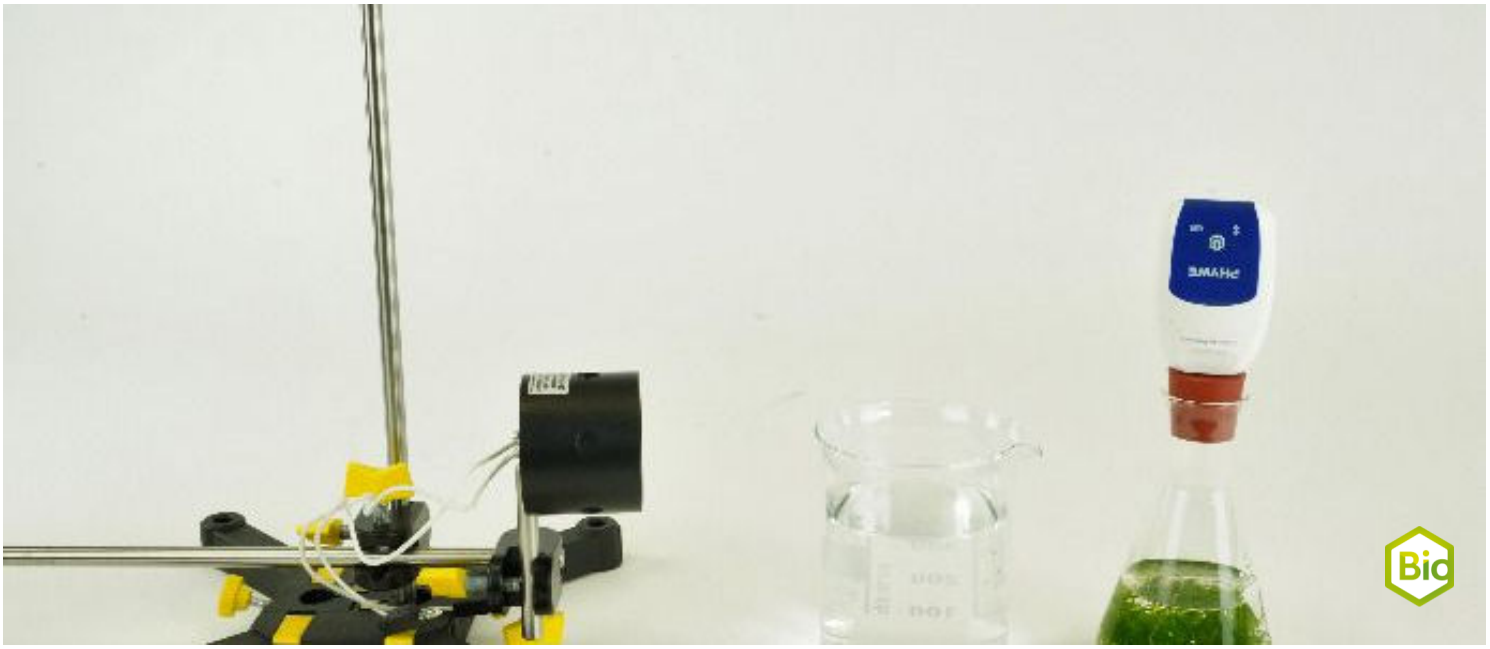
Photosynthesis (measurement of oxygen pressure) with Cobra SMARTsense



Biology | Plant Physiology / Botany | Photosynthesis

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

This content can also be found online at:

http://localhost:1337/c/61276a5b870bca000351fa69

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General information

Application

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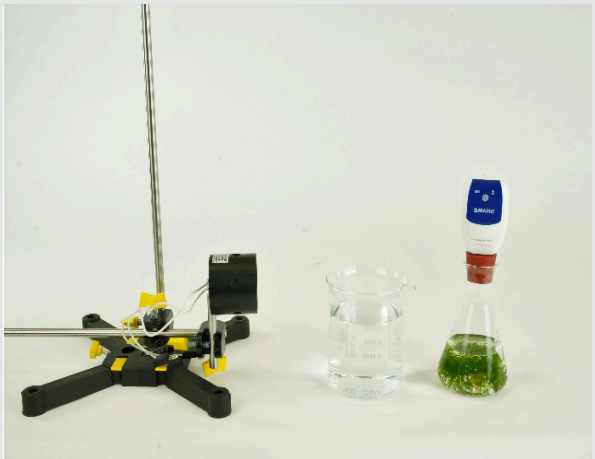

Experiment setup

This experiment indirectly measures a product of photosynthesis, oxygen. The pressure increase in a closed container is measured: due to the production of oxygen, the pressure inside the container increases when photosynthesis takes place. A quantitative measurement of the photosynthetic activity under different conditions is thus easily possible.

