Science Objectives

- Students will describe the difference between anabolism and catabolism.
- Students will identify factors that affect the rate of chemical reactions.

Vocabulary

- anabolic
- catabolic
- catalase
- catalyst
- denatured
- globular proteins

About the Lesson

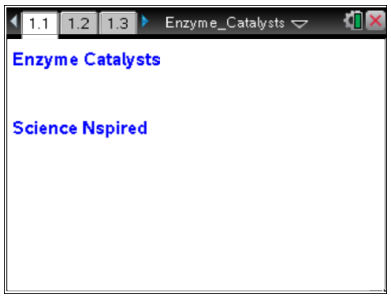
- In this activity, students will use an enzyme catalase to speed up the breakdown of hydrogen peroxide into oxygen. They will measure the pressure produced by the oxygen that is released in this reaction. Students will draw a conclusion about factors that increase or decrease the rate of this chemical 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_Catalysts.tns* file.
- Monitor student progress using Screen Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- *Enzyme_Catalysts.tns* document
- Vernier EasyLink™or Go!®Link interface
- Gas Pressure Sensor & Syringe
- H_2O_2
- 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/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:

Student Activity

Enzyme_Catalysts_Student.doc

Enzyme_Catalysts_Student.pdf

TI-Nspire document

Enzyme_Catalysts.pdf

Teacher Preparation and Classroom Management

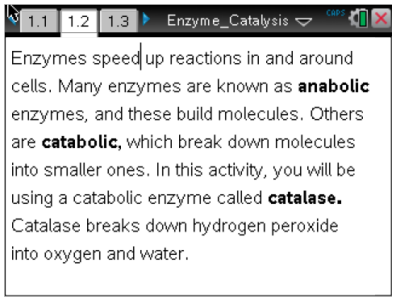
- Prepare an enzyme suspension: Place a 250 mL flask into a large beaker filled with ice so that the enzyme suspension remains cold. Place a funnel that has been lined with 2–3 layers of cheesecloth into the flask. Obtain a 2 cm cube of fresh liver (chicken, beef, or pork). Place the meat in a blender 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

Problem 1 – Prelab Questions

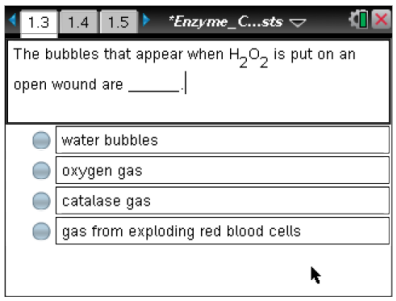
Move to page 1.2.

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



Move to pages 1.3–1.7.

Have students answer the questions on either the handheld, on the 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. Why do you think hydrogen peroxide is stored in a brown bottle?

Answer: A. Because it is photosensitive.

Q3. The following reaction would be anabolic: A + B → AB

Answer: A. True

Q4. The process of cellular respiration, which is breaking glucose into water and carbon dioxide, would be a (an) _____ reaction.

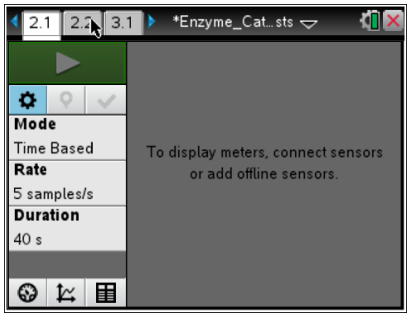
Answer: B. catabolic

Q5. Photosynthesis, which builds glucose from CO_2 and H_2O, would be a (an) _____ reaction.

Answer: A. anabolic

Problem 2 – Reaction Rate Data Collection

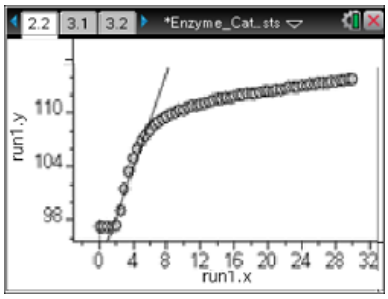
Move to page 2.1.



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.

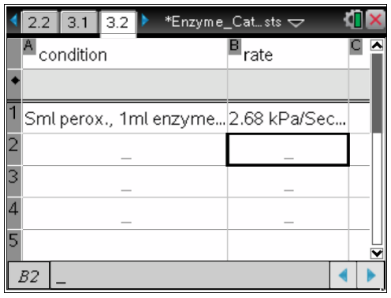
Move to page 2.2.

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 to the variable run1.time and the y-axis to run1.pressure. Students next fit a line to the data using the **Moveable Line** tool. 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 page 3.2.

8. 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.



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.

Problem 3 – Manipulation of Reaction Variable

9. Students modify a variable in the investigation and then repeat steps 1–8. Remind students that the reaction flask should be rinsed out and dried between each experiment.
10. Each time they repeat the experiment, students should view the collected data on page 2.2.
11. For each set of newly collected data, students determine the rate of reaction and record it on page 3.2.

Problem 4 – Analysis

Q6. Catalase is an enzyme; it is also a protein. What are the monomers of proteins?

Answer: A. amino acids

Q7. Since catalase is a protein, where in the cell is it probably made?

Answer: D. on ribosomes

Q8. Because catalase is a protein, where are the instructional blueprints for making catalase?

Answer: B. in the DNA in the nucleus

Q9. In this activity, hydrogen peroxide was the catalyst that was used to speed up the reaction.

Answer: A. False

Q10. 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.

Q11. Which trial should have had the fastest rate of reaction? The trial using the flask that had _____.

Answer: D. catalase in warm water

Q12. What was the result of increasing the amount of catalase used?

Answer: The rate increased.

Q13. What was the result of decreasing the amount of catalase used?

Answer: The rate decreased.

Q14. What graphical evidence was there to suggest that the rate of the reaction did not stay constant throughout the data collection?

Answer: The graph was not linear.

Q15. 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_Catalysts.tns* file. In addition, students can answer questions on the student activity sheet.