



Science Objectives

- Students will identify factors that affect the rate of chemical reactions.

Vocabulary

- catalase
- enzyme
- catalyst
- oxygen gas

About the Lesson

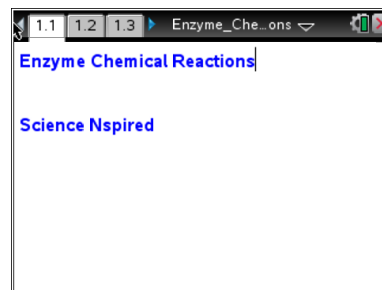
- In this activity, students will use an enzyme catalase to speed up the breakdown of hydrogen peroxide into oxygen. They will measure the pressure produced by the oxygen that is released in this reaction. Students will draw a conclusion about factors that increase or decrease the rate of this chemical reaction.
- As a result, students will:
 - Measure and graph changes in gas pressure during a chemical reaction
 - Relate the change in gas pressure to the rate of the chemical reaction
 - Draw conclusions about which variables affect the rate of reaction.

TI-Nspire™ Navigator™

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

Activity Materials

- *Enzyme_Chemical_Reactions.tns* document
- Vernier EasyLink™ or Go!® Link interface
- Gas Pressure Sensor & Syringe
- H₂O₂
- 125 mL flask and 10 mL graduated cylinder
- Enzyme suspension
- Boiled enzyme suspension



TI-Nspire Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Collect Data with Probes

Tech Tip:

Access free tutorials at <http://education.ti.com/calculator/spd/US/Online-Learning/Tutorials>

Lesson Files:

Student Activity

- Enzyme_Chemical_Reactions_Student.doc
- Enzyme_Chemical_Reactions_Student.pdf

TI-Nspire document

- Enzyme_Chemical_Reactions.tns



Teacher Preparation and Classroom Management

- Prepare an enzyme suspension: Place a 250 mL flask into a large beaker filled with ice so that the enzyme suspension remains cold. Place a funnel that has been lined with 2–3 layers of cheesecloth into the flask. Obtain a 2 cm cube of fresh liver (chicken, beef, or pork). Place the meat in a blender with 200 mL distilled water and blend on the highest setting for 10–15 seconds. Slowly pour the suspension through the cheesecloth and into the flask. Discard the cheesecloth with the residue. Cover the flask and keep it on ice until you are ready to use it. For best results, prepare fresh enzyme prior to each lab period.
- Prepare the boiled enzyme suspension: Pour 50–100 mL (depending on the amount needed) of the prepared suspension into a 125 mL flask, and place the flask into a boiling water bath for about 5 minutes.
- Students may record their answers to the questions on blank paper or answer in the .tns file using the Notes application.
- In some cases, these instructions are specific to those students using TI-Nspire handheld devices, but the activity can easily be done using TI-Nspire computer software.
- The following questions will guide student exploration during this activity:
 - How does the amount of pressure of the oxygen released relate to the chemical reaction rate?
 - Which variables affect the reaction rate?

Discussion Points and Possible Answers

Allow students to read the background information on their student worksheet.

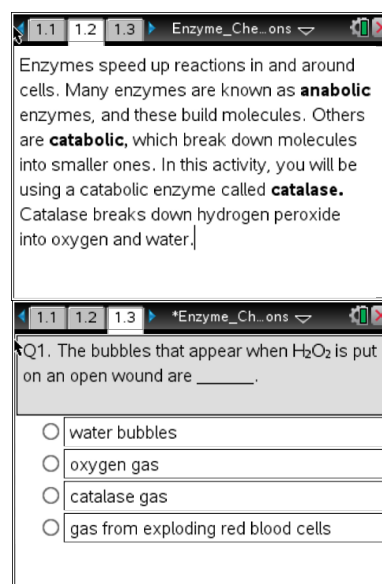
Part 1 – Preliminary Questions:

Move to page 1.2.

1. Students should open the file *Enzyme_Chemical_Reactions.tns* and read page 1.2.

Move to pages 1.3 – 1.5.

Have students answer questions 1 - 3 on the handheld, on their activity sheet, or both.





Q1. The bubbles that appear when H_2O_2 is put on an open wound are _____.

Answer: B. oxygen gas

Q2. Catalase separates hydrogen peroxide into _____.

