



Science Objectives

- Students will observe the interaction between an enzyme and its substrate.
- Students will observe the effect that enzymes have on chemical reactions.
- Students will explore the effects of temperature and substrate concentration on enzymatic reactions.

Vocabulary

- anabolic
- catabolic
- catalase
- enzyme
- hydrogen peroxide
- metabolism
- substrate

About the Lesson

- This lesson investigates the properties of enzymes and how they affect reaction rates.
- As a result, students will:
 - Understand how enzymes interact with their substrates.
 - Observe the effect of enzymes on the activation energy of chemical reactions.
 - Observe the effect of temperature and substrate concentration on enzymatic reaction rates.

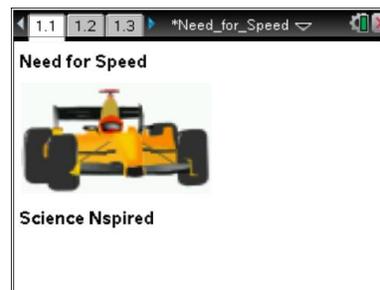


TI-Nspire™ Navigator™

- Send out the *Need_for_Speed.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

- Need_for_Speed_Student.doc
- Need_for_Speed_Student.pdf

TI-Nspire document

- Need_for_Speed.tns

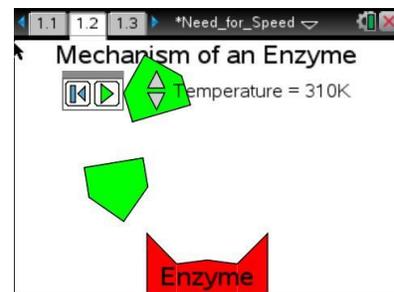
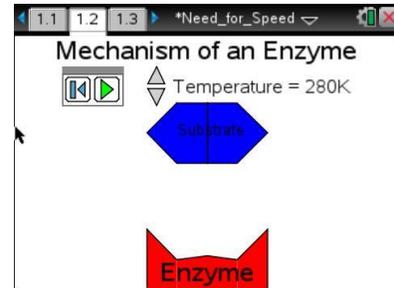


Discussion Points and Possible Answers

Move to page 1.2.

1. After reading the instructions on pages 1.2 and 1.3, students should close the directions box by selecting .
2. The play and reset buttons in the upper left corner stop and start the animation. The students will start the animation by clicking on the .
3. Students will change the temperature using the arrows until they find the temperature that produces a reaction.

Note: Be sure your students Pause the animation before they move to the next page. ()



Tech Tip: To access the Directions again, select  > **Need for Speed > Directions**



Tech Tip: To access the Directions again, select selecting  or **Document Tools** () > **Need for Speed > Directions**.



Tech Tip: Inform students that the animation on page 1.2 must be paused  before moving on. This will be critical when they get to the animation on page 1.7.

Move to pages 1.3 and 1.4.

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

- Q1. The simulation on the previous page represents a catabolic reaction. True or False?

Answer: False

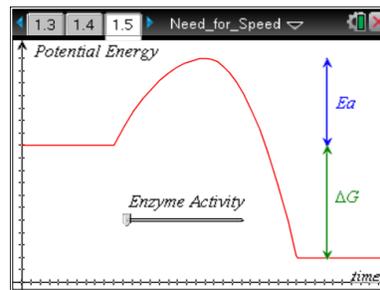
- Q2. What is the name of the region on the enzyme where the reaction took place?

Answer: active site



Move to page 1.5.

- Directions are given for the next simulation. The purpose of this animation is to demonstrate how enzymes LOWER the activation energy of a reaction.



Move to page 1.6.

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

- Which of the following changes with the use of an enzyme?

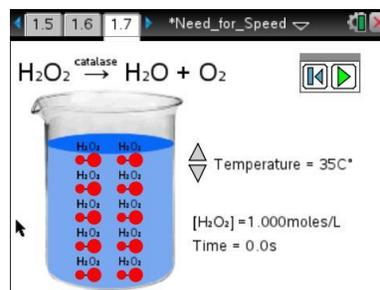
Answer: A. activation energy, E_a

Move to page 1.7.

