Photosynthesis (measurement of oxygen pressure) with Cobra4 (Item No.: P4110260)

Curricular Relevance

Area of Expertise: Biology

Education Level: University

Topic: Plant Physiology / Botany

Subtopic: Photosynthesis

Experiment: Photosynthesis (measurement of oxygen pressure) with Cobra4

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	50 Minutes	2 Students

Additional Requirements:

- Waterweed (Elodea canadensis)
- Tap water
- Distilled water
- Aluminium foil
- Android tablet or iPad
- PHYWE measure App

Experiment Variations:

- with PC with USB port, Windows XP or higher

Keywords:

Photosynthesis, Intensity and colour of the light, Pressure measurement

Overview

Principle

Photosynthesis leads to the production of O_2, which in turn causes the pressure to rise. In this experiment the photosynthesis rate of a plant is determined by measuring the oxygen pressure increase, in white and green light as well as in the dark.

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Fig. 1: Experiment set-up

Equipment

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

Position No.	Material	Order No.	Quantity
1	Cobra4 Wireless/USB-Link incl. USB cable	12601-10	1
2	Cobra4 Sensor-Unit Pressure, 7 bar absolute	12647-00	1
3	Holder for Cobra4 with support rod	12680-00	1
4	Support base, variable	02001-00	2
5	Support rod, stainless steel, 500 mm	02032-00	1
6	Boss head	02043-00	2
7	Universal clamp	37715-00	1
8	Lab jack, 160 x 130 mm	02074-00	1
9	Filament lamp, 220V/120W, with reflector	06759-93	1
10	Ceramic lamp socket E27	06751-01	1
11	Beaker, low, BORO 3.3, 1000 ml	46057-00	1
12	Rubber stopper 26/32, 1 hole 7 mm	39258-01	1
13	Rubber tubing, i.d. 6 mm	39282-00	1
14	Test tube,200x30 mm,DURAN, PN29	36294-00	1
15	Glass tube, straight, l=80 mm, 10/pkg.	36701-65	1
16	Glass rod, boro 3.3, l=200mm, d=6mm	40485-04	1
17	Microspoon, steel	33393-00	1
18	Glycerol 99% 100 ml	30084-10	1
19	Sodium hydrogen carbonate 250 g	30151-25	1
20	Tartrazine 25 g	48498-04	1
21	Patent Blue V (sodium salt), 25 g	48376-04	1
22	Compact Balance, OHAUS TA 302, 300 g / 0.01 g	49241-93	1
23	USB charger for Cobra4 Mobile-Link 2 and Wireless/USB-Link	07932-99	1
Additional material			
	Android tablet or iPad		
	PHYWE measure App		
	Waterweed (Elodea canadensis)		
	Tap water		
	Distilled water		
	Aluminium foil		

Android iPad

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Experiment with Cobra4 Wireless/USB-Link and PC

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24	USB charger for Cobra4 Mobile-Link 2 and Wireless/USB-Link	07932-99	1
Additional material			
	PC with USB port, Windows XP or higher		
	Waterweed (Elodea canadensis)		
	Tap water		
	Distilled water		
	Aluminium foil		

Task

Determine the photosynthesis rate of a plant by measuring the oxygen pressure increase, in white and green light as well as in the dark.

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Set-up and procedure

- Set up the equipment as shown in Fig. 1.
- Use one of the two support bases to set up the lamp.
- Use the second support base to attach the Cobra4 Wireless/USB-Link with the Cobra4 Sensor-Unit Pressure.
- Position the test tube with the universal clamp and the bosshead below the Cobra4 Sensor-Unit Pressure. Screw the glass tube into the rubber stopper with the aid of some glycerol. Then, connect the Sensor-Unit Pressure to the glass tube. Ensure that the rubber tube that is used for the connection is as short as possible.
- Place a water-filled beaker which is big enough so that it can serve as a heat filter between the lamp and test tube. Avoid that light from the lamp shines onto the 250 ml beaker. Otherwise the water will be heated up.
- When using a computer: Set up a connection of the Cobra4 Wireless/USB-Link to the PC either wirelessly or with the USB cable and switch it on.
  When using a tablet: Connect the Cobra4 Wireless/USB-Link to the tablet in the wireless WiFi mode after switching it on.
- Start the software . The Cobra4 measuring device will be automatically detected.
- - Choose the sensor Pressure in the sensor list (Fig. 2).
  - It is best to choose the measurement window with the measurement graph.

