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

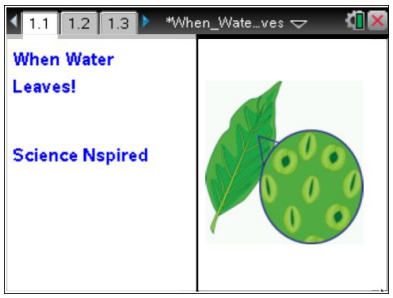
- This lesson involves students using TI-Nspire™ technology to model the effects of various environmental conditions on the rate of transpiration from the leaves of a plant.
- As a result, students will:
  - Better understand the process of transpiration.
  - Predict the effect of these environmental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

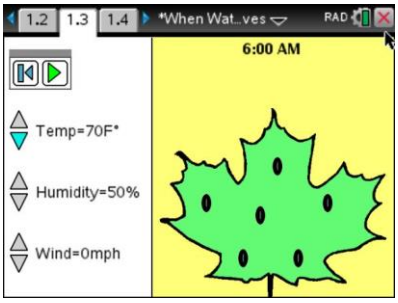
- When_Water_Leaves.tns

Discussion Points and Possible Answers

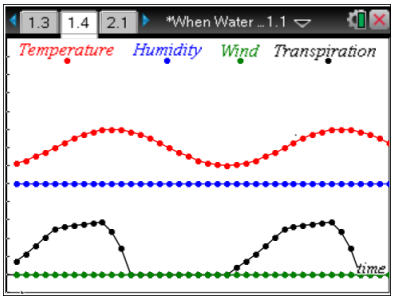
Water moves through a plant from roots to stem to leaves to air. The most important driving force behind this movement is transpiration. More generally, the movement of water is based on a gradient of water. The plant acts as a conduit between the soil and air. Since there is more water in the soil than 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.

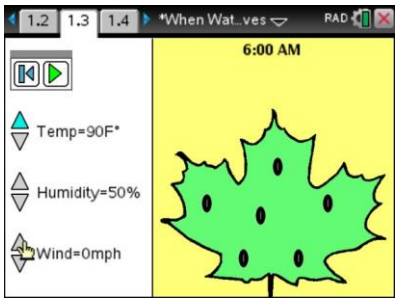
Sample answer: Answers will vary.

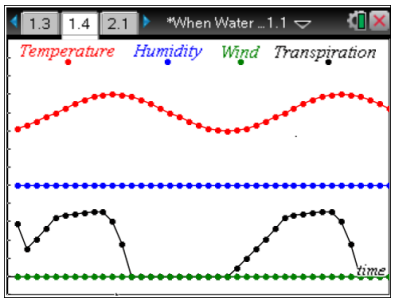
Q5. Does the transpiration rate change when the temperature changes? Explain.

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

Changing the Environmental Conditions

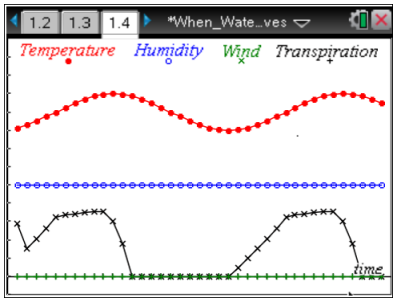
2. After running the simulation at the default settings, the students are asked to do two more simulations at different temperatures—one warmer at 90°F and one cooler at 50°F. The warmer one will show a corresponding increase in transpiration and the cooler one will show a decrease. A simulation that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



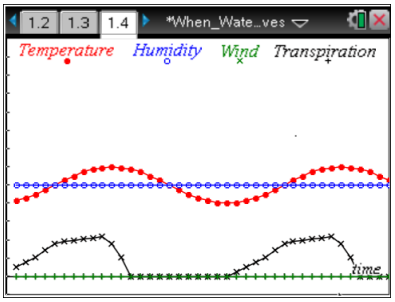


Now, have students answer the Questions Q6- Q7 on the student activity sheet.

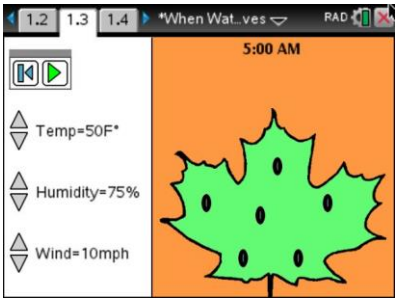
Q6. **Graph at 90°F.**

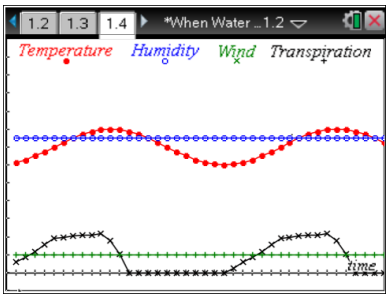


Q7. **Graph at 50°F.**



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.