Glycolysis (temperature measurement) with Cobra4

(Item No.: P4110560)

Curricular Relevance

Area of Expertise: Biology

Education Level: University

Topic: Biochemistry

Subtopic: Biochemistry

Experiment: Glycolysis (temperature measurement) with Cobra4

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	30 Minutes	2 Students

Additional Requirements:

- Fresh baker's yest, cube
- Refined sugar
- Android tablet or iPad
- PHYWE measure App

Experiment Variations:

- with Computer with USB port, Windows

Keywords:

Glycolysis, Yeast fermentation of sugar, Temperature measurement, Respiration energy

Information for teachers

Principle

Investigation of the temperature increase during the fermentation of sugar by yeast cells.

Fig.1: Experimental setup

Equipment

Experiment with Cobra4 Wireless/USB-Link with android tablet or iPad

Position No.	Material	Order No.	Quantity
2	Cobra4 Sensor-Unit 2 x Temperature, NiCr-Ni	12641-00	1
3	Immersion probe NiCr-Ni, steel, -50...400 °C	13615-03	2
4	Compact Balance, OHAUS TA 302, 300 g / 0.01 g	49241-93	1
5	Thermos flask	64841-00	2
6	Rubber stopper,d=41/34mm, 2 holes	39261-02	2
7	Beaker, low, BORO 3.3, 1000 ml	46057-00	1
8	Cobra4 Wireless/USB-Link incl. USB cable	12601-10	1
9	USB charger for Cobra4 Mobile-Link 2 and Wireless/USB-Link	07932-99	1
Additional material:			
	Android tablet or iPad		
	PHYWE measure App		
	Fresh baker's yest, cube		
	Refined sugar		

Android iPad

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Experiment with Cobra4 Wireless/USB-Link and PC

Position No.	Material	Order No.	Quantity
1	curricuLAB measureLAB	14580-61	1
2	Cobra4 Sensor-Unit 2 x Temperature, NiCr-Ni	12641-00	1
3	Immersion probe NiCr-Ni, steel, -50...400 °C	13615-03	2
4	Compact Balance, OHAUS TA 302, 300 g / 0.01 g	49241-93	1
5	Thermos flask	64841-00	2
6	Rubber stopper,d=41/34mm, 2 holes	39261-02	2
7	Beaker, low, BORO 3.3, 1000 ml	46057-00	1
8	Cobra4 Wireless/USB-Link incl. USB cable	12601-10	1
9	USB charger for Cobra4 Mobile-Link 2 and Wireless/USB-Link	07932-99	1
Additional material:			
	Computer with USB port, Windows		
	Fresh baker's yest, cube		
	Refined sugar		

Task

- Investigate the temperature increase during the fermentation of sugar by yeast cells.

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Overview

Task

- Investigate the temperature increase during the fermentation of sugar by yeast cells.

Fig. 1. Experimental set-up

Equipment

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9	USB charger for Cobra4 Mobile-Link 2 and Wireless/USB-Link	07932-99	1
Additional material:			
	Android tablet or iPad		
	PHYWE measure App		
	Fresh baker's yest, cube		
	Refined sugar		

Android iPad

Set-up and procedure

Set-up

- Set up the equipment as shown in Fig. 1.
- Connect the Cobra4 Sensor-Unit "Temperature" with the Wireless/USB-link.
  Connect both temperature probes to the Sensor-Unit "Temperature".
  Immersion probe
- Provide the thermos flasks.
- Switch Cobra4 Wireless/USB-link on ( ).
  Connect your tablet via WiFi with the Cobra4 Wireless/USB-Link (maximum range 50m).
  Open the PHYWE measure App and select the sensor "Temperature".

Fig. 2: Selecting the sensor Temperature

- The temperature will be measured (T1 and T2).

