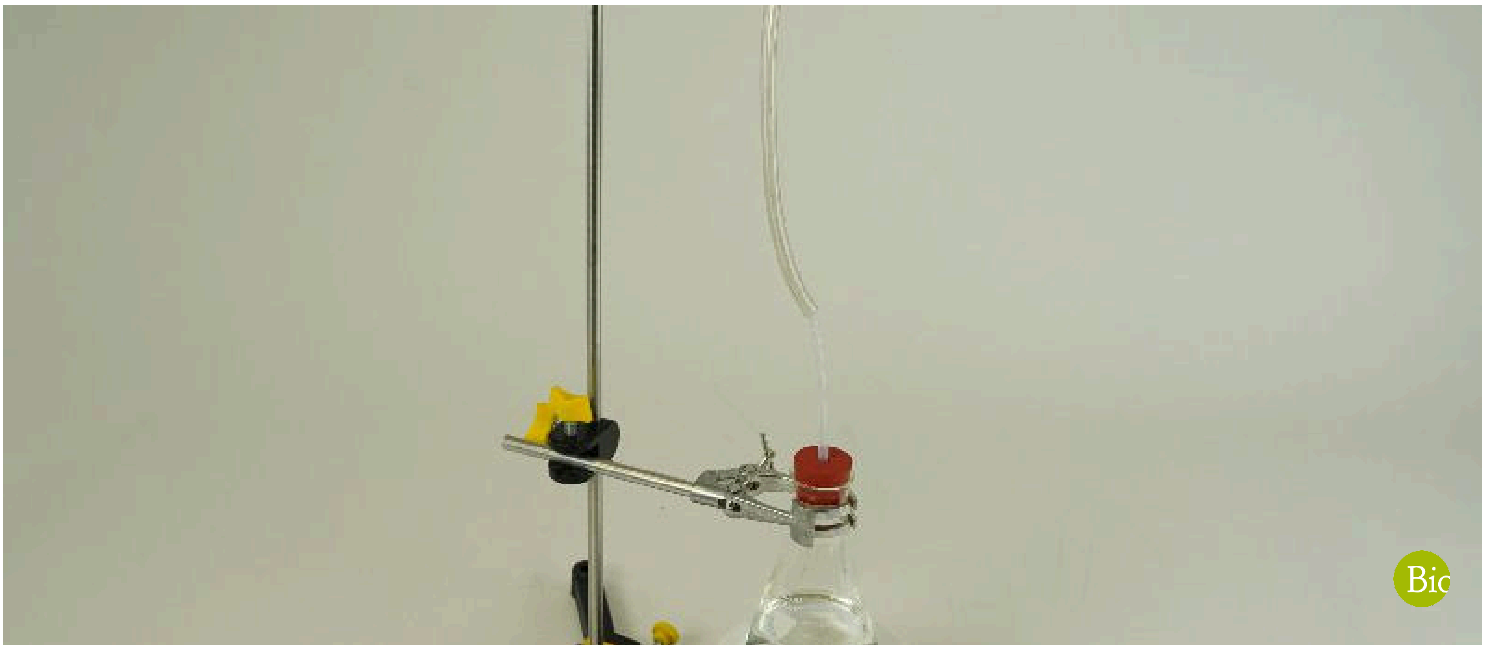
# Glycolysis (pressure measurement) with Cobra SMARTsense



| | | |
|---|---|---|
| Chemistry | Organic chemistry | Biochemistry |
| Biology | Biochemistry | |
| Applied Science | Medicine | Biochemistry |

| Difficulty level | Group size | Preparation time | Execution time |
|---|---|---|---|
| medium | 2 | 20 minutes | 30 minutes |

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# General information

## Application

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Experiment set-up

During glycolysis, i.e. the decomposition of monosaccharides to pyruvate by baker's yeast (Saccharomyces cerevisiae), respiration produces $CO_2$. In a sealed container, the production of $CO_2$ by increasing the pressure.



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## Other information (1/6)

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**Prior knowledge**

Students should be familiar with the basic principle and function of glycolysis. They should also know how and why temperature and pH changes can affect glycolysis.

