water temperature was increased.

Q13. What happened to the amount of dissolved oxygen as you decreased the temperature of the water?

Answer: The amount of dissolved oxygen increased when water temperature was decreased.

Q14. Which term do you think best describes the relationship between water temperature and dissolved oxygen levels?

Answer: B. Inverse

Q15. Fish such as salmon and trout need a lot of oxygen to survive. Which water temperature do you think would be best for these fish?

Answer: D. 10 ^{o}C

Q16. In which of the following environments would you expect to find the most salmon and trout?

Answer: B. in mountain rivers and streams

Q17. Catfish have a lower oxygen requirement than many freshwater fish. In which state do you think catfish would thrive?

Answer: A. Alabama

Q18. Why do you think it would be difficult to have salmon and catfish together in the same aquarium?

Answer: Salmon and catfish have different water temperature and dissolved oxygen requirements. Salmon have a high need for oxygen, so they could not survive in the warm waters that catfish prefer.

Move to page 2.9.

6. On page 2.9, there is a graph of the data that was collected automatically as the students made changes to the water temperature in the simulation. Spend some time with the students analyzing the graph.

Tech Tip: To modify the scale of the *x* and *y*-axes, place two fingers on the screen and then drag your fingers away from each other or towards each other parallel to the axis.

Move to pages 2.10 – 2.11.

Have students answer questions 19 and 20 on the device, the activity sheet, or both.

Q19. Which words could be placed in the blanks below to make the statement true? (Select all that apply.)

As water temperature goes _____, the dissolved oxygen level goes _____.

Answers: B. up; down and C. down; up

Q20. Predict what would happen if the water continued to get warmer and warmer.

Answer: A. The dissolved oxygen levels would continue to drop.

Move to page 2.12.

7. The final page of the activity shows the student the actual data that was collected as they made changes to the temperature of the water in the dissolved oxygen simulation.

TI-Nspire Navigator Opportunities

Make a student a Live Presenter to demonstrate how to adjust the pH and temperature of the water. The questions in the activity may be distributed as Quick Polls or used as a formative or summative assessment

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. 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.

Extension

If a Vernier Dissolved Oxygen Sensor is available, you could experimentally determine that cold water is able to hold more dissolved oxygen than warm water. Half-fill a bottle with warm water and shake it for a few seconds, then test the dissolved oxygen level. Next, do the same with cold water.

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Paradise Island

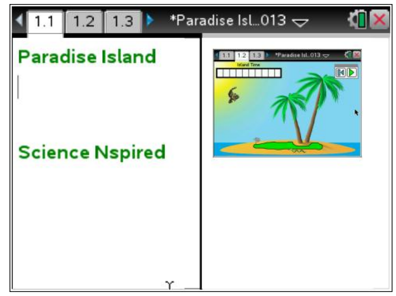
Student Activity

Name ________________

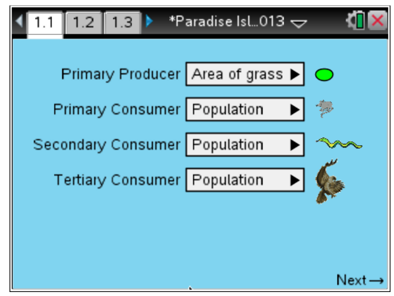
Class ________________

Open the TI-Nspire document *Paradise_Island.tns*

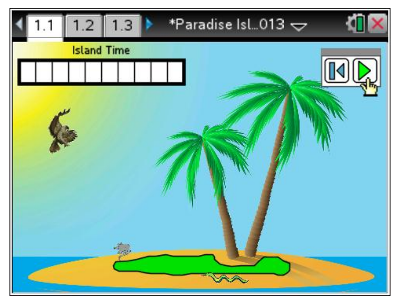
Welcome to Paradise! On this Island you will be able to control the populations of grass, mice, snakes, and hawks. You must determine a good balance of each population in order to sustain all the life within the island. If you are able to maintain all populations for 10 years, you win! However, if you do not determine the correct balance, all of the organisms die and the island is lost.



Move to page 1.2.
Read the instructions for the simulation.



1. The goal is to correctly set the initial populations of a variety of organisms to ensure that they all survive for a minimum of 10 years. Use the drop down menus to select the initial values for each population. Once you have done this, select NEXT → at the bottom left corner of the screen. Select the Play button to run the simulation.



2. Observe the outcome of your initial population values. If all of the organisms die before 10 years, you can select the Reset Button and try again with new values. Continue to select new outcomes until you can sustain an island community for 10 years.

3. Once you are able to keep all populations alive for 10 years, explore the graphs on pages 1.3 -1.6 and the spreadsheet on 1.7 to see how each population fluctuated. Note: Do not select the reset button once you have successfully run the simulation or you will delete all of the data from the graphs.

Tech Tip: If you are unable to view the entirety of the data on pages 1.3 - 1.6, select menu **> 5: Window/Zoom > 2: Zoom-Data.**

Tech Tip: To access the Directions again, select menu or **Document Tools ( ) > Paradise Island > Directions.**

Tech Tip: To access the Directions again, select > **Paradise Island > Directions.**

Paradise Island

Student Activity

Name ________________

Class ________________

Move to pages 2.1 – 2.11.

After completing the simulation on page 1.2, answer questions 1 – 11 below and/or in your .tns file.

Q1. Identify the ecological role of the following organism: grass

A. producer

B. primary consumer

C. secondary consumer

D, tertiary consumer

Q2. Identify the ecological role of the following organism: mouse

A. producer

B. primary consumer

C. secondary consumer

D, tertiary consumer

Q3. Identify the ecological role of the following organism: snake

A. producer

B. primary consumer

C. secondary consumer

D, tertiary consumer

Q4. Identify the ecological role of following organism: hawk

A. producer

B. primary consumer

C. secondary consumer

D, tertiary consumer

Q5. Describe the scenario that would sustain the island's ecosystem for 10 years.

Q6. Based on your response to question 5, why is this ecosystem successful? Use evidence from the scenario and graphs to defend your answer.

Paradise Island

Student Activity

Name ______________

Class ______________

Q7. Describe a scenario that would not sustain the island's ecosystem for 10 years.

Q8. Based on your response to question 7, why is this ecosystem unsuccessful?

Q9. What tropic level should have the most number of organisms?

A. producer
B. primary consumer
C. secondary consumer
D, tertiary consumer

Q10. What tropic should have the least number of organisms?

A. producer
B. primary consumer
C. secondary consumer
D, tertiary consumer

Q11. Justify your answers for questions 9 & 10.

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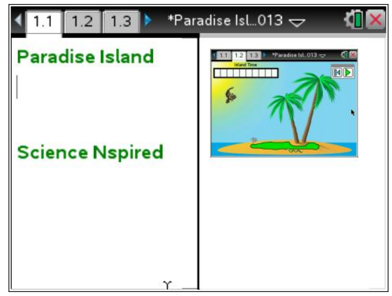
Paradise Island

MIDDLE GRADES SCIENCE NSPIRED



Science Objectives

- Students will explore a model to understand how matter and energy are transferred among producers, consumers, and decomposers in an ecosystem.
- Students will explore how the number of organisms in different trophic levels affects the stability of an ecosystem.

