Photosynthesis (Oxygen bubble counting) with Cobra SMARTsense (Item No.: P4110160)

Curricular Relevance

Area of Expertise: Biologie

Education Level: Hochschule

Topic: Pflanzenphysiologie/ Botanik

Subtopic: Fotosynthese

Experiment: Photosynthese (Blasenzählmethode) mit Cobra4

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

Additional Requirements:

- Mineral water (carbonated)
- Tap water
- Waterweed (Elodea canadensis)
- Android tablet or iPad
- PHYWE measure App

Experiment Variations:

- with Computer with USB port, Windows

Keywords:

Dependence of photosynthesis on light and carbon dioxide content, Oxygen bubble counting, Lux measurement, Rate of photosynthesis

Overview

Principle

Measurement of the photosynthesis rate as a function of light intensity by counting the oxygen bubbles that are released by a water plant.

Fig. 1: Experiment set-up

Equipment

Position No.	Material	Order No.	Quantity
1	Cobra SMARTsense - Light, 1 ... 128 kLX	12906-00	1
4	Support base, variable	02001-00	2
5	Support rod, stainless steel, l = 250 mm, d = 10 mm	02031-00	1
6	Boss head	02043-00	1
7	Lab jack, 160 x 130 mm	02074-00	1
8	Filament lamp, 220V/120W, with reflector	06759-93	1
9	Ceramic lamp socket E27	06751-01	1
10	Beaker, low, BORO 3.3, 1000 ml	46057-00	1
11	Beaker, high, BORO 3.3, 250 ml	46027-00	1
Additional material:			
	Android tablet or iPad		
	PHYWE measure App		
	Mineral water (carbonated)		
	Tap water		
	Waterweed (Elodea canadensis)		

Android iPad

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Tasks

1. To measure the dependence of photosynthesis on light by counting the oxygen bubbles given off by an aquatic plant.
2. To investigate the influence of the carbon dioxide content of the water on the rate of photosynthesis.

Set-up and procedure

Set-up

- 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 Cobra SMARTsense "Light" horizontally, facing the lamp. The distance between the lamp and mesurement device should be approximately 1.5 m.
- Fill the 250 ml beaker with the mineral water and place it on the lab jack between the lamp and the Cobra4 Weather module.
- Place a water-filled 1000 ml beaker as a heat filter between the lamp and the 250 ml beaker. Avoid that light from the lamp shines onto the 250 ml beaker. Otherwise the water will be heated up.
- Switch on the Cobra SMARTsense "Light" by pressing the power button.
- Start the PHYWE measureAPP and ensure that Bluetooth is activated on your device.
- Choose the sensor "Light" in the sensor list and for the measurement channel.