**Scientific principle**

Detection of glycolysis by measuring the $CO_2$-production under different experimental conditions (temperature, pH).

## Other information (2/6)

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**Learning objective**

In this experiment, the pupils and students measure whether glycolysis is attenuated or enhanced by changes in temperature and pH value.

**Tasks**

Pupils and students are supposed to test glycolysis by measuring the $CO_2$-production (of increasing pressure) and investigate the influence of temperature and pH value on metabolic activity.



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# Other information (3/6)

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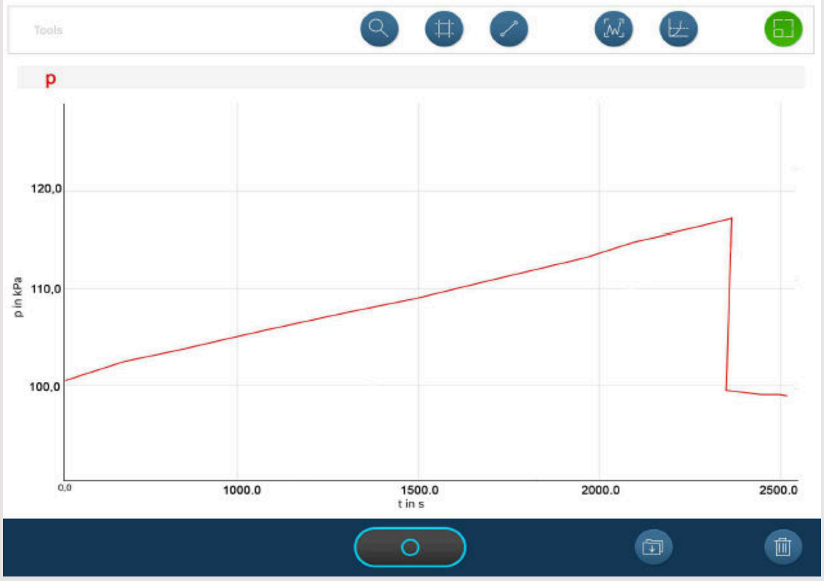
### Observations and results

**Test 1 (normal conditions):** The curve rises sharply. After about 40 minutes at a pressure of about 1150 hPa the rubber stopper was pushed out of the Erlenmeyer flask (figure right).




# Other information (4/6)

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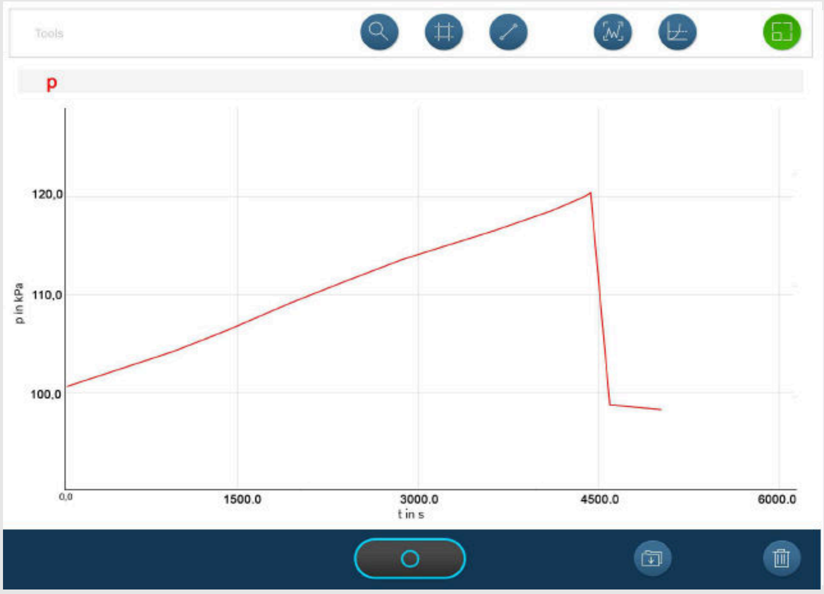
### Observations and results

**Test 2 (temperature reduced)**The pressure rises hardly at all at first, but then increases more strongly, but less strongly overall than when measured at room temperature. After about 74 min at a pressure of 1200 hPa, the rubber stopper was pushed out of the Erlenmeyer flask (right figure).



