1B. ENZYME ACTION (OXYGEN SENSOR)

How does the catalyzed decomposition rate of hydrogen peroxide compare with the uncatalyzed spontaneous decomposition rate?

Objectives

- Compare the spontaneous hydrogen peroxide decomposition rate with the catalyzed rate.

Materials and Equipment

- Data collection system
- Oxygen gas sensor
- Sampling bottle, 250-mL
- Graduated cylinder, 25-mL
- Pipet, 1-mL
- 1.5% Hydrogen peroxide, H_2O_2, 40.0 mL
- Catalase suspension, 2.0 mL

Safety

Follow these important safety precautions in addition to your regular classroom procedures:

- Wear safety goggles at all times.

Procedure

1. Select Sensor Data in SPARKvue.
2. Connect the oxygen gas sensor to your device.
3. Make sure only the oxygen concentration measurement is checked and choose the Graph template.
4. Seal the empty sampling bottle with the oxygen gas sensor. Calibrate the sensor.
5. Use a graduated cylinder to measure 20.0 mL of 1.5% H_2O_2 and add it to the sampling bottle. Loosely seal the bottle with the oxygen sensor.
6. Gently swirl the bottle. Make sure the solution does not contact the sensor. Select Start to begin collecting data and record the initial oxygen (O_2) concentration for spontaneous decomposition in Table 1.
7. Continue to swirl at a medium speed while collecting data. Stop collecting data after 3 minutes. Record the final O_2 concentration and time elapsed in Table 1.
8. Pour the bottle contents into a waste container. Thoroughly rinse the sampling bottle.
9. Measure 20.0 mL of 1.5% H_2O_2 and add it to the bottle.
10. Stir the catalase suspension. Use a pipet to add 2.0 mL of catalase to the bottle. Swirl to mix.
11. Loosely seal the bottle with the oxygen sensor. Select Start to begin collecting data. Record the initial O_2 concentration for catalyzed decomposition in Table 1.
12. Gently swirl the bottle at a medium speed while collecting data. Stop collecting data after 3 minutes. Record the final O_2 concentration and time elapsed in Table 1.

13. Pour the bottle contents into a waste container. Rinse the sampling bottle.

14. Show both runs in SPARKvue and scale the display. Sketch your results in Graph 1. Include numbers, labels, and units on the x- and y-axes. Add a key to identify each run.

15. Calculate the change in oxygen concentration for each run. Use the following equation and enter the result in Table 1.

    Change in O_2 Concentration = Final O_2 Concentration - Initial O_2 Concentration

16. Calculate the rate of H_2O_2 decomposition for each run. Use the following equation and enter the result in Table 2.

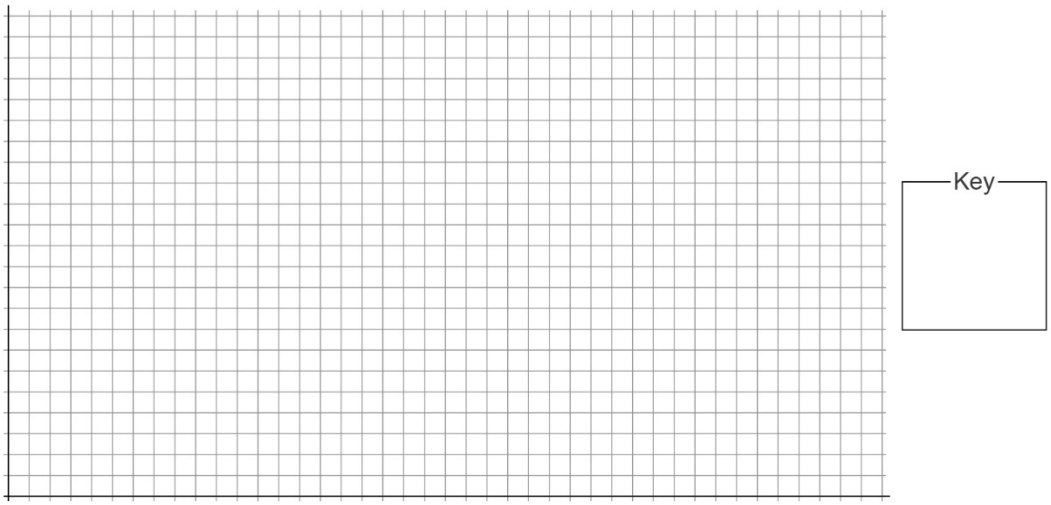
    Decomposition Rate = Change in O_2 Concentration ÷ Time

Data Collection

Table 1: Comparison of hydrogen peroxide decomposition rate with and without a catalyst

Decomposition Reaction Type	Initial O_2 Concentration (%)	Final O_2 Concentration (%)	Time Elapsed (s)	Change in O_2 Concentration (%)	Decomposition Rate (%O_2/s)
Spontaneous					
Catalyzed					

Graph 1: Oxygen production from 1.5% hydrogen peroxide with and without a catalyst



Questions and Analysis

1. Why does the oxygen concentration inside the bottle change when the yeast suspension is added?

2. How much faster is the catalyzed reaction rate compared to the spontaneous decomposition rate?

3. Explain why the reaction is so much faster when an enzyme is present.

4. Is the reaction rate constant for the entire time data is recorded? Support your answer with evidence.

5. If the reaction continued to run, do you predict the reaction rate to be constant? Explain your thinking.

6. What kinds of conditions could you test in your lab classroom that might affect the rate at which catalase breaks down hydrogen peroxide?