Fig. 2: Selecting the Sensor-Unit Pressure in the measure APP

Experiment 1:

- Cut off one stem of the waterweeds plant and place it into the test tube with the cut facing upwards. Prepare 300 ml of a 3 % $NaHCO_3$ solution (9 g on 300 g of distilled water) and fill it into the test tube just below the rim. The water-filled beaker is to absorb the heat of the lamp.
- Seal the test tube in an airtight manner via the stopper and connect the rubber tube to the pressure module.
  Attention: Ensure that no liquid penetrates the Cobra4 Sensor-Unit Pressure!
- When connecting the rubber tube, i.e. when pressing it on, ensure not to produce too much pressure, since this would affect the measurement results. Hint: Compress the tube slightly when connecting it so that the measured pressure corresponds roughly to the atmospheric pressure. Wait for a brief period until the measurement recording system has stabilised in the "resting state".
- Switch on the lamp and start the measurement.

Experiment 2:

- Prepare a green solution with the dyes (to do so, add one tip of the spatula of the yellow and blue dye to approximately 1 000 ml of water) and fill it into the beaker which serves as a heat trap. Remove the stopper prior to the measurement in order to allow the gas, which has been produced, to escape.

Experiment 3:

- Wrap up the test tube completely in aluminium foil so that no light can reach the plant. Prior to the measurement, allow

any gas that has been produced to escape.

Observation and results

- The first experiment shows a clear rise of the pressure curve, which is due to the production of oxygen (Fig. 3).

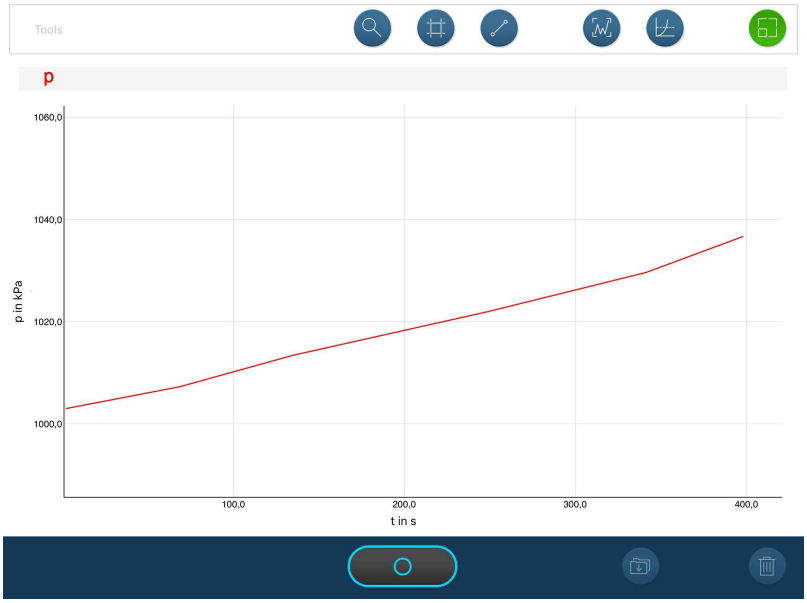

Fig. 3: Measurement result in white light

- In the second experiment, the pressure curve rises less clearly (Fig. 4).

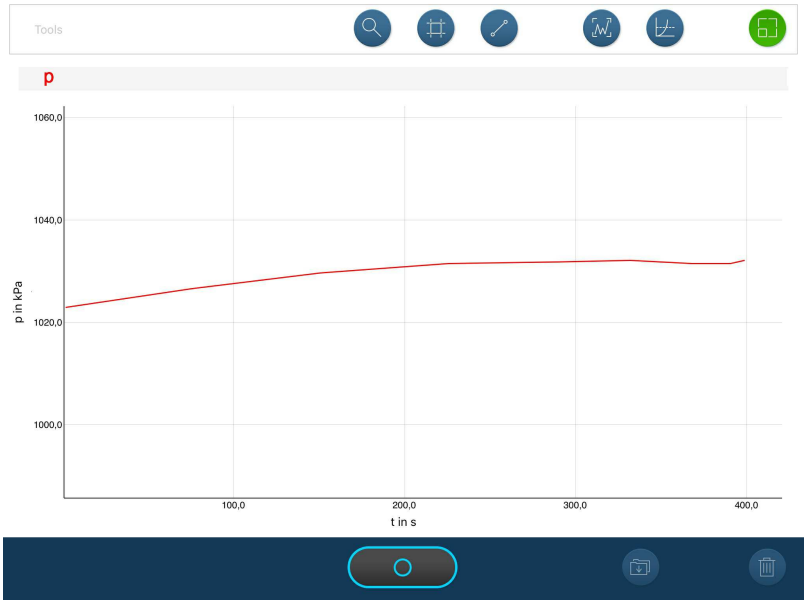

Fig. 4: Measurement result in green light

- During this experiment, the pressure curve does not rise at all (Fig. 5).