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# Other information (5/6)

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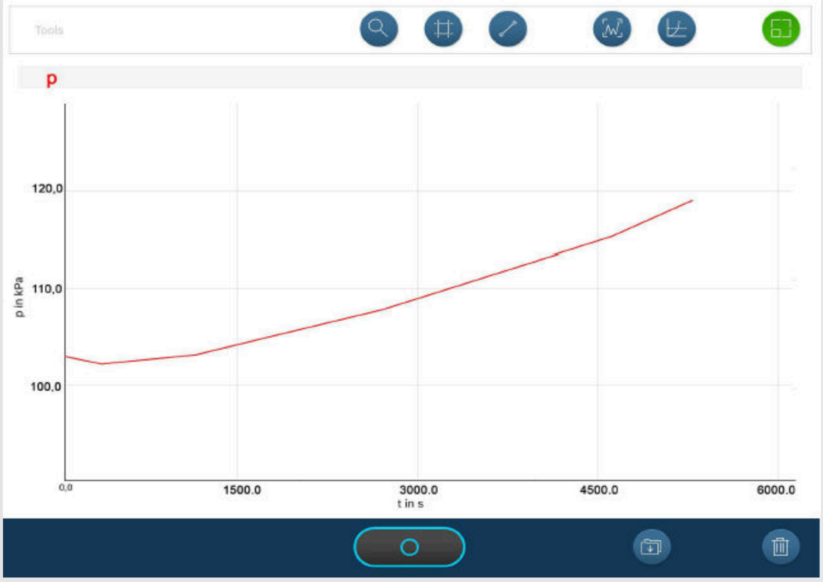
### Observations and results

**Test 3 (temperature increased)**: The curve first falls, then recovers after about 17 minutes and then rises more and more steeply (right figure).




# Other information (6/6)

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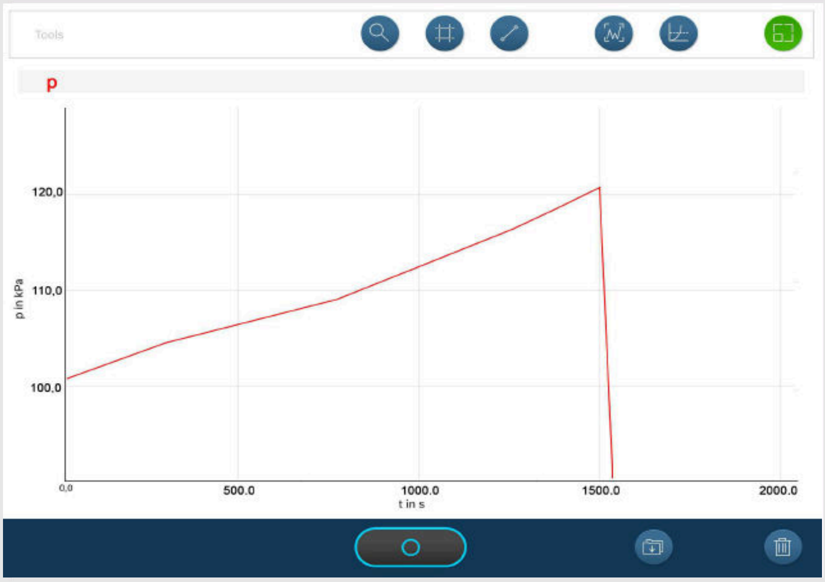
### Observations and results

**Test 4 (pH value of the nutrient medium reduced)**The curve rises steeply until after about 25 minutes at a pressure of about 1250 hPa the rubber stopper is pushed out of the Erlenmeyer flask (figure on the right).



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## Safety instructions

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- The general instructions for safe experimentation in science teaching apply to this experiment.
- For the H and P phrases, please refer to the corresponding safety data sheets.

## Theory

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In glycolysis, i.e. the breakdown of simple sugars (monosaccharides) to pyruvate by baker's yeast (*Saccharomyces cerevisiae*), respiration generates not only energy but also $CO_2$. In a sealed container, the production of $CO_2$ by increasing the pressure.