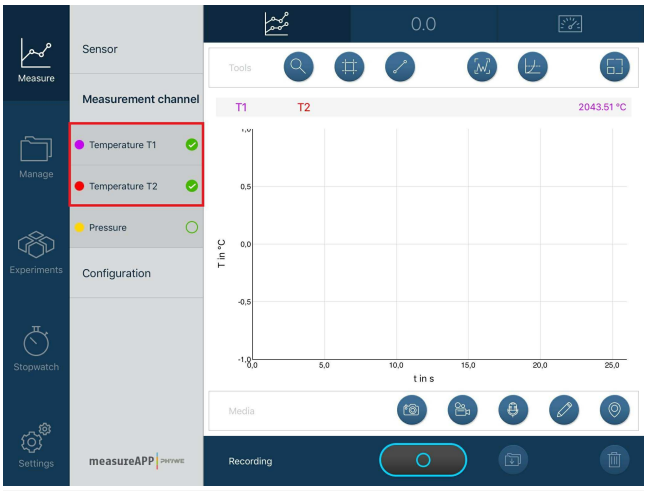

Fig. 3: Measurement of the temperature

Procedure

- If the two immersion probes do not show the same temperature values, then they must be calibrated:
  - go to "Configuration" (fig. 4)
  - then go to (scroll down if necessary) "Calibration" (fig. 4)
  - Click on the value (fig. 5)

  You can alternatively set each of them to zero / tare them ("Set to zero").

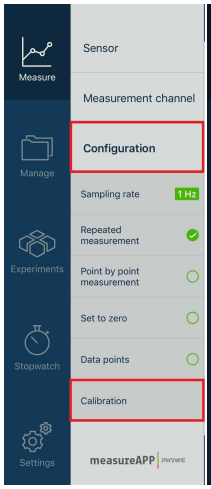

Fig. 4

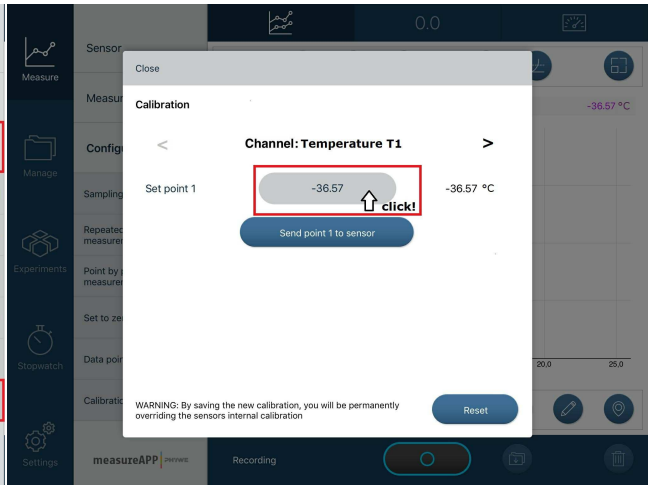

Fig. 5

- Follow the numbers in figure 6 by clicking on the appropriate buttons in measure APP. Enter the right value with digits under number 2.

  Repeat the procedure for the second probe (T2).

