

## Temperature and Enzyme Activity

### Problem

Hydrogen peroxide is a poisonous waste product of reactions in living things. Catalase is an enzyme that speeds up the breakdown of hydrogen peroxide into water and oxygen gas. How does temperature affect the action of the enzyme catalase?

### Skills Focus

calculating, interpreting data, drawing conclusions

### Materials

forceps

stopwatch

test tube with a one-hole stopper

0.1% hydrogen peroxide solution

filter paper disks soaked in liver preparation (catalase enzyme) and kept at four different temperatures (room temperature, 0–4°C, 37°C, and 100°C)

container to hold water (beaker or bowl)

### Procedure



*Review the safety guidelines in Appendix A of your textbook.*

1. Write a hypothesis below that predicts how the action of the catalase enzyme is related to temperature.  

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2. Use the data table on the next page.
3. Fill a container with water. Then fill a test tube with 0.1% hydrogen peroxide solution until the test tube is overflowing. Do this over a sink or the container of water.
4. Moisten the small end of a one-hole stopper with water.
5. Using forceps, remove a filter paper disk soaked in liver preparation (catalase enzyme) that has been kept at room temperature. Stick it to the moistened end of the one-hole stopper. Your partner should be ready with the stopwatch for the next step.
6. Place the stopper firmly into the test tube, hold your thumb over the hole, and quickly invert the test tube. Start the stopwatch. Put the inverted end of the test tube into the container of water, as shown in the photograph in your textbook, and remove your thumb.

**Chemical Reactions ▪ Skills Lab**

7. If the hydrogen peroxide breaks down, oxygen will be produced. Oxygen bubbles will cling to the disk and cause it to float. Record the time it takes for the disk to rise to the top in the data table below. If the disk does not rise within 30 seconds, record “no reaction” and go on to Step 8.
8. Rinse the test tube and repeat the procedure with catalase enzyme disks kept at 0°C, 37°C, and 100°C. **CAUTION:** *When you remove the disk kept in the hot water bath, do not use your bare hands. Avoid spilling the hot water.*

**Data Table**

| Temperature (°C) | Time (s) | Average Time for Class (s) |
|------------------|----------|----------------------------|
|                  |          |                            |
|                  |          |                            |
|                  |          |                            |
|                  |          |                            |

**Analyze and Conclude**

Write your answers in the spaces provided.

1. **Calculating** Calculate the average time for each temperature based on the results of the entire class. Enter the results in your data table.
2. **Graphing** Make a line graph of the data you collected. Label the horizontal axis (*x*-axis) “Temperature” with a scale from 0°C to 100°C. Label the vertical axis (*y*-axis) “Time” with a scale from 0 to 30 seconds. Plot the class average time for each temperature.
3. **Interpreting Data** What evidence do you have that your hypothesis from Step 1 is either supported or not supported?

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4. **Interpreting Data** How is the time it takes the disk to rise to the top of the inverted tube related to the rate of the reaction?

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**Chemical Reactions ▪ Skills Lab****Temperature and Enzyme Activity** *(continued)*

5. **Drawing Conclusions** What can you conclude about the activity of the enzyme at the various temperatures you tested? (*Hint: Enzyme activity is greater when the rate of reaction is faster.*)

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6. **Predicting** Make a prediction about how active the enzyme would be at 10°C, 60°C, and 75°C. Give reasons to support your prediction.

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7. **Communicating** A buildup of hydrogen peroxide in living things can damage cells. The normal human body temperature is 37°C. Write a paragraph relating your results to the body's temperature and its need to break down hydrogen peroxide.

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**Design an Experiment**

The activity of an enzyme also depends upon the concentration of the enzyme. Design an experiment that explores the relationship between enzyme activity and enzyme concentration. (Your teacher can give you disks soaked with different enzyme concentrations.) *Obtain your teacher's permission before carrying out your investigation.*