The activity of baker's yeast (*Saccharomyces cerevisiae*) can be influenced by various factors. For example, a change in temperature or pH value can have a considerable effect on the speed of the yeast metabolism.



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# Equipment

| Position | Material | Item No. | Quantity |
|---|---|---|---|
| 1 | Cobra SMARTsense - Absolute Pressure, 20 ... 400 kPa (Bluetooth + USB) | 12905-01 | 1 |
| 2 | USB charger for Cobra SMARTsense and Cobra4 | 07938-99 | 1 |
| 3 | Support base, variable | 02001-00 | 1 |
| 4 | Boss head | 02043-00 | 2 |
| 5 | Universal clamp with joint | 37716-00 | 1 |
| 6 | Magnetic stirrer with heating, stainless steel, digital, 280 °C, 100-1500 rpm | FHO-RSM10HS | 1 |
| 7 | Pt1000 for magnetic stirrer RSM-10HS/HP/A | FHO-RSME320 | 1 |
| 8 | Magnetic stirring bar, 50 mm, cylindrical | 46299-03 | 1 |
| 9 | Erlenmeyer flask, stopper bed, 250 mlSB 29 | MAU-EK17082306 | 1 |
| 10 | Beaker, Borosilicate, low form, 1000 ml | 46057-00 | 1 |
| 11 | Beaker, Borosilicate, tall form, 250 ml | 46027-00 | 2 |
| 12 | Graduated pipette 10 ml | 36600-00 | 1 |
| 13 | Rubber stopper 26/32, 1 hole 7 mm | 39258-01 | 1 |
| 14 | Glass tube, straight, l=80 mm, 10/pkg. | 36701-65 | 1 |
| 15 | Rubber tubing, i.d. 6 mm | 39282-00 | 1 |
| 16 | Glass rod, boro 3.3, l=200mm, d=6mm | 40485-04 | 1 |
| 17 | Universal clamp | 37715-01 | 1 |
| 18 | Buffer solution tablets pH4, 100 | 30281-10 | 1 |
| 19 | Buffer solution tablets pH10, 100 | 30283-10 | 1 |
| 20 | Glycerol 99% 100 ml | 30084-10 | 1 |
| 21 | Dropping bottle,plastic,50ml | 33920-00 | 1 |
| 22 | Compact Balance, OHAUS TA 302, 300 g / 0.01 g | 49241-93 | 1 |
| 23 | measureAPP - the free measurement software for all devices and operating systems | 14581-61 | 1 |



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## Additional equipment

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| Position | Art. No. | Designation |
|---|---|---|
| 1 | | mobile device (Smartphone / Tablet) or PC with Windows 10 |
| 2 | 14581-61 | measureAPP |
| 3 | | Grape juice |
| 4 | | fresh baker's yeast (*Saccharomyces cerevisiae*) |
| 5 | | Ice cube |

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# Setup and procedure



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## Set-up (1/3)

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To measure the pressure the Cobra SMARTsense absolute pressure sensor and the measureAPP is required. Check that "Bluetooth" is enabled on your device (Tablet, Smartphone, PC with Windows 10) (the app can be downloaded for free from the App Store - QR codes below). Now open measureAPP on your device.

measureAPP for

Android operating systems

measureAPP for

iOS operating systems

measureAPP for

Tablets and PCs with Windows 10

## Set-up (2/3)

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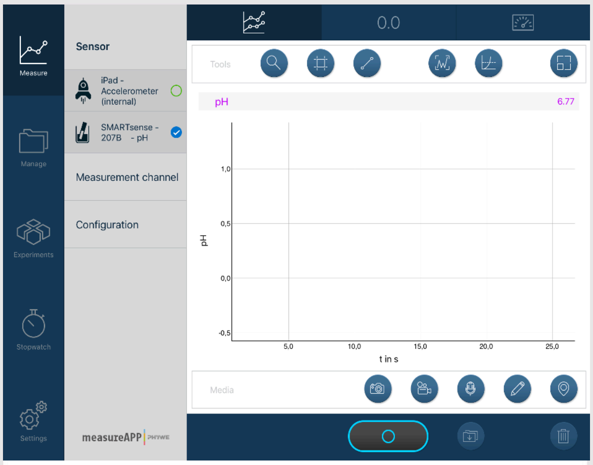


measureApp user interface

- Turn on the SMARTsense Absolute Pressure Sensor by pressing and holding the power button.
- Connect the sensor in the measureAPP under the point "Measure" to the device as shown in the figure on the left.
- The SMARTSense Absolute Pressure sensor is now displayed in the app.