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Other information (1/4)

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Previous knowledge

Students should be familiar with the basic biological and chemical principle of photosynthesis.

Principle

Photosynthesis leads to the production of O_2 which in turn results in an increase in pressure. In this experiment, the photosynthetic performance of a plant is shown by measuring the increase in oxygen pressure in white and green light or in the dark.

Other teacher information (2/4)

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Learning objective

Students should recognize that as the rate of photosynthesis increases, the pressure increases due to oxygen production.

Tasks

Pupils and students are to demonstrate the photosynthetic performance in white and green light as well as in the dark. To do this, they measure the increase in pressure due to oxygen production.

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Other information (3/4)

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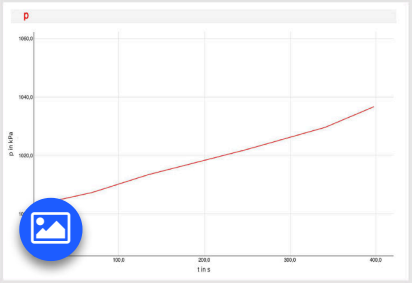
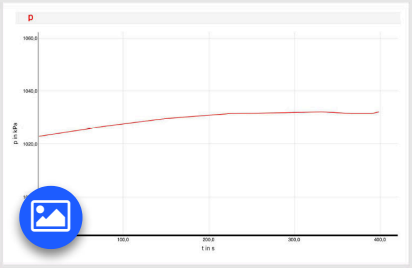
Further information on the results

- In the first experiment, a clear increase in the pressure curve due to oxygen production can be seen (Fig. top right).
- In the second experiment, the pressure curve rises less steeply (Fig. bottom right).
- On the third experiment, no increase in the pressure curve can be seen.





Other information (4/4)

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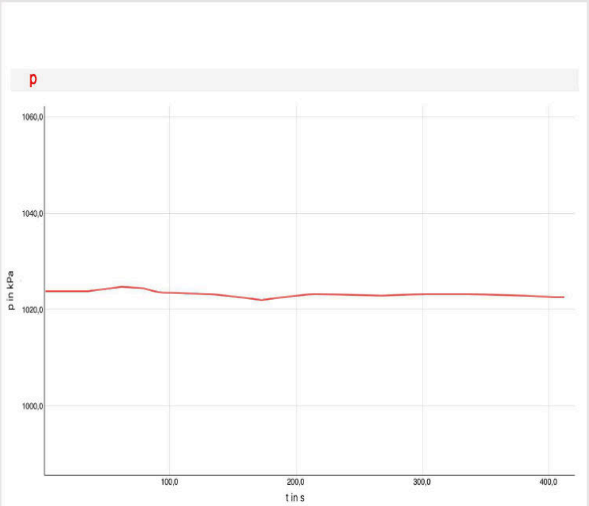
Notes

- Photosynthesis leads to the production of O_2which causes the pressure to rise. The dissolved $NaHCO_3$ serves here as CO_2-Donor.
- Due to the green solution, the red and blue-violet light required for photosynthesis is absorbed to a large extent. Therefore, only a small production of oxygen occurs, which is evidenced by the weaker increase of the pressure curve.
- In complete darkening, no photosynthesis takes place. For this reason, there is no increase in the pressure curve (Fig. right).



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Safety instructions

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- The general instructions for safe experimentation in science lessons apply to this experiment.

Theory

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Without plants that carry out photosynthesis, our life as we know it would not be possible. The air, which currently consists of approx. 78 % nitrogen, 21 % oxygen, 1 % noble gases and 0.04 % carbon dioxide, would have a completely different composition.