- Directions are given for the next simulation.

The purpose of this simulation is to model the effect that temperature has on enzyme activity.

Students should start with a temperature of 30°C and click on the play button (▶). The simulation at different times will take longer to run. Students will need to wait for this process to complete.



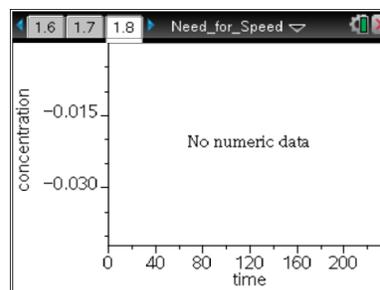
When the simulation is complete, students advance to page 1.8.



Tech Tip: The second time they run the simulation on page 1.7, students can move to page 1.8 to watch as the data is plotted. Or they can move back to page 1.7 and watch the simulation.

Move to page 1.8.

- The first time the simulation is run, students need to choose concentration as the correct variable for the y-axis. The graph of the simulated reaction will appear.





Have students answer the following question on the student activity sheet.

- Q4. Describe the relationship between substrate concentration and time that occurs during an enzymatic reaction.

Answer: At the beginning, there is a steep decline because there is a large concentration of substrate. Therefore, there are multiple interactions between substrate and enzyme. As the substrate is used up, the reaction slows down because there are fewer molecules for the enzyme to encounter.

Teacher Tip: Check for Understanding-

There is a common misconception that the *enzyme* is being used up! Discuss with your students how detrimental it would be if an organism constantly needed to replenish enzyme concentrations.

Move to page 1.9.

7. Students will label column A **time** and column B **concentration**.

They will label column C **ln c** (which stands for natural log of concentration). They will press natural log ($\text{ctrl} \text{ } e^x$) in the equation box and type *b* in the ().

Even if your students have not studied natural logs, this will teach them how a linear representation can be generated in order to determine slope (which is the **rate** of the reaction).

A	B	C
time	conce...	ln c
		=ln(b[])
1	20.00	0.99
2	40.00	0.97
3	60.00	0.96
4	80.00	0.95
5	100.00	0.93

CI = -0.0140000000000002

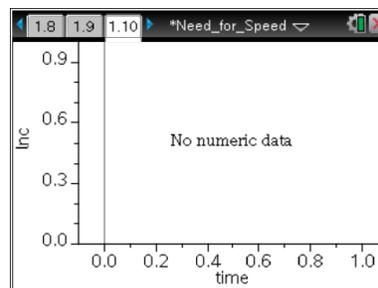


TI-Nspire Navigator Opportunities

Select a student to be the live presenter to demonstrate how to label the columns and insert the formula for Column C. This may help ensure that all students accomplish this correctly.

Move to page 1.10.

6. Here students will graph ln c versus time. This will generate a line that students will analyze to determine the rate of the simulated reaction. Students will perform a linear regression on this graph by pressing **Menu > Analyze > Regression > Show Linear (mx+b)**.



Tech Tip: To perform a linear regression on this graph, select **Analyze > Regression > Show Linear (mx+b)**.



Students will return to page 1.7 and click on the reset button (↩).

7. Students choose a different temperature and then click on the play button. (▶) Students then will advance to page 1.8.

Once the animation is completed, students will advance to page 1.10 and record the slope of the Inc curve for the new temperature. They will repeat this step three more times to obtain data for five different temperatures.

RESULTS		
	Temperature (°C)	Slope of Inc Curve (Reaction Rate)
1.	10°C	-0.000175 molecules/sec
2.	20°C	-0.00035 molecule/sec
3.	30°C	-0.0007 molecules/sec
4.	40°C	-0.0014 molecule/sec
5.	50°C	-0.0028 molecule/sec

Have students answer the following question on the student activity sheet.

- Q5. Analyze the data in the chart. Describe the pattern illustrated by the data.

Answer: As the students record the data for the five different temperatures, they will see the pattern that for every 10° C increase in temperature, the reaction rate doubles. This is called a Q_{10} relationship, and commonly occurs in many other situations. For example, when Daphnia are exposed to different temperatures and heart rate is recorded, the same Q_{10} relationship is observed.

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.