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## Set-up (3/3)

- Set up the devices as shown in the figure on the right.
- Place the Erlenmeyer flask on the magnetic stirrer and lock it with the universal clamp and the double sleeve below the pressure module. Screw the glass tube with a little glycerine into the rubber stopper. Then connect the pressure module with the glass tube using the shortest possible piece of tubing.

## Procedure (1/3)

**Test 1**

- Heat 150 ml grape juice to 30-35°C.
- Weigh 10 g baker's yeast, pour into a 250 ml beaker, fill up to 100 ml with warm tap water and mix with the glass rod.
- Place the heated fruit juice, 10 ml of the yeast suspension and the stirring rod in the 250 ml Erlenmeyer flask.
- Close the Erlenmeyer flask with the rubber stopper, place it on a magnetic stirrer and fix it with the universal clamp. Set small stirring step and connect to pressure module.
- Start the measurement and continue measuring until usable measured values are obtained for comparison with the other partial tests.



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# Procedure (2/3)

**Test 2**

- Fill 1000 ml beaker halfway with tap water. Place the Erlenmeyer flask in the beaker and add some ice cubes. Seal the Erlenmeyer flask with the stopper and start the measurement. Measure until the results are usable for comparison with the other partial tests.

**Test 3**

- Fill 1000 ml beaker halfway with hot tap water (try different temperatures, e.g. 50/70/90°C).
- Place the Erlenmeyer flask in the beaker, close it with stopper and start the measurement. Measure until you obtain usable results for comparison with the other partial tests.

# Procedure (3/3)

**Test 4**

- Add different buffer solutions (e.g. 20 ml buffer solution pH 4.01 or pH 10.01). For this purpose, add one buffer tablet to 20 ml of water.
- Seal the Erlenmeyer flask with the stopper and start the measurement. Measure until the results are usable for comparison with the other partial tests.



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# Report

## Task 1

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What role does an elevated temperature play in glycolysis by yeast?

- [ ] If the temperature is too high, the yeasts' metabolism stops, if the temperature rises above 45°C for a long time, the yeast dies.
- [ ] If the temperature is too high, the yeasts' metabolism ceases; if the temperature rises above 45°C in the long term, the metabolic activity increases exponentially.
- [ ] Temperatures which are in the optimum range of the yeast (approx. 32°C) promote the metabolic activity.

Check



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## Task 2

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What role does cold play in glycolysis by yeast?

- [ ] The influence of the cold leads to an acceleration of the metabolism of the yeasts, which is particularly noticeable in the beginning.
- [ ] The glycolysis is temperature-dependent.
- [ ] Glycolysis is independent of temperature.
- [ ] Due to the influence of the cold, the metabolism of the yeasts slows down, which is particularly noticeable at the beginning.

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## Task 3

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Select the correct statements on the influence of the pH value on the metabolic activity of the yeast.

- [ ] With an acidic buffer solution the living conditions of the yeast are no longer optimal and the metabolic activity decreases.
- [ ] Since yeasts prefer a range of pH 3.8-5.2, the addition of an acidic buffer solution results in a significant increase in metabolic activity.
- [ ] With a basic buffer solution the living conditions of the yeast are no longer optimal and the metabolic activity decreases.

Check


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| Slide | Score / Total |
| --- | --- |
| Slide 21: Increased temperature during glycolysis | 0/2 |
| Slide 22: Cold with glycolysis | 0/2 |
| Slide 23: Influence of the pH-value | 0/2 |

**Total amount** 0/6

Solutions Repeat



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