In photosynthesis, water, carbon dioxide and solar energy are converted by the plant into oxygen and sugar. In the process, the plant builds up biomass and releases oxygen into its environment.

Since both plants on land and plants under water carry out photosynthesis, aquatic plants are suitable objects for investigation, since oxygen production by air bubbles is visible here.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense Absolute Pressure - Sensor for measuring the absolute pressure 20 ... 400 kPa (Bluetooth + USB)	12905-01	1
2	Support base, variable	02001-00	2
3	Boss head	02043-00	2
4	Universal clamp	37715-00	1
5	Lab jack, 150 x 150 mm	02074-02	1
6	Filament lamp, 220V/120W, with reflector	06759-93	1
7	Ceramic lamp socket E27, with reflector, switch and security plug	06751-01	1
8	Beaker, Borosilicate, low form, 1000 ml	46057-00	1
9	Rubber stopper 26/32, 1 hole 7 mm	39258-01	1
10	PVC tubing, inner dia. = 7 mm, l = 1 m	03985-00	1
11	Test tube,200x30 mm, PN29	MAU-17080601	1
12	Glass tube, straight, l=80 mm, 10/pkg.	MAU-16074541	1
13	Glass rod, boro 3.3, l=200mm, d=6mm	40485-04	1
14	Spoon, special steel	33398-00	1
15	Glycerol 99% 100 ml	30084-10	1
16	Sodium hydrogen carbonate 250 g	30151-25	1
17	Patent Blue V (sodium salt), 25 g	48376-04	1
18	Tartrazine 100 g	48498-04	1
19	Portable Balance, OHAUS YA302	49213-00	1
20	measureAPP - the free measurement software for all devices and operating systems	14581-61	1
21	Dye set for coloring water	35040-10	1

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Additional material

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Position	Art. No.	Designation
1		mobile device (smartphone / tablet)
2	14581-61	measureAPP
3		Water plant (Elodea canadensis)
4		Tap water
5		Distilled water
6		Aluminium foil

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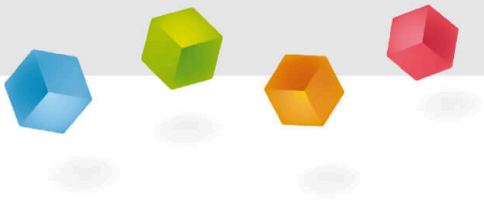

Structure and implementation

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Set-up (1/3)

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For measurement with the **Cobra SMARTsense sensors** the **PHYWE measureAPP** is required. The app can be downloaded free of charge from the relevant app store (see below for QR codes). Before starting the app, please check that on your device (smartphone, tablet, desktop PC) **Bluetooth** is **activated**.

iOS

Android

Windows

Set-up (2/3)

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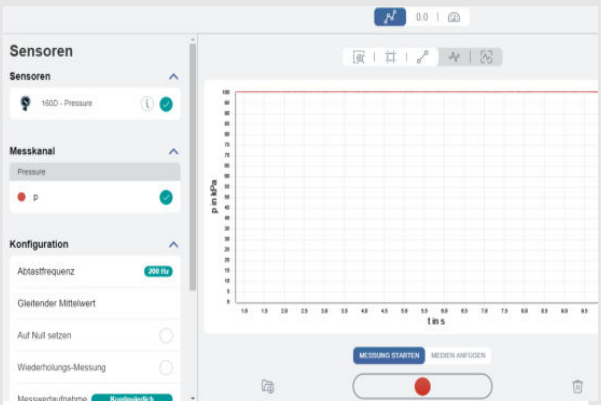

User interface measureApp

in the Windows 10 version

- Turn on the SMARTsense Absolute Pressure Sensor by pressing and holding the power button.
- Connect the sensor in the measureAPP under the item "Measure" with 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)

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- On one side, fix the lamp in one of the two support bases.
- Position the test tube below the SMARTsense Absolute Pressure Sensor using the universal clamp and bosshead. Alternatively, use an Erlenmeyer flask. Screw the glass tube with a little glycerine into the rubber stopper. Then connect the Pressure sensor unit to the glass tube or connect the sensor directly to the rubber stopper as shown in the illustration.
- Place a beaker filled with water large enough so that it can act as a heat filter between the lamp and the test tube. In any case, avoid allowing light from the lamp to fall into the test tube to prevent heating of the water.