Vocabulary

- producer
- consumer
- secondary consumer
- tertiary consumer
- population
- community
- trophic level
- ecosystem
- predator
- prey

About the Lesson

- In this lesson, students will:
  - Describe how energy is transferred through an ecosystem.
  - Explain how organisms depend on one another to create a balanced ecosystem.

TI-Nspire™ Navigator™

- Send out the *Paradise_Island.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 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.
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- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:

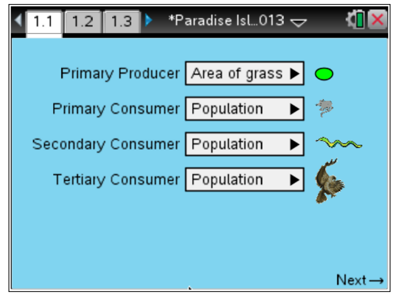
Student Activity

- Paradise_Island_Student.doc
- Paradise_Island_Student.pdf

TI-Nspire document

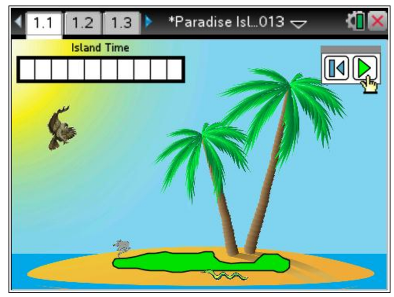
- Paradise_Island.tns

Discussion Points and Possible Answers



Move to page 1.2

1. The goal is for students to correctly set the initial populations of a variety of organisms to ensure that they all survive for a minimum of 10 years. Students will use the drop down menus to select the initial values for each population. Once students have done this, they will select NEXT → at the bottom left corner of the screen. Then, they should select the Play button to run the simulation.



2. Have students observe the outcome of the initial population values. If all of the organisms on the island die before 10 years have passed, the student can select the Reset Button and try again with new values. Students should continue to select new outcomes until all populations can be sustained on the island for 10 years. Note: If students are struggling to create a successful outcome, a discussion of the correct balance of organisms within an ecosystem may be necessary to point them in the right direction.

3. Once all populations are alive for 10 years, the students will explore the graphs on pages 1.3 -1.6 and the spreadsheet on 1.7 to see how each population fluctuated. Note: Students should not select the reset button once they have successfully run the simulation or you they delete all of the data from the graphs.

Tech Tip: If students are unable to view the entirety of the data on pages 1.3 - 1.6, have students select menu **> 5: Window/Zoom > 2: Zoom-Data.**

Tech Tip: To access the Directions again, select menu or **Document Tools ( ) > Paradise Island > Directions.**

Tech Tip: To access the Directions again, select > **Paradise Island > Directions.**

Move to page 2.1.

Have students answer question 1 - 11 in the .tns file, the activity sheet, or both.

Q1. Identify the ecological role of the following organism: grass

Answer: A. producer

Q2. Identify the ecological role of the following organism: mouse

Answer: B. primary consumer

Q3. Identify the ecological role of the following organism: snake

Answer: C. secondary consumer

Q4. Identify the ecological role of the following organism: hawk

Answer: D. tertiary consumer

Q5. Describe the scenario that would sustain the island's ecosystem for 10 years.

Sample Answer: There would need to be a high amount of producers, a lesser amount of primary consumers, an even lower numbers of secondary consumers, and the lowest amount of tertiary consumers.

Q6. Based on your response to question 5, why is this ecosystem successful? Use evidence from the scenario and graphs to defend your answer.

Sample Answer: There would need to be a large number of producers to feed the primary producers and enough organisms on each level to feed the level above it. If any of the trophic levels disappeared, the levels above it would also disappear.

Q7. Describe a scenario that would not sustain the island's ecosystem for 10 years.

Sample Answer: There would an imbalance in the number of organisms in each trophic level. For example, there might be too many primary consumers and not enough producers.

Q8. Based on your response to question 7, why is this ecosystem unsuccessful?

Sample Answer: If there were too many primary consumers and not enough producers, there would not be enough food energy for the primary consumers to live. Thus, their population would decrease and possibly die off. This would then cause organisms at higher levels to die as well.

Q9. What tropic level would have the most number of organisms?

Answer: A. producer

Q10. What tropic would have the least number of organisms?

Answer: D. tertiary consumer

Q11. Justify your answers for questions 9 & 10.

Sample Answer: Producers will have the highest numbers to provide the energy needed to other trophic levels. The tertiary consumers have the least number of organisms because food availability and energy are lost through the trophic levels.

TI-Nspire Navigator Opportunities

Make a student a Live Presenter to illustrate how to change the initial values of the different populations. Throughout the activity, monitor student progress. At the end of the activity, collect the .tns file and save to Portfolio.

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. The Slide Show will be utilized to give students immediate feedback on their assessment.
- Summative assessment could consist of questions/problems on the chapter test or a performance assessment involving the creation of their own model demonstrating the trophic levels of a local ecosystem.

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Aquatic Food Webs

Student Activity

Name ________________

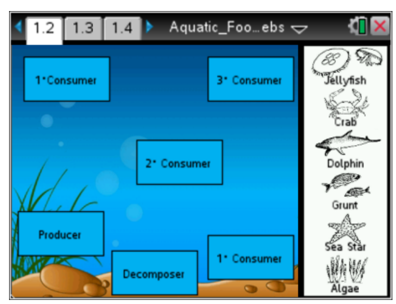
Class ________________

Open the TI-Nspire document *Aquatic_Food_Webs.tns*

All living things need to obtain energy. In an **ecosystem**, some organisms, known as **producers**, produce their own food to obtain energy. There are also some organisms, known as **consumers**, that consume other organisms to obtain energy. A final group of organisms, known as **decomposers**, obtain energy by breaking down dead organisms and waste matter. The energy relationship between organisms in an ecosystem is known as a **food web**.

All organisms have a role in a food web. The **producers** make food by transforming energy from the Sun, water, and nutrients into carbohydrates and other molecules. **Primary consumers** eat producers to obtain energy. In turn, **secondary consumers** will obtain energy from primary consumers, and **tertiary consumers** will obtain energy from secondary consumers. Decomposers break down dead organisms into basic nutrients that producers can use to make their food. In this activity, you will determine the roles of different organisms in an aquatic food web and identify the ecological relationships between different organisms.

Move to page 1.2.
Read the directions for the simulation.



1. Move the organisms on the right by dragging and dropping them on the correct label. If the organism correctly matches its role in the food web, the border of the label box will turn green.
2. Once the organisms are in the correct positions, select two different organisms to show their ecological connection in the food web. (In other words, show "who eats whom" in the food web). There should be 10 connections.

Tech Tip: To access the Directions again, select 🔧 > **Food Web> Directions.**

Tech Tip: To access the Directions again, select [menu] or **Document Tools ( ) > Food Web > Directions.**

Aquatic Food Webs

Student Activity

Name _______________

Class _______________

Move to pages 1.3 – 1.15.

After completing the simulation on page 1.2, answer questions 1 – 13 below and/or in your .tns file.

