

Investigation

Measuring the rate of reaction of an enzyme controlled reaction

Hydrogen peroxide (H_2O_2) is a toxic substance produced by the metabolism of cells. To stop this substance building up they break it down into water and oxygen. This reaction is **catalysed** by a group of **enzymes** called **peroxidases**. The reaction is **exothermic**, it releases heat energy.

Materials

TI Graphing Calculator with DataMate program installed	50cm ³ of 8% yeast suspension
Lab Pro or CBL2 interface	20 volume H_2O_2
Temperature probe	10cm ³ syringe or graduated pipette with pump
Large test tube in a stand	5cm ³ syringe or graduated pipette with pump
safety glasses	25 cm ³ measuring cylinder
	paper towel

Starting the DataMate Program and setting up

1. Use the following steps to start the DataMate program on your calculator:

TI—73, TI—82, and TI—83 Calculators:

Press **PRGM** then press the calculator key for the number that precedes DATAMATE. Press **ENTER**. An introductory screen will appear, followed by the main screen.

TI-83 Plus Calculators:



Press **APPS**, then press the calculator key for the number that precedes DATAMATE. Press **ENTER**. An introductory screen will appear, followed by the main screen.

2. Plug the Temperature Probe into channel **CH 1** on the CBL2 interface.
3. Check that you are getting a reading at about room temperature. If you get -999.9°C you know something is wrong! You will need to specify the probe. Press **CLEAR** to reset the program. Then reboot DataMate.

WARNING *Hydrogen peroxide is corrosive, avoid contact with the skin and the eyes and wear safety glasses. Wash off any spills with plenty of water.*



4. Measure 10cm³ H_2O_2 into a large test tube. Slide the temperature probe into to the H_2O_2 and let it come to the temperature of the liquid (let the probe equilibrate). What would happen if you did not do this? How do you know if the probe has equilibrated? How long did this take?

Setting your recording times

1. Start the DataMate program. DataMate should detect the auto-ID sensor, set the data collection parameters, and display the current sensor reading.
2. Press **1: SETUP** and using the cursor buttons,  or  (be patient it's a bit sluggish!) select **MODE** press **ENTER**.
3. Select **2: TIME GRAPH** and the screen **TIME GRAPH SETTINGS** will appear.
4. The default settings are 180 samples every 1s experiment will collect temperature readings for 3 minutes. To change this select **2: CHANGE TIME SETTINGS**
5. Type in a time interval in seconds, press **ENTER**, then the number of samples press **ENTER**. The experimental length in seconds is then given this should be about 5 minutes (300s) for a trial run.

6. Press **1**: **OK** then and again press **1**: **OK** to return to the main screen.

Collecting data

1. Select **2**: **START** to begin data collection, a double “beep!” from the interface will confirm you are recording. You may stop data collection at any time by pressing the **STO→** key
2. A live graph will appear on the calculator screen. Wait about 15 seconds and add 2cm³ yeast suspension and stir it in.
3. After the data collection is complete the interface will “beep!” again and an autoscaled graph of the data will appear.
4. A cursor will appear flashing on the y-axis. Use the cursor keys  or  to examine the data points along the displayed curve of temperature vs. time. As you move the cursor right or left, the time (X) and temperature (Y) values of each data point are displayed below the graph. Move the cursor to the point when the salt was added to the ice. Record that time. Move the cursor to find the highest temperature and record that time. How long did it take for the yeast to raise the temperature of the test tube to this point?
5. To return to the main screen press **ENTER**.

Recording data

1. To save the data use the **5**: **TOOLS** option, then **1**: **STORE LATEST RUN**.
2. To see the stored data select **6**: **QUIT** and press the **STAT** key. Select **1**: **Edit** your data should appear in **L1** (time) and **L2** (temperature). You may now shut down the calculator and transfer the data to a computer for further processing in a program such as MS Excel or Star Calc using the TI Graph Link. Alternatively you may store and archive your data under another name for later analysis.

Further points to consider

- Write out a **balanced equation** for this reaction. **Note:** catalysts such as enzymes are not consumed by the reactions they influence, they simply make them easier to react.
- How could you confirm that the enzyme has not been used up by the reaction?
- Which is the **most appropriate recording method** and why?
- What would you use as a **control** for these experiments?
- From the graph it should be possible to calculate the approximate **rate of reaction** in as rise in temperature per unit time or °C min⁻¹
- Repeated the experiment with **different concentrations** of hydrogen peroxide? (Store and archive your data first)
- What **sources of error** are there in this experiment (list at least three)?
- What would you do to improve the **reliability and accuracy** of this investigation?