Photosynthesis (bubble counting method) with CobraSMARTsense

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/61276a43870bca000351fa64

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General information

Application

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Experiment setup

In this experiment, the dependence of photosynthetic performance on brightness is measured by counting the oxygen bubbles secreted from an aquatic plant.

In addition, the influence of the carbon dioxide content of water on the photosynthetic rate is investigated.

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Other information (1/4)

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Prior knowledge

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

Scientific Principle

In this experiment, the dependence of photosynthetic performance on brightness is measured by counting the oxygen bubbles secreted from an aquatic plant.

Other teacher information (2/4)

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Learning objective

Students should recognize that with increased light, the photosynthetic rate of waterweed increases. They count the oxygen bubbles as part of this.

Tasks

Students will use the vesicle counting method to detect the photosynthetic activity of an aquatic plant. They will also investigate the effect of the carbon dioxide content of water on the photosynthetic rate.

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Other information (3/4)

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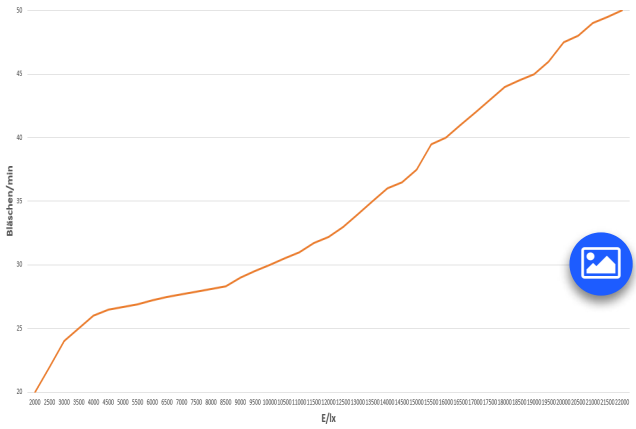
Further information on the results

After completion of the measurements, the values determined can be transferred to a spreadsheet using any program, e.g. measureLAB or Microsoft Excel, and displayed graphically and evaluated in detail.

- The photosynthetic rate measured by the oxygen released increases almost linearly with brightness, because at lower brightness light is the limiting factor in photosynthesis (Fig. right).



Graphical representation of the values after transfer to Microsoft Excel

Other information (4/4)

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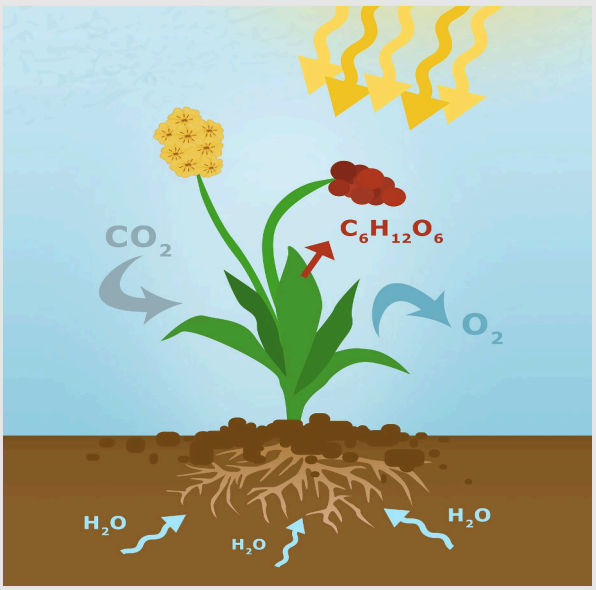
Notes

- At higher brightness levels (e.g. film light), other factors, such as the available carbon dioxide, play the limiting role. The photosynthesis rate then no longer increases linearly with brightness, but tends towards a saturation value.
- Reducing the carbon dioxide content in the water (distilled water or tap water instead of CO_2-containing mineral water), the influence on the photosynthesis rate can be demonstrated.



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Safety instructions

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- The general instructions for safe experimentation in science lessons to be applied 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 as study objects, since oxygen production is visible here through air bubbles, which can be easily counted.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense Light - Sensor for measuring the illuminance 0 ... 128 kLx (Bluetooth + USB)	12906-01	1
2	Support base, variable	02001-00	2
3	Support rod, l = 600 mm, d = 10 mm, split in 2 rods with screw threads	02035-00	1
4	Boss head	02043-00	1
5	Lab jack, 150 x 150 mm	02074-02	1
6	Filament lamp, 220V/120W, with reflector	06759-93	1
7	Beaker, Borosilicate, low form, 1000 ml	46057-00	1
8	Beaker, Borosilicate, tall form, 250 ml	46027-00	1
9	measureAPP - the free measurement software for all devices and operating systems	14581-61	1
10	Ceramic lamp socket E27, with reflector, switch and security plug	06751-01	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		Mineral water (strongly sparkling)
4		Tap water
5		Water plant (Elodea canadensis)

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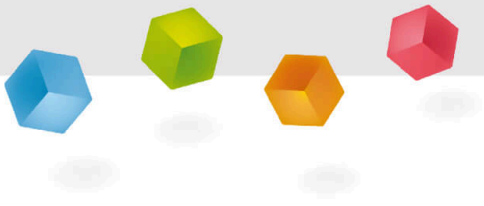