Q1. Identify the ecological role of the following organism: algae

A. producer
B. primary consumer
C. secondary consumer
D, tertiary consumer
E. decomposer

Q2. Identify the ecological role of the following organism: sea star

A. producer
B. primary consumer
C. secondary consumer
D, tertiary consumer
E. decomposer

Q3. Identify the ecological role of the following organism: grunt

A. producer
B. primary consumer
C. secondary consumer
D, tertiary consumer
E. decomposer

Q4. Identify the ecological role of the following organism: dolphin

A. producer
B. primary consumer
C. secondary consumer
D, tertiary consumer
E. decomposer

Q5. Identify the ecological role of the following organism: crab

A. producer
B. primary consumer
C. secondary consumer
D, tertiary consumer
E. decomposer

Aquatic Food Webs

Student Activity

Name ______________

Class ______________

Q6. Identify the ecological role of the following organism: jellyfish

A. producer
B. primary consumer
C. secondary consumer
D, tertiary consumer
E. decomposer

Q7. From which organism(s) does the crab obtain energy? (Multiple answers possible.)

A. algae
B. jellyfish
C, sea star
D. dolphin
E. grunt

Q8. From which organism(s) does the jellyfish obtain energy? (Multiple answers possible.)

A. algae
B. crab
C, sea star
D. dolphin
E. grunt

Q9. From which organism(s) does the sea star obtain energy? (Multiple answers possible.)

A. algae
B. jellyfish
C, crab
D. dolphin
E. grunt

Q10. From which organism(s) does the dolphin obtain energy? (Multiple answers possible.)

A. algae
B. jellyfish
C, sea star
D. crab
E. grunt

Q11. From which organism(s) does the grunt obtain energy? (Multiple answers possible.)

A. algae

B. jellyfish

C, sea star

D. crab

E. dolphin

Q12. What is the main source of energy for all living things?

Q13. What does a food web tell us about an ecosystem?

Aquatic Food Webs

MIDDLE GRADES SCIENCE NSPIRED

Science Objectives

- Students will construct a model to describe the cycling of matter and flow of energy among organisms in an ecosystem.
- Students will identify ecological relationships among producers, consumers, and decomposers in a food web.

Vocabulary

- producer
- primary consumer
- secondary consumer
- tertiary consumer
- decomposer
- food web
- ecosystem

About the Lesson

- In this lesson, students will:
  - Construct a foodweb to describe the flow of energy through an aquatic ecosystem.
  - Identify and describe the relationships among organisms that allow for the transfer of energy in an ecosystem.

TI-Nspire™ Navigator™

- Send out the .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 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.
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- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:

Student Activity

- Aquatic_Food_Webs_Student.doc
- Aquatic_Food_Webs_Student.pdf

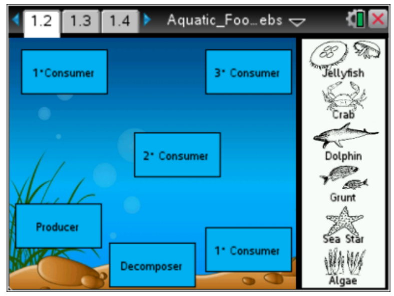
TI-Nspire document

- Aquatic_Food_Webs.tns

Discussion Points and Possible Answers

Have students read the background information stated on their activity sheet.

Move to page 1.2.

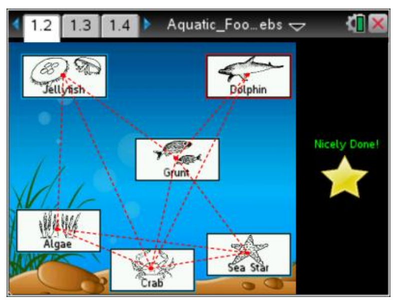


1. Students will move the organisms on the right by dragging and dropping them on the correct label. If the organism correctly matches its role in the food web, the border of the label box will turn green.

2. Once the organisms are in the correct positions, students will select two different organisms to show their ecological connection. Students should select the organism that provides the energy first and then select the organism that obtains the energy. There should be 10 connections.

Tech Tip: To access the Directions again, select > **Food Web > Directions.**

Tech Tip: To access the Directions again, select menu or **Document Tools ( ) > Food Web > Directions.**



3. When students have correctly selected all of the ecological connections, a gold star with the words "Nicely Done!" will appear.

Move to pages 1.3 – 1.15.

Have students answer questions 1 - 13 on the device, the activity sheet, or both.

Q1. Identify the ecological role of the following organism: algae

Answer: A. producer

Q2. Identify the ecological role of the following organism: sea star

Answer: C. secondary consumer

Q3. Identify the ecological role of the following organism: grunt

Answer: C. secondary consumer

Q4. Identify the ecological role of the following organism: dolphin

Answer: D. tertiary consumer

Q5. Identify the ecological role of the following organism: crab

Answer: E. decomposer

Q6. Identify the ecological role of the following organism: jellyfish

Answer: C. secondary consumer

Q7. From which organism(s) does the crab obtain energy? (Multiple answers possible.)

Answer: All Choices

Q8. From which organism(s) does the jellyfish obtain energy? (Multiple answers possible.)

Answer: E. grunt

Q9. From which organism(s) does the sea star obtain energy? (Multiple answers possible.)

Answer: A. algae

Q10. From which organism(s) does the dolphin obtain energy? (Multiple answers possible.)

Answer: E. grunt

Q11. From which organism(s) does the grunt obtain energy? (Multiple answers possible.)

Answer: jellyfish & sea star

Q12. What is the main source of energy for all living things?

Answer: The Sun

Q13. What does a food web tell us about an ecosystem?

Sample Answer: A food web shows the flow of energy through an ecosystem.

TI-Nspire Navigator Opportunities

Make a student a Live Presenter to illustrate how to drag and drop the organisms in the food web. Throughout the activity, monitor student progress. At the end of the activity, collect the .tns file and save to Portfolio.

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.

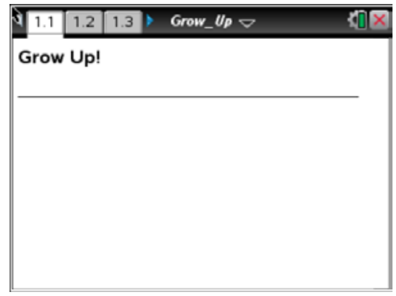
Assessment

- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved. The Slide Show will be utilized to give students immediate feedback on their assessment.
- Summative assessment could consist of questions/problems on the chapter test or a performance assessment in which they create their own food web.

Grow Up!
Student Activity

Name ______________
Class ______________

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



Because we are humans, we tend to believe that we are "the norm" in every way. It's only natural for us to use ourselves as the model animal because we've never been anything BUT human!

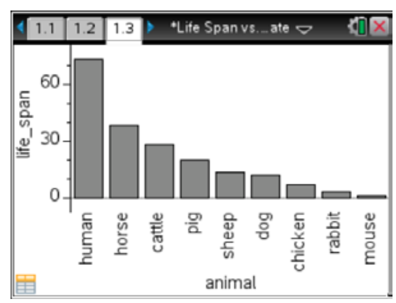
Actually, however, most animals are not all that much like us. The vast majority of animals on the planet are insects. Get this: There are about 1.5 TRILLION insects for each person alive on Earth! The total number of insects is estimated to be about 10^{19}! Thankfully for us, most insects are really, really small and they don't live very long. Some live for just a few hours; long enough to reproduce, then they die. So maybe we DO have it better than bugs!