Answer: C. water and oxygen

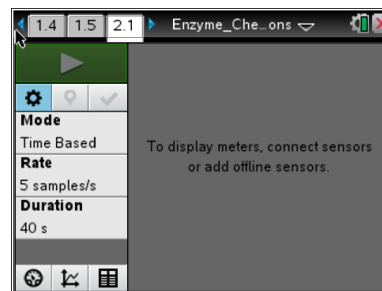
Q3. Catalase is an example of _____.

Answer: A. an enzyme

Part 2 – Reaction Rate Data Collection:

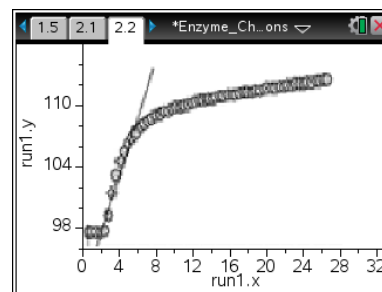
Move to page 2.1.

2. First students set up the experimental apparatus. They connect the EasyLink to the TI-Nspire and connect the Gas Pressure Sensor to the EasyLink. Students should set the TI-Nspire to collect data every 1 second for 30 seconds.
3. Secondly, they attach the tube to the sensor and the black stopper to the tube.
4. Next students use the graduated cylinder to measure 5 mL of hydrogen peroxide and pour it into the flask.
5. They draw 1 mL of the enzyme suspension into the syringe.
6. Then students click start on the TI-Nspire and immediately add the enzyme suspension to the flask. They should quickly put the stopper firmly in the mouth of the flask.



Move to page 2.2.

7. They should view the collected data in the *Data & Statistics* application on page 2.2. Use the Entry Line to set the x-axis (horizontal axis) to the variable *run1.time* and the y-axis (vertical axis) to *run1.pressure*.
8. Students next fit a line to the data using the **Moveable Line** tool (**Menu > Analyze > Add Moveable Line**). They should use only the initial “uphill” part of the graph for best analysis. Sometimes, this includes only 5–10 seconds of the graphed data.





Move to pages 3.1 – 3.2.

9. Students should observe the slope of the fitted line to determine the rate of the chemical reaction. They should record these data in the *Lists & Spreadsheet* application on page 3.2.

	condition	rate
1	Sml perox., 1ml enzyme...	2.68 kPa/Sec...
2		
3		
4		
5		
6		

TI-Nspire Navigator Opportunity

Quick Poll can be used here to ensure that students understand the relationships in this experiment. Ask students to explain the correlation between the rate of gas pressure changes and the rate of chemical reaction. Students should note that the rate of gas pressure change is directly proportional to the rate of the reaction.

Part 3 – Manipulation of Reaction Variable:

10. Students modify a variable in the investigation and then repeat steps 1–9. Remind students that the reaction flask should be rinsed out and dried between each experiment.
11. Each time they repeat the experiment, students should view the collected data on page 2.2.
12. For each set of newly collected data, students determine the rate of reaction and record it on page 3.2.

Part 4 – Analysis:

Move to pages 4.1 – 4.6.

Have students answer questions 4-9 on either the handheld, on the activity sheet, or both.

- Q4. In this activity, hydrogen peroxide was the catalyst that was used to speed up the reaction.

Answer: A. False

- Q5. When you used boiled catalase, you probably noticed a very slow reaction rate. Predict why this happened.

Answer: The catalase was denatured by the boiling.

- Q6. Which trial should have had the fastest rate of reaction? The trial using the flask that had _____.

Answer: D. catalase in warm water



Q7. What was the result of increasing the amount of catalase used?

Answer: The rate increased.

Q8. What was the result of decreasing the amount of catalase used?

Answer: The rate decreased.

Q9. As a variation of the experiment you could increase the amount of catalase but keep the amount of peroxide the same. How would the final pressure in the flask compare to that of the initial experiment (the control)?

Answer: C. It would be at the same level.

TI-Nspire Navigator Opportunity

Use the TI-Nspire Navigator System to collect, grade, and save the .tns file to the Portfolio. Use Slide Show to view student responses. See Note 1 at the end of this lesson.

Wrap Up

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

- The difference between anabolism and catabolism.
- Factors that affect the rate of chemical reactions.

Assessment

The students should collect data and can complete the embedded multiple choice questions in the *Enzyme_Chemical_Reactions.tns* file. In addition, students can answer questions on the student activity sheet.