Fig. 3: Selecting the Sensor-Unit Weather in the measure APP

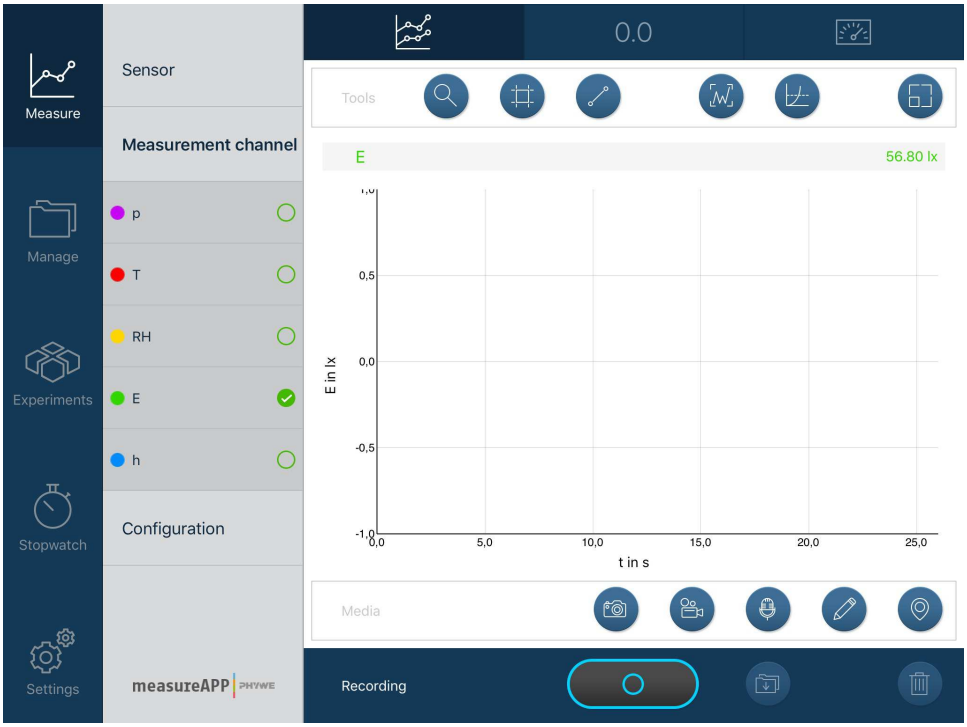

Fig. 4: Selecting the measurement channel Brightness E in the measure APP. The other parameters are not required.

Procedure

- Cut off one stem of the waterweeds plant and place it into the 250 ml beaker with the cut facing upwards. Attach a weight to the plant in order to prevent it from floating. This requires a certain degree of creativity. During the example experiment, a paper clip that had a small bolt nut attached was used as the weight.
- At first, the carbon dioxide bubbles up and out of the stem and the water itself also bubbles strongly (ensure that the beaker is not contaminated!).
  This is why the actual measurement should not be started until a few minutes later.
- Then, for one minute, count the oxygen bubbles that are released at the end of the stem and note the values on a piece of paper. Furthermore, also note the light intensity values in lux (Fig. 3).
- Push the lamp approximately 10 to 15 cm closer to the object and wait approximately one minute until the plant has adapted to this new condition. Repeat the measurement, which is described above, until the lamp is located directly in front of the 1000 ml beaker. Please note: The measurements
  should be performed as quickly as possible, since the mineral water is continuously losing CO_2.
  If the number of bubbles decreases even though the light intensity increases, then the mineral water should be replaced.
- After the first measurement, investigate influencing factors light intensity (change the distance of the light source) and carbon dioxide concentration (use tab water instead of carbonized water).

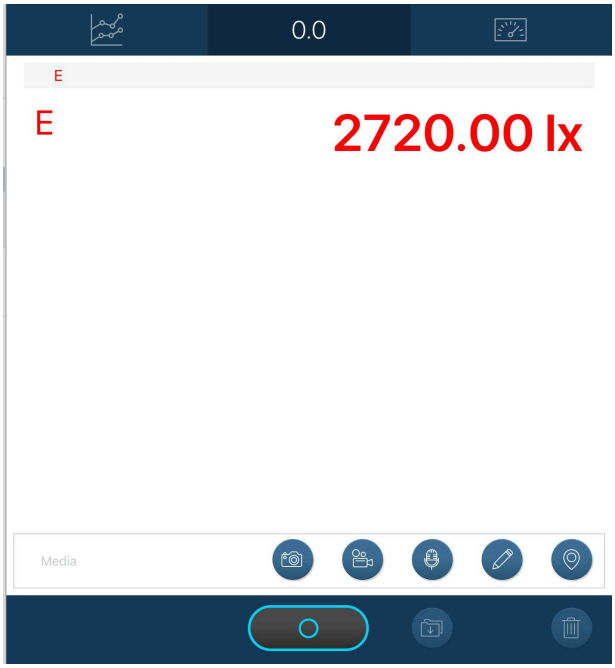

Fig. 3: Exemplary measurement value with Cobra SMARTsense Light

Observation and results

After measuring, use a spreadsheet program to evaluate and then display the data in a spreadsheet program, e.g. the free PHYWE software 'Measure'.

- The photosynthesis rate, which is measured based on the oxygen that is released, increases nearly linearly as a function of the light intensity.
  This is due to the fact that under conditions with reduced light intensity, the light is the limiting factor of the photosynthesis (Fig. 4).