In this activity, you'll take a look at the lifespans and growth rates of several familiar animals. Animals that are more like you than an ant or a grasshopper.

Move to page 1.2.

1. Start working your way through the document, and answer the questions on pages 1.4 through 1.7.
2. Examine the bar graph on page 1.9 and then answer the questions on pages 1.10 through 1.12.
3. Examine the graph on page 1.13 and then answer the question on page 1.14.
4. Examine the graphs on pages 1.15 and 1.16. Then answer the questions on pages 1.18 through 1.23.

Questions

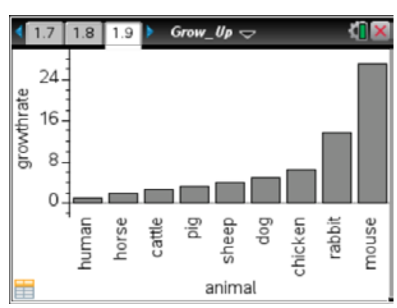


Q1. From the bar graph on page 1.3 showing the lifespans of various animals, estimate the approximate lifespan of a human.

Q2. Estimate the lifespan of a sheep.

Q3. Which animal has a lifespan of about 7 years?

Q4. Look at the animals included in the graph. Give it some thought and name one thing that all of the animals have in common.



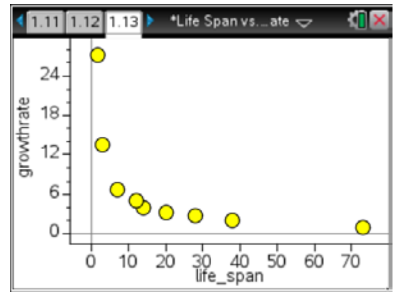
Q5. Based on the bar graph on the previous page, which animal has the fastest growth rate?

Q6. In general, the _____ the animal is, the _____ its growth rate. (Select all that are true.)

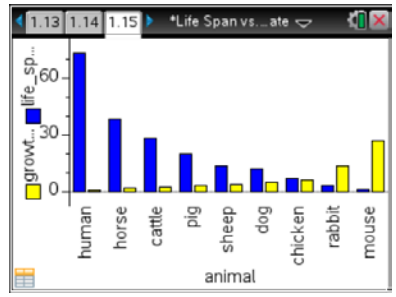
A. Larger; faster
B. Larger, slower
C. Smaller; slower
D. Smaller, faster

Grow Up!
Student Activity

Name ______________
Class ______________



Q7. Describe what is shown by the graph on page 1.13.



Q8. In the graph on page 1.16, what is represented by the yellow bars?

A. The type of animal
B. Growth rate
C. Life span

Q9. In the graph, what is represented by the blue bars?

A. The type of animal
B. Growth rate
C. Life span

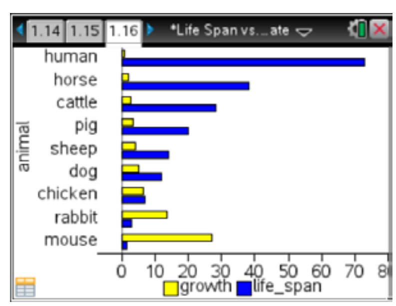
Q10. Which of the following adds new body cells to an animal?

A. Mitosis
B. Meiosis

Q11. Which animal in this activity do you think has the fastest rate of cell division?

Q12. Based on the information in this activity, which animal would you predict would take the longest to reach an age when it can reproduce?

A. Mouse
B. Dog
C. Human



Q13. Which words to you think would most accurately complete this statement: The _____ the lifespan, the _____ babies the animal has. (Select all that are true.)

A. Longer; more
B. Longer; fewer
C. Short; more
D. Short; fewer

Grow Up!
TI PROFESSIONAL DEVELOPMENT — **TEACHER NOTES**

Science Objectives

- Students will draw conclusions about the relationship between the lifespan and the growth rate of various animals.
- Students will make a connection between growth rate and the rate of mitosis.
- Students will evaluate various types of graphs.

Vocabulary

- growth rate
- lifespan
- bar graph
- mitosis
- meiosis

About the Lesson

- This lesson has students working their way through a TI-Nspire™ document dealing with the relationship between the lifespan and the growth rate of several warm-blooded (endothermic) animals.
- Different types of bar graphs are used to show this relationship. A scatterplot is also used.

TI-Nspire™ Navigator™

- Monitor student progress using Class Capture.
- Use Live Presenter to allow students to show how they are analyzing the graphs in the document.

TI-Nspire™ Technology Skills:

- Open a document
- Move between pages
- Answer questions embedded in a document

Tech Tips:

- Students can move between pages by clicking ctrl ▶ and ctrl ◀.

Lesson Files:

Student Activity

- Grow_Up_Student.doc
- Grow_Up_Student.pdf

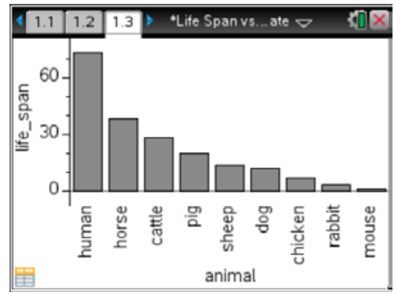
TI-Nspire document

- Grow_Up.tns

Discussion Points and Possible Answers

Have students answer all questions on their activity sheet.

Questions



Q1. From the bar graph on page 1.3 showing the lifespans of various animals, estimate the approximate lifespan of a human.

Sample answer: 73 years

Q2. Estimate the lifespan of a sheep.

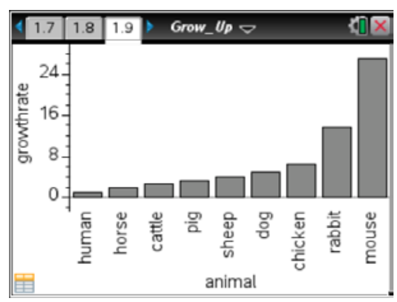
Sample answer: 14 years

Q3. Which animal has a lifespan of about 7 years?

Answer: Chicken

Q4. Look at the animals included in the graph. Give it some thought and name one thing that all of the animals have in common.

Sample answer: They are all warm blooded.

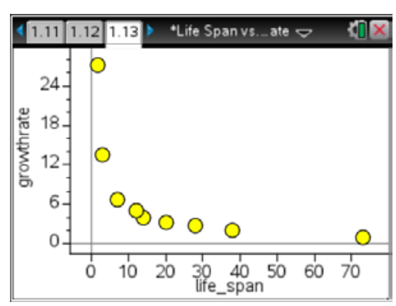


Q5. Based on the bar graph on the previous page, which animal has the fastest growth rate?

Answer: Mouse

Q6. In general, the _____ the animal is, the _____ its growth rate.(Select all that are true.)

A. Larger; faster
B. Larger, slower
C. Smaller; slower
D. Smaller, faster

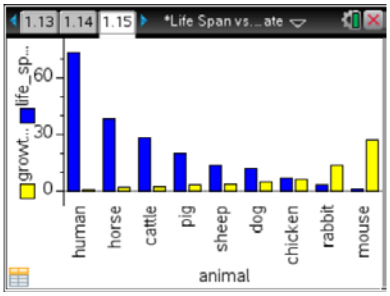


Q7. Describe what is shown by the graph on page 1.13.