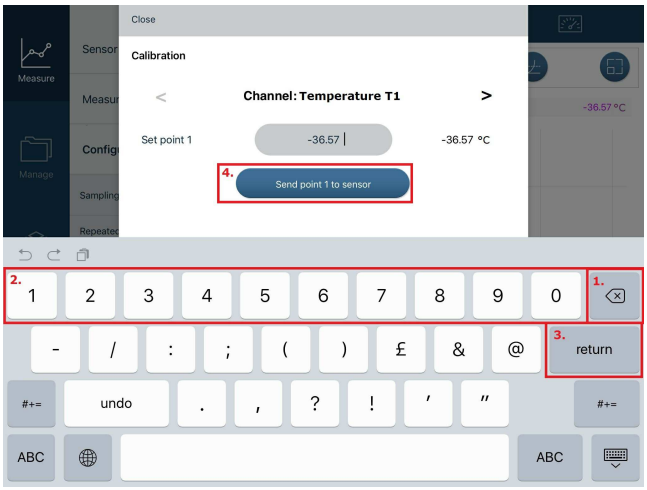

Fig. 6

- Use 40 °C hot water to prepare an approx. 10% sugar solution in the 1000 ml beaker.
- Fill equal amounts of the sugar solution into the Dewar vessels. Add 25 grams of yeast, in small pieces, to one of the Dewar vessels. Dissolve the yeast with a swirling motion of a glass rod while it is being adding.
- Fit the rubber stoppers on and ease the temperature probes through the boreholes (Fig. 1).
- Start measured value recording  (runtime about 60 minutes; Stop: ).

Theory and evaluation

Results

- The sugar solution had the same temperature as it was filled into the two Dewar flasks. The sugar solution containing yeast was slightly cooler at the start of measurement though, because the yeast was taken from the refrigerator and so had a cooling effect on it (Fig. 7). During the course of measurement the sugar solution without yeast cools but the yeast suspension gets warmer because of the exothermic course of the reaction.

Fig. 7: Typical course of measurement

- If measurement is carried out for a long time, it can be seen that it takes several hours before the temperature of the yeast suspension starts to decrease.

Notes

- The yeast cells do not completely utilize the energy generated by respiration. A part of it is lost as heat. The temperature only starts to slowly drop after several hours, the time needed for the sugar solution to be completely fermented. The temperature drops right from the start in the blank Dewar flask.
- This experiment enables a discussion to be carried out on metabolic processes and phenomena such as glycolysis, fermentation, aerobic vs. anaerobic respiration, the Pasteur effect.

Fig. 8: Froth formation during CO2 production

Overview

Task

- Investigate the temperature increase during the fermentation of sugar by yeast cells.

Fig. 1. Experimental set-up

Equipment

Position No.	Material	Order No.	Quantity
1	curricuLAB measureLAB	14580-61	1
2	Cobra4 Sensor-Unit 2 x Temperature, NiCr-Ni	12641-00	1
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7	Beaker, low, BORO 3.3, 1000 ml	46057-00	1
8	Cobra4 Wireless/USB-Link incl. USB cable	12601-10	1
9	USB charger for Cobra4 Mobile-Link 2 and Wireless/USB-Link	07932-99	1
Additional material:			
	Computer with USB port, Windows		
	Fresh baker's yest, cube		
	Refined sugar		

Set-up and procedure

Set-up

- Set up the equipment as shown in Fig. 1 and 2.
- Connect the Cobra4 Sensor-Unit "Temperature" with the Wireless/USB-link.
  Fasten the Cobra4 Wireless/USB-link to the support rod of the holder.

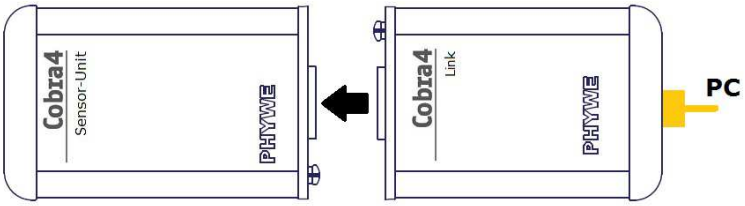


Fig. 2: Cobra4 Sensor-Unit with Cobra4 Link in USB mode

- Place the Erlenmeyer flask on the magnetic stirrer and position it below the pressure module with the aid of the universal clamp and the bosshead. Screw the glass tube into the rubber stopper with the aid of some glycerol. Then, connect the pressure module to the glass tube. Ensure that the rubber tube that is used for the connection is as short as possible.
- Switch on the Cobra4 Wireless/USB-link .
  Connect your PC with the Wireless/USB-link (via WiFi or via cable in USB-mode).
- Start the software . The Cobra4 measuring device will be automatically detected.
  Choose the experiment from the start screen by selecting `Load Experiment`. Accordingly, choose “PHYWE experiments”, search for “P4110560”, and select desired folder containing the experiment. All necessary presetting will be loaded.