Set-up and procedure

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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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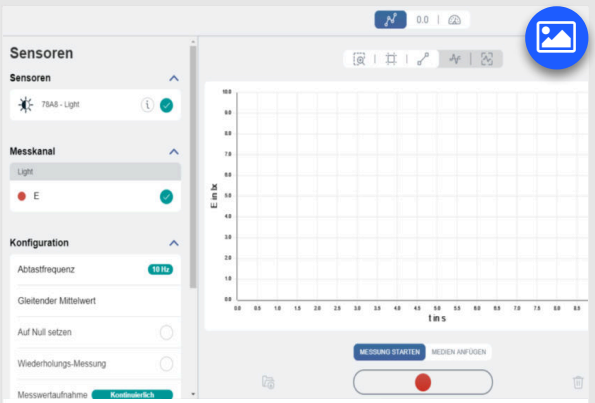

User interface measureApp

in the Windows 10 version

- Turn on the SMARTsense Light 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 Light Sensor is now displayed in the app.

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Set-up (3/3)

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- Set up the equipment as shown in the experimental setup diagram.
- On one side, fix the lamp in one of the two tripod feet.
- With the other tripod base, attach the Cobra SMARTsense Light horizontally to the tripod rod on the holder in the direction of the lamp (can be seen on the far right in the test image). The distance between the lamp and the measuring unit should be approx. 1.5 m at the beginning.
- Fill the 250 ml beaker with the water and place it on the lifting platform between the lamp and the SMARTsense Light.
- Place a 1000 ml beaker filled with water as a heat filter between the lamp and the 250 ml beaker. In any case, avoid allowing light from the lamp to fall into the water in the 250 ml beaker to prevent the water from heating up.

Procedure (1/2)

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- Cut off one stem of the water plant and place it in the 250 ml beaker with the cut side facing upwards. So that the plant does not drift upwards, it should be provided with a weight. A little creativity is required here: In the example experiment, a paper clip served as a weight, to which a small screw nut was attached.
- Initially, carbon dioxide bubbles bubble out of the stem, and the water also bubbles very strongly at the beginning (make sure that the beaker is not dirty!). The actual measurement should therefore only be started after a few minutes.
- Then count the oxygen bubbles that swell out of the end of the stem in one minute and note the values on a piece of paper for the time being. At the same time, note the brightness in lux.

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Procedure (2/2)

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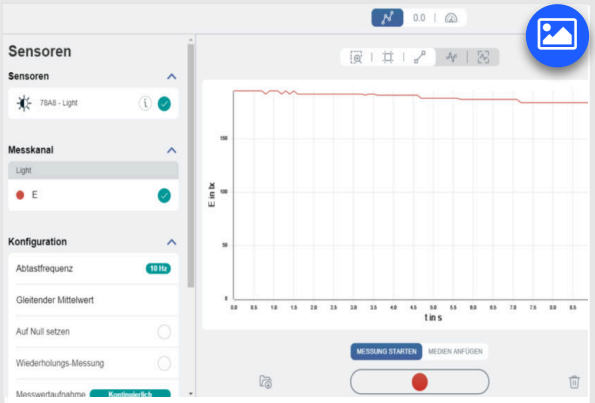
- Move the lamp approx. 10-15 cm closer to the test object and wait approx. 1 minute until the plant has adapted to the new conditions. Repeat the measurement as described above until the lamp is directly in front of the 1000 ml beaker. Please note: the measurements should be carried out as quickly as possible, as the sparkling water continuously releases CO_2 loses. If the number of bubbles drops despite higher brightness, the sparkling water should be replaced.
- After completion of the measurements, the determined values can also be graphically displayed and evaluated in a spreadsheet with any program.



Measure the light intensity, if you put the lamp closer

Report

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Task 1

Drag the words to the correct places.

Plants need _____ to perform photosynthesis. By _____ the light intensity, the rate of photosynthesis can be affected. As light intensity _____, so does the demand for _____ needed by the plant. The rising water bubbles represent _____.

- oxygen
- increases
- carbon dioxide
- changing
- light and carbon dioxide

Check

Task 2

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Which statement about photosynthesis is correct?

- In photosynthesis, the plant converts sunlight (i.e. energy), carbon dioxide and water into oxygen and sugar. The oxygen is released by the plant in the process.
- During photosynthesis, the plant stores a seen image of an optimal environment in the genes. This information later gives rise to new subspecies.
- None.
- In photosynthesis, the plant converts sunlight (i.e. energy), oxygen and water into carbon dioxide and sugar. The carbon dioxide is released by the plant in the process.

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Task 3

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Complete the equation for photosynthesis.

6 [ ] + 6 CO2 = 6 [ ] + C6H12O6

Check

Photosynthesis is carried out by plants on land and in water. Important for photosynthesis is the green pigment, i.e. chlorophyll.

○ True ○ Incorrect

Check

Slide	Score / Total
Slide 18: Photosynthesis	0/5
Slide 19: Process photosynthesis	0/1
Slide 20: Multiple tasks	0/3

Total 0 / 9

Solutions Repeat

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