Answer: The longer the lifespan, the slower the growth rate.

Q8. In the graph on page 1.16, what is represented by the yellow bars?

A. The type of animal
B. Growth rate
C. Life span



Q9. In the graph, what is represented by the blue bars?

A. The type of animal
B. Growth rate
C. Life span

Q10. Which of the following adds new body cells to an animal?

A. Mitosis
B. Meiosis

Q11. Which animal in this activity do you think has the fastest rate of cell division?

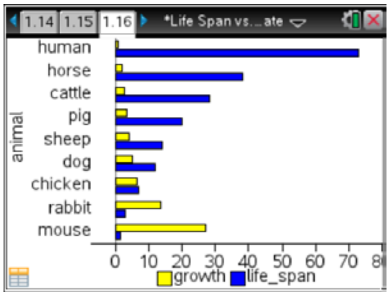
<u>Answer:</u> Mouse

Q12. Based on the information in this activity, which animal would you predict would take the longest to reach an age when it can reproduce?

A. Mouse
B. Dog
C. Human

Q13. Which words to you think would most accurately complete this statement: The _____ the lifespan, the _____ babies the animal has. (Select all that are true.)

A. Longer; more
B. Longer; fewer
C. Short; more
D. Short; fewer



TI-Nspire Navigator Opportunities
Allow students to volunteer to be the Live Presenter.
Use Quick Poll to check for understanding during the course of the activity.

Wrap Up

When students are finished with the activity, discuss with them the suggested answers to the questions.

Assessment

- Answers to questions are written into the student worksheet.
- Use Quick Poll to collect answers to questions given in the student worksheet.

Energy in Food

Food supplies energy for all animals—without it we could not live. The quantity of energy stored in food is of great interest to humans. The energy your body needs for running, talking, and thinking comes from the foods you eat. Not all foods contain the same amount of energy, nor are all foods equally nutritious for you. An average person should consume a minimum of 2,000 kilocalories per day, which is equivalent to 8,360 kilojoules. Calories and joules are both units of energy. We will use joules in this lab since it is the accepted SI metric standard.

You can determine the energy content of food by burning a portion of it and capturing the heat released to a known amount of water. This technique is called *calorimetry*. The energy content of the food is the amount of heat produced by the combustion of 1 gram of a substance. It is measured in kilojoules per gram (kJ/g).

OBJECTIVES

In this experiment, you will

- Use a temperature probe to measure temperature changes.
- Monitor the energy given off by food as it burns.
- Determine and compare the energy content of different foods.

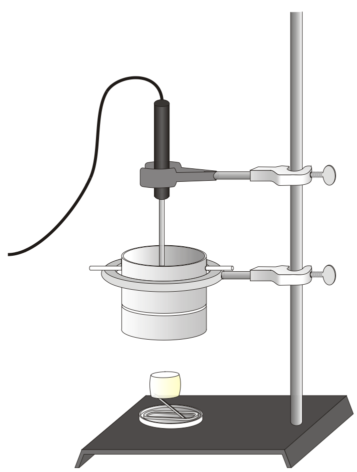


Figure 1

MATERIALS

TI-Nspire handheld **or**
computer and TI-Nspire software
EasyTemp **or** Go!Temp **or**
Temperature Probe and data-collection interface
100 mL graduated cylinder
ring stand and 10 cm (4") ring
balance
utility clamp

aluminum foil
matches
soup or juice can
wooden splint
two stirring rods
cold water
two single-hole stoppers
two food samples (nut, popcorn,

food holder or marshmallow)

PROCEDURE

1. Obtain and wear goggles.

2. Connect the Temperature Probe to the data-collection interface. Connect the interface to the TI-Nspire handheld or computer. (If you are using an EasyTemp or Go!Temp, you do not need a data-collection interface.)

3. Set up DataQuest for data collection.
   a. Choose New Experiment from the Experiment menu
   b. Choose Collection Setup from the Experiment menu.
   c. Enter **0.2** as the rate (samples/second).
   d. Enter **480** as experiment duration in seconds. The number of points collected will be 97.
   e. Select OK.

4. Obtain a sample of food and a food holder similar to the one shown in Figure 1. Mount the food onto the food holder so that it can burn without damaging the holder. Determine and record the initial mass of the food sample and food holder in Table 1. **CAUTION:** *Do not eat or drink in the laboratory.*

5. Set up the apparatus shown in Figure 1.
   a. Determine the mass of an empty can. Record the value in Table 1.
   b. Place about 50 mL of cold water into the can.
   c. Determine and record the mass of the can plus the water.
   d. Insert a stirring rod through the holes in the top of the can and hold it in place with two one-hole stoppers. Position the can 2.5 cm (~1 inch) above the food sample.
   e. Use a utility clamp to suspend the temperature probe in the water as shown in Figure 1. The probe should not touch the bottom or side of the can.

6. You are now ready to begin collecting data.
   a. Start data collection by hitting the play button.
   b. Use a match to light the food sample. Position the burning food sample directly below the center of the water-filled can. Quickly light the food sample again if it stops burning during data collection. **CAUTION:** *Always keep hair and clothing away from open flames.*
   c. A real-time graph of temperature *vs.* time will be displayed on the screen during data collection.
   d. Temperature readings (in °C) are displayed in the Graph Details box located to the left of the graph.

7. Stir the water slowly and continuously using the stirring rod until data collection stops.

8. After data collection has stopped, click any data point by using the cursor button to examine the data points on the graph. Locate the maximum and minimum temperatures and record these values in Table 1.

9. Remove the food holder and determine the final mass of the food and holder. Record the mass in Table 1.

10. Clean off the food holder and empty the can of water.

11. Click the Store Data button to save the first run data.
12. Repeat Steps 4–10 for the second food sample.
13. A good way to compare the two samples is to view both sets of data on one graph. To display a graph click on graph view and click **run 2** then click select **All**. Sketch or print the graph as directed by your instructor.
14. When finished, discard all burnt matches and food samples as directed by your teacher.

DATA

Table 1		
Measurements	Sample 1	Sample 2
Food used		
Mass of empty can (g)		
Mass of can plus water (g)		
Initial temperature of water (°C)		
Final temperature of water (°C)		
Initial mass of food and holder (g)		
Final mass of food and holder (g)		

PROCESSING THE DATA

Record the following calculations in Table 2. Show your work in Table 3.