Procedure

- If the two immersion probes do not show the same temperature values, then they must be calibrated (settings). Follow the numbers in figure 4 by clicking on the appropriate buttons in measureLAB. Enter the right value under 5.

  You can alternatively set each of them to zero (tare them).

  Repeat the procedure for the second probe (T2).

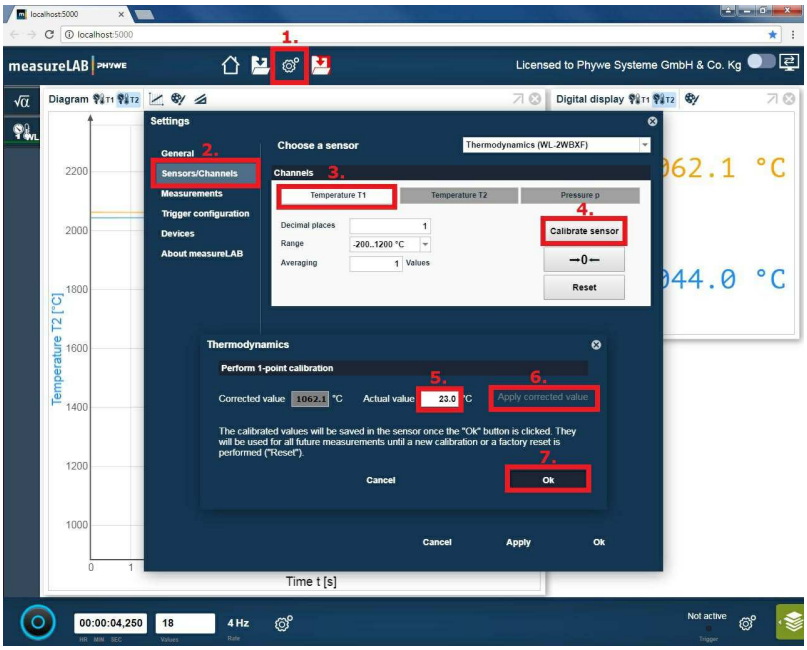


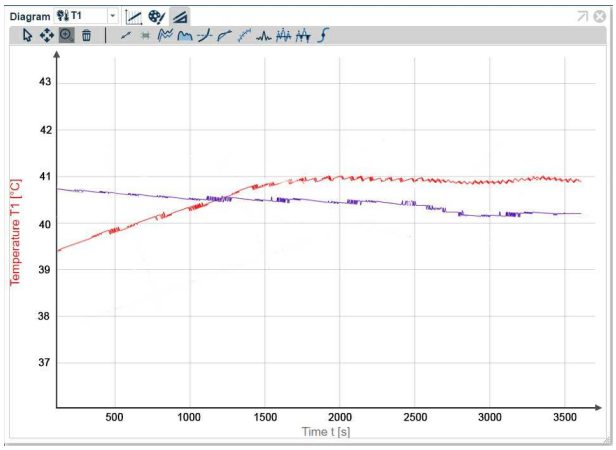
Fig. 4: Example: Steps to calibrate probe T1

- Use 40 °C hot water to prepare an approx. 10% sugar solution in the 1000 ml beaker.
- Fill equal amounts of the sugar solution into the Dewar vessels. Add 25 grams of yeast, in small pieces, to one of the Dewar vessels. Dissolve the yeast with a swirling motion of a glass rod while it is being adding.
- Fit the rubber stoppers on and ease the temperature probes through the boreholes (Fig. 1).
- Start measured value recording (runtime about 60 minutes; Stop:).

Theory and evaluation

Results

- The sugar solution had the same temperature as it was filled into the two Dewar flasks. The sugar solution containing yeast was slightly cooler at the start of measurement though, because the yeast was taken from the refrigerator and so had a cooling effect on it (Fig.5). During the course of measurement the sugar solution without yeast cools but the yeast suspension gets warmer because of the exothermic course of the reaction.



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