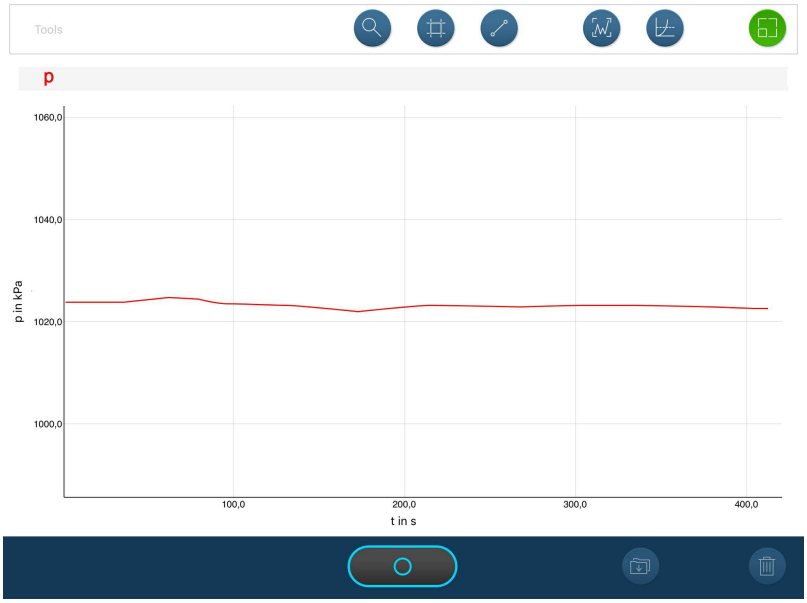

Fig. 5: Measurement result in the dark

Notes

- Photosynthesis leads to the production of O_2, which in turn causes the pressure to rise. The dissolved $NaHCO_3$ is used as the CO_2-donor.
- The green solution absorbs most of the red and blue-violet light, which is required for photosynthesis. This is why less oxygen is produced, which in turn leads to a weaker rise of the pressure curve.
- There is no photosynthesis in the dark. This is why the pressure curve does not rise at all.

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- Start the software . The Cobra4 measuring device will be automatically detected.
-
  - Switch on the Cobra4 Wireless/USB-link .
  - Connect your PC with the Cobra4 Wireless/USB-link (via WiFi or via cable in USB-mode).
  - Start PHYWE measureLAB and The sensor is detected automatically.
  - Choose the experiment from the start screen by selecting `Load Experiment' .
  - Go to “PHYWE experiments”, search for “P4110260”, and select the respective folder containing the experiment. All necessary presetting will be loaded.

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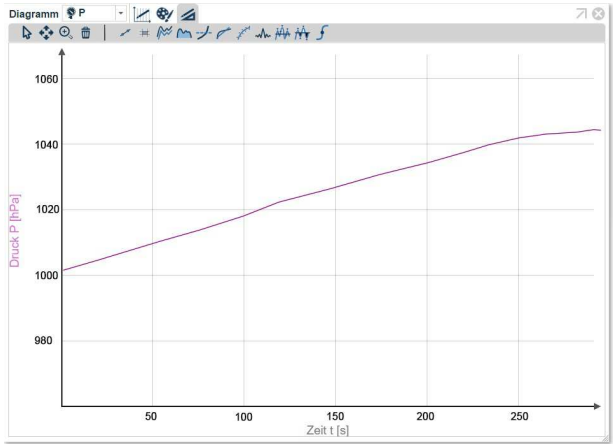

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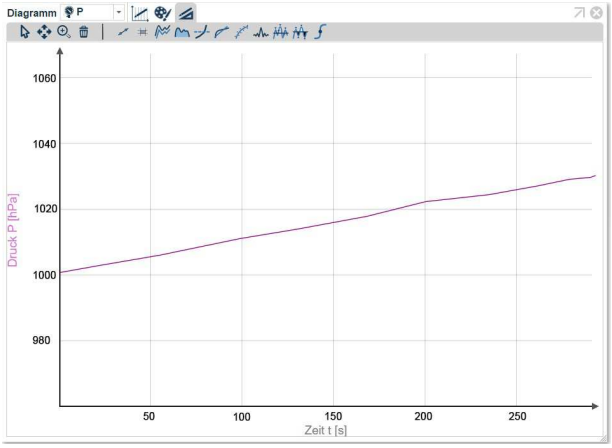

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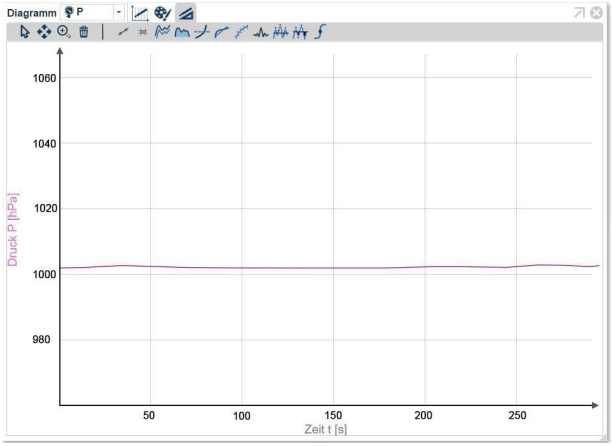

Fig. 4: Measurement result in the dark

Notes

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