1. Determine the mass of the water and record in Table 2.
2. Calculate the change in mass of each food sample. Show your calculations.
3. Calculate the changes in the temperature of the water, Δt. Record this in Table 2. Show your calculations.
4. Calculate the energy gained by the heated water. Show your calculations. To do this, use the following equation:

$$\text{Energy gained by water} = (\text{mass of water}) \times (\Delta t \text{ of water}) \times (4.18\ \text{J/g°C})$$

5. Convert the energy you calculated in Step 4 to kilojoules (1 kJ = 1000 J).
6. Use your answer in Step 5 to calculate the energy content of each food sample (in kJ/g):

$$\text{Energy content of food} = \text{Energy gained by water} / \Delta\text{mass of food}$$

7. Record your results and the results of other groups in Table 4.

Table 2		
Calculations	Sample 1	Sample 2
Mass of water (g)		
Δt of water (°C)		
Δmass of food (g)		
Energy gained by water (J)		
Energy content of food (J/g)		

Table 3		
Calculation	Sample 1	Sample 2
Δmass		
Δt		
Energy gained		
Energy content		

Table 4: Class Results				
Food type:				
	Energy content (kJ/g)			
Group 1				
Group 2				
Group 3				
Group 4				
Group 5				
Group 6				
Class Average:				

QUESTIONS

1. Which of the foods has the greatest energy content?
2. Which of the tested foods is the best energy source? Why?
3. What was the original source of energy in the foods tested?
4. Why might some foods with a lower energy content be better energy sources than other foods with a higher energy content?
5. Would you expect the energy content values that you measured to be close to the value listed in dietary books? Why?

EXTENSION

1. Determine the energy content of other combustible foods.

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TEACHER INFORMATION

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Energy in Food

1. The student pages with complete instructions for data collection using LabQuest App, Logger *Pro* (computers), DataQuest (TI-Nspire Technology), EasyData or DataMate (calculators), and DataPro (Palm handhelds), can be found on the CD that accompanies this book. See *Appendix A* for more information.

2. Any four nuts could be used for this experiment. Walnuts, pecans, peanuts, and almonds are easy to obtain and give excellent results.

3. The water should be approximately 1-1/2 to 2 inches in diameter and about 3 inches long. A small juice can will do. Drill two holes in the can just under the metal rim, large enough so that a solid glass rod can easy fit in. The can will be suspended by the glass rod with a one-hole rubber stopper at each end. The rubber stoppers will rest on a metal 4 inch ring.

4. The food stand is made using a cork stopper, size 7 or larger, and a paper clip. Straighten one end of the paper clip and push it into the bottom of the cork stopper. Bend the other end of the paper clip into a ring so it will cup the food sample.

5. The two rubber stoppers on the very end of the stirring rod holding the can will prevent the can from slipping off the ring stand.

6. Heat is lost to the environment during this experiment as the fuel is burning. Therefore, the energy content that students measure will not be similar to the published values. This lab is still valid, however, since the heat lost to the environment is nearly proportional in every experiment. If the physical conditions in every experiment are the same, the energy contents will be proportional. Several key factors include:
   - The distance from the bottom of the can to the flame (or table top) should be equal.
   - The cans should be of equal dimensions.
   - The flame should not be in a breeze.

7. Provide each lab group with a container to discard their burnt foods. The charred pieces will make a mess otherwise. Soot will accumulate on the outside of the calorimeter can. Provide a paper towel for students to set the can onto between experiments. Soap may be needed after this experiment!

8. The Vernier temperature calibrations that are stored in the data-collection software will work fine for this experiment.

9. Use of nuts, especially peanuts, is being restricted and phased out of schools due to increasing numbers of allergic reactions and the heightened sensitivity that some students exhibit.

10. If you are collecting data on a calculator, we suggest that you clear all other programs and miscellaneous data off of the calculators to make room in the memory for collected data before loading EasyData.

SAMPLE RESULTS

Table 1			
Measurements	Sample 1	Sample 2	Sample 3
Food used	walnut	almond	pine nut
Mass of empty can (g)	28.51	28.51	28.51
Mass of can plus water (g)	77.35	78.27	76.99
Initial temperature of water (°C)	21.6	22.5	22.3
Final temperature of water (°C)	47.7	49.8	31.4
Initial mass of food (g)	12.85	12.92	12.30
Final mass of food (g)	12.25	12.18	12.10

Table 2			
Calculations	Sample 1	Sample 2	Sample 3
Mass of water (g)	49.18	49.76	48.48
Δt of water (°C)	26.1	27.3	9.1
Δmass of food (g)	0.60	0.74	0.20
Energy gained by water (J)	5330	5680	1840
Energy content of food (J/g)	8880	7670	9220

Since this experiment is designed for 9th and 10th grade students, the mathematics has been simplified. Here is a more complete description of some of the mathematical reasoning.

The law of conservation of energy states that the energy lost by the food should equal the energy gained by the water.

$$\Delta E_{\text{food}} = \Delta E_{\text{water}}$$

The energy lost to the environment is nearly proportional in every experiment so it can be ignored. The energy gained by the water can be calculated using the equation below where m_{water} is the mass of the water in grams, C_p is the heat capacity of water which is equal to 4.186 J/g^{o}C, and Δt is the change in temperature in ^{o}C.

$$\Delta E_{\text{water}} = m_{\text{water}} \bullet C_p \bullet \Delta t$$

Since the energy gained by the water is equal to the energy lost by the food, then the energy lost by the food can be found by using this equation.

$$\Delta E_{\text{food}} = \Delta E_{\text{water}} = m_{\text{water}} \bullet C_p \bullet \Delta t$$

To calculate how much energy would be lost by one gram of the same food, divide the energy lost by the food by the mass of food that did burn.

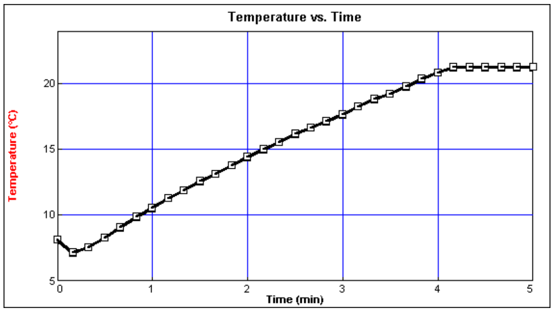
$$\text{Energy content} = \frac{\Delta E_{\text{food}}}{1\ \text{gram}} = \frac{m_{\text{water}} \bullet C_p \bullet \Delta t}{\Delta m_{\text{food}}}$$

After converting joules to kilojoules, this gives us an answer similar to that in the student handout. We define the term *energy content* to be that amount of energy that can be obtained by the combustion of one gram of food.

The energy contents of a few sample foods are listed below. Note that these should be proportional to the measured energy contents, not equal to them, since heat was lost to the environment, and combustion was not complete.

Food	Energy content (kJ/g)
almond	26.8
brazil nuts	29.0
cashews	25.5
coconut (dry)	23.8
kidney beans	25.9

Food	Energy content (kJ/g)
lard	37.6
lima bean	14.3
peanuts	25.9
walnut	29.3



Walnut burning and warming water

ANSWERS TO QUESTIONS

1. Answers may vary, depending upon the type of food used. In the above experiment, pine nuts had the highest heat content, followed by walnuts, then almonds.

2. Answers may vary. The food with the highest energy content is the best energy source.

3. The sun is the source of energy for land plants. Plants can transform this radiant energy into chemical energy. This energy is used to manufacture many different substances, possibly in the form of fats, carbohydrates, or other high energy chemicals. When these chemicals are broken down, they release energy.

4. Some high energy foods might be indigestible. Food with a high energy content might be high in cholesterol or saturated fats. These may be harmful to some people in large amounts.