Procedure (1/2)

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Experiment 1

- Cut off a stem of the water plant and place it in the test tube with the cut side facing upwards. Prepare 300 ml of 3% NaHCO3 solution (9 g to 300 g distilled water) and fill the test tube with it to just below the rim. The beaker filled with water should absorb the heat of the lamp.
- Close the test tube airtight with the stopper and insert the Absolute Pressure Sensor into the opening.
- When connecting the sensor, make sure that too much pressure is not generated by pressing on the sensor, as this could influence the measured values.
- Switch on the lamp and start the measurement.

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Procedure (2/2)

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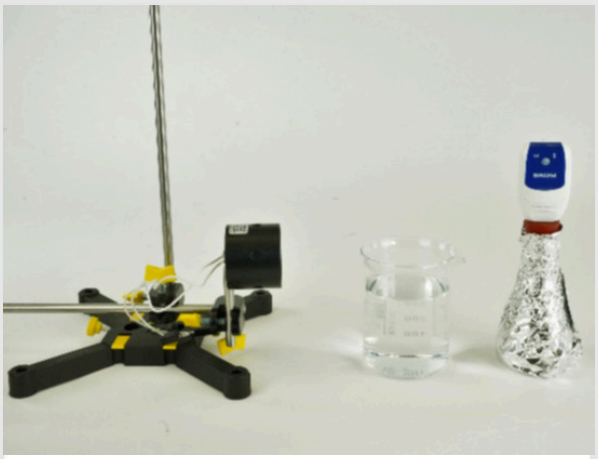
Experiment 2

- Prepare a green solution using the dyes (add one spatula tip of yellow and one spatula tip of blue dye to approximately 1 000 ml of water) and fill the beaker used as a heat filter. Before taking the measurement, remove the stopper to allow the gas produced to escape.

Experiment 3

- Wrap the test tube completely with aluminium foil so that no more light reaches the plant. Allow any gas that has formed to escape again before measuring.



For experiment 3 no light is allowed to reach the plant

Report

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Task 1

Drag the words to the correct places.

Photosynthesis results in the production of _____, which causes the pressure to rise. The green solution _____ much of the red and blue-violet light needed for photosynthesis. Therefore, only a small production of _____ occurs, as evidenced by the weaker _____ of the pressure curve.

rise

oxygen

absorbs

O2

Check

Task 2

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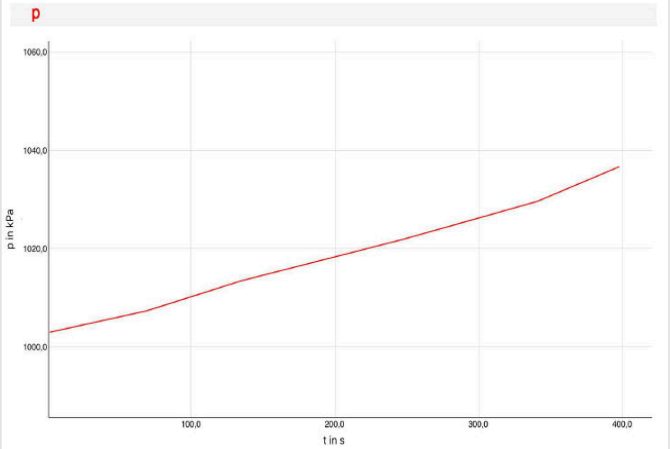
Which experimental curve is shown in the picture on the right?

The curve for experiment 3 without light.

The curve for experiment 2 with green light.

The curve for experiment 1 with white light.



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Task 3

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Choose the correct statements.

- [ ] Photosynthesis produces sugar as well as carbon dioxide.
- [ ] In complete darkening, particularly strong photosynthesis takes place. For this reason, there is a steep rise in the pressure curve.
- [ ] With complete darkening, no photosynthesis takes place. For this reason, there is no increase in the pressure curve.
- [ ] Photosynthesis produces sugar as well as oxygen.

Check

Slide	Score / Total
Slide 18: Photosynthesis	0/4
Slide 19: Test curve	0/1
Slide 20: Photosynthesis	0/2

Total 0 / 7

Solutions Repeat

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