5. No, the measured values should be lower than those listed in a reference book.
   - There would be a certain amount of heat lost to the air and is not used to heat the water.

Experiment 1

- Soot that collects indicates incomplete combustion of the food. The published values assume complete combustion.

Needs of Living Things

Student Activity

Name ______________

Class ______________

Open the TI-Nspire document Needs_of_Living_Things.tns.

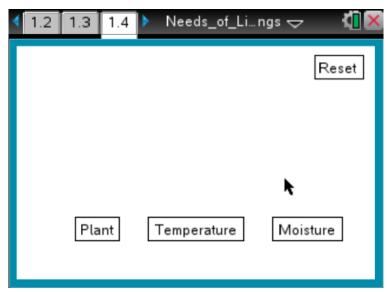
Move to pages 1.2 – 1.3.

1. Read through pages 1.2 and 1.3 in the .tns file as well as the background information stated below. Page 1.3 will also give instructions on how to complete the simulation on page 1.4.

Living things are dependent upon several factors which include the use of energy, nutrients, water availability, predators and their environment. These factors are known as **limiting factors**, which include anything that would put a “limit” on an animal’s ability to thrive in an ecosystem. There is a direct relationship between a healthy and stable ecosystem and an organism’s ability to thrive. Each organism has a different set of requirements for survival.

In this simulation, you will manipulate the requirements first for a set of plants and finally for an array of animals, to see what will happen when they are placed in a specific ecosystem.

Move to page 1.4.



2. On this page, you will see four buttons— Plant, Temperature, Moisture, and Reset.
   - Each time you select the Plant button, a different plant will appear.
   - The same thing goes for Temperature and Moisture.
   - Once you have selected all three variables, a new button will appear, Show Population.
   - When you select Show Population, a graph will appear showing the change in population of that specific plant over a period of time.
   - Select the correct conditions and the plant population will increase; select the wrong conditions and the plant population will decrease.

Try different combinations to see which plant is best suited to which environment. Once you feel comfortable with the different scenarios, move on to the next page.

Tech Tip: You can also modify the variables by selecting 🔧, the desired variable, and then the desired option. You may need to back-out to the main Tools Menu 🔧 to see the desired menu option.

Move to page 1.5.

3. Before moving onto the questions, read the background information on page 1.5 about biomes.

Needs of Living Things

Student Activity

Name ______________

Class ______________

After going through this simulation, you should notice that different plants need different environmental conditions to survive. These different environments are called **biomes**, also known as large distinctive regions of plant and animal communities maintained by a specific climate. In the previous simulation, you looked at plant life in four different biomes including boreal forest, temperate forest, tropical rainforest and desert. These are just a few of the major biomes that make up the Earth.

Move to pages 1.6 – 1.9. Answer questions 1-4 below and/or in the .tns file.

Q1. Of the four different kinds of plants, which plant is most capable of adapting to a variety of living conditions?

A. Evergreen Tree
B. Willow Tree
C. Palm Tree
D. Hedgehog Cactus

Q2. In which biome would you most likely find a willow tree?

A. Tropical Rainforest
B. Boreal Forest
C. Temperate Forest
D. Desert

Q3. Palm trees are typically found in a sub-tropical or tropical climate. Which conditions most accurately describe a tropical climate?

A. hot and dry
B. hot and wet
C. cool and dry
D. cool and wet

Q4. Name three "limiting factors" in a Hedgehog Cactus' environment.

Move to page 2.1.

4. Read through page 2.1. It explains how to complete the simulation.

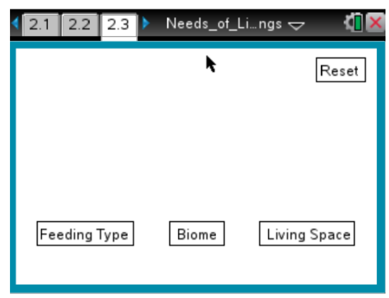
On page 2.3, you will see four different buttons, similar to the ones you saw in the previous simulation. This time, the four buttons are Feeding Type, Biome, Living Space, and Reset. You will be able to manipulate the limiting factors in this simulation.

- Once you have selected the buttons and selected your three variables, another button will come up indicating Show Animal.
- This time, you manipulate the environment and an animal that is adapted to those living conditions will be displayed on the screen.
- Explore the different conditions before you move on.

Move to page 2.2.

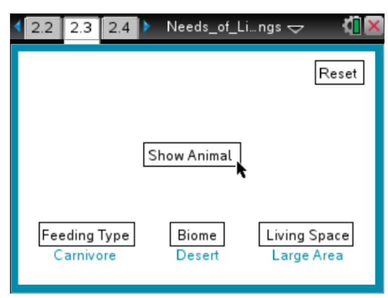
5. Read through page 2.2. It reviews key vocabulary you will need to know in order to fully understand the simulation.
    - A **carnivore** is a meat eater that receives most of its energy and nutrient requirements from a diet consisting of animal tissue.
    - A **herbivore** is an organism that primarily eats autotrophs (producers), also known as plants, algae, and certain types of bacteria.
    - An **autotroph** is an organism that is capable of self-nourishment by processes such as photosynthesis as a source of nutrients and energy.

6. On Page 2.3, you can manipulate the three major categories including Feeding Type, Biome, and Living Space to show a specific animal that lives in that particular region.
    - Feeding type is broken down into three options including carnivore, herbivore, and autotroph.
    - Biome is broken down into three options including desert, lake, and swamp.
    - Living space is broken down into two options including minimal area and large area.



Note: Once you have made a selection in all three categories a new button will appear in the middle of the screen displaying Show Animal. Select Show Animal to display the animal that best fits with the limiting factor choices you made.

- You can restart the simulation by selecting the Reset button on the top right corner of the screen.



Move to pages 2.4 – 2.11. Answer questions 5-12 below and/or in the .tns file.

Q5. Which of the following animals is NOT an example of a carnivore?

A. oscar
B. heron
C. macaw
D. anaconda

Needs of Living Things

Student Activity

Name ________________

Class ________________

Q6. Which term best describes an organism that is capable of producing its own food through photosynthesis?

A. carnivore
B. herbivore
C. autotroph

Q7. Which of the following organisms would most likely be found in a desert?

A. lizard
B. anaconda
C. snail
D. heron

Q8. According to the simulation, which environment best fits a coyote's needs?

A. swamp, large area
B. desert, large area
C. lake, large area
D. swamp, minimal area

Q9. Which organism in this simulation is most acclimated to a variety of living conditions?

A. beaver
B. rattlesnake
C. snail
D. grass

Q10. Pick an animal and list at least three things it needs in order to survive. Place both parts of your answer below.

Q11. Using what you have learned from both simulations on pages 1.4 and 2.3, what would most likely happen to an organism if it was removed from its natural environment? Why?

Q12. Living organisms have a direct relationship with the environment they live in. How have humans affected the natural environments of other organisms?

Needs of Living Things

TEACHER NOTES

MIDDLE GRADES SCIENCE NSPIRED

Science Objectives

- Students will describe and identify the survival needs for both plants and animals.
- Students will simulate what will happen to a population when limiting factors in its environment are manipulated.
- Students will match an animal with its appropriate feeding type, water requirements, and living space.
- Students will analyze the impact humans have had on different environments.

Vocabulary

- Biomes
- Carnivore
- Herbivore
- Limiting Factors
- Autotroph

About the Lesson

- This lesson will have students analyze the different limiting factors that allow an organism to thrive in a particular environment.
- As a result, students will:
  - Understand that there are different biomes on Earth, each with its own unique limiting factors which provide specific species what they need to survive.
  - Manipulate environmental factors and analyze what happens to a population if placed in an unsuitable environment.
  - Evaluate the impact humans have had on different biomes around the world.

TI-Nspire™ Navigator™

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

Activity Materials

- Compatible TI Technologies: TI-Nspire™ CX Handhelds, TI-Nspire™ Apps 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

- Needs_of_Living_Things_Student.doc
- Needs_of_Living_Things_Student.pdf

TI-Nspire document

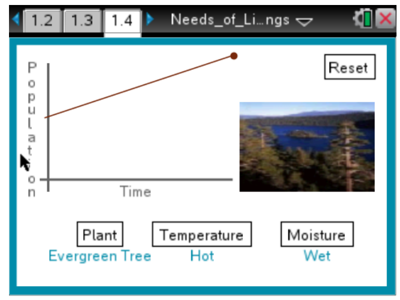
- Needs_of_Living_Things.tns

Discussion Points and Possible Answers

Move to pages 1.2 – 1 .3.

1. Have students read through pages 1.2 and 1.3 in the .tns file as well as the background information on their activity sheet as it reviews what limiting factors are and how they impact the survival of an organism. Page 1.3 will also give instructions on how to complete the simulation on page 1.4.

Move to page 1.4.



2. On this page, students will see four buttons—Plant, Temperature, Moisture, and Reset.
   - Each time they select the Plant button, a different plant will appear.
   - The same thing goes for Temperature and Moisture.
   - Once all three variables have been selected, a new button will appear, Show Population.
   - When the student selects Show Population, a graph will appear showing the change in population of that specific plant over a period of time.
   - Select the correct conditions and the plant population will increase; select the wrong conditions and the plant population will decrease.

Tech Tip: Students can also modify the variables by selecting , the desired variable, and then the desired option. Students may need to back-out to the main Tools Menu to see the desired menu option.

Have students go through the simulation, attempting all of the combinations before progressing onto the subsequent pages to answer the questions.

Move to page 1.5.

3. Before moving onto the questions, students will read this page which discusses biomes. It gives the student some background knowledge about the four biomes discussed in the previous simulation, which includes boreal forest, temperate forest, tropical rainforest, and desert.

Move onto pages 1.6 – 1.9.

Have students answer questions 1 – 4 in the .tns file, the activity sheet, or both.

Q1. Of the four different kinds of plants, which plant is most capable of adapting to a variety of living conditions?

Answer: A. Evergreen Tree

Q2. In which biome would you most likely find a willow tree?

Answer: C. Temperate Forest

Q3. Palm trees are typically found in a sub-tropical or tropical climate. Which conditions most accurately describe a tropical climate?

Answer: B. hot and wet

Q4. Name three limiting factors in a Hedgehog Cactus' environment.

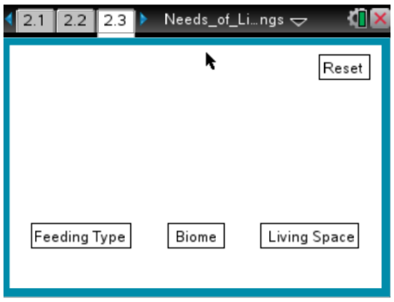
Sample Answers: Answers may include temperature, moisture, sunlight, or type of soil.

Move to page 2.1.

4. Have students read through page 2.1. It explains how to complete the simulation on page 2.3. On page 2.3, students will see four different buttons, similar to the ones they saw in the previous simulation. This time, the four buttons are Feeding Type, Biome, Living Space, and Reset. Again, they will be able to manipulate the limiting factors in this simulation.
   - Once they have selected the buttons and selected their three variables, another button will come up indicating Show Animal.
   - This time, they manipulate the environment and an animal that is adapted to those living conditions will be displayed on the screen.
   - Once they have seen their animal, students can select the Reset button and try a different combination.
   - Have the students explore the different conditions before moving on.

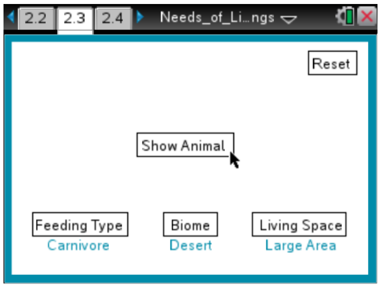
Move to page 2.2.

5. Have students read through page 2.2. It reviews key vocabulary the students will need to know in order to fully understand the simulation.



Move to page 2.3.

6. On Page 2.3, students can manipulate the three major categories including Feeding Type, Biome, and Living Space to show a specific animal that lives in that particular region.
   - Feeding type is broken down into three options including carnivore, herbivore, and autotroph.
   - Biome is broken down into three options including desert, lake, and swamp.
   - Living space is broken down into 2 options including minimal area and large area.



Note: Once students have made a selection in all three categories a new button will appear displaying Show Animal. Have them select Show Animal to display the animal that best fits with the limiting factor choices they made.

- They can restart the simulation by selecting the Reset button on the top right corner of the screen.

Move onto pages 2.4 – 2.11.

Have students answer questions 1 – 4 on the device, the activity sheet, or both.

Q5. Which of the following animals is NOT an example of a carnivore?

Answer: C. macaw

Q6. Which term best describes an organism that is capable of producing its own food through photosynthesis?

Answer: C. autotroph

Q7. Which of the following organisms would most likely be found in a desert?

Answer: A. lizard

Q8. According to the simulation, which environment best fits a coyote's needs?

Answer: B. desert, large area

Q9. Which organism in this simulation is most acclimated to a variety of living conditions?

Answer: D. grass

Q10. Pick an animal and indicate at least three things it needs in order to survive. Place both parts to your answer below.

Answers may include: (Animal) and energy source, sufficient water resource, suitable temperature range

Q11. Using what you have learned from both simulations on pages 1.4 and 2.3, what would most likely happen if an organism was removed from its natural environment? Why?

Answers may include: An organism removed from its natural environment would have a hard time surviving due to differences in climate, food sources, water availability, etc. Some exotic species, however, become invasive in habitats other than their own because they have characteristics that enable them to survive.

Q12. Living organisms have a direct relationship with the environment they live in. How have humans affected the natural environments of other organisms?

Answers may include: overuse of natural resources, climate change, human population increase

Extension

On a separate sheet of paper design your own ecosystem using one of the four major biomes listed in this activity (boreal forest, temperate forest, tropical rainforest, and desert). Include at least six organisms in your drawing and indicate how each organism is dependent upon one another.

TI-Nspire Navigator Opportunities

Throughout the simulation, discuss the activity with students using live presenter. You can also monitor student progress using the class capture feature. At the end of the simulation, collect the .tns files and save to Portfolio and review the students' responses as a whole class discussion.

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 the Review Workspace.

Assessment

- Formative assessment will consist of questions embedded in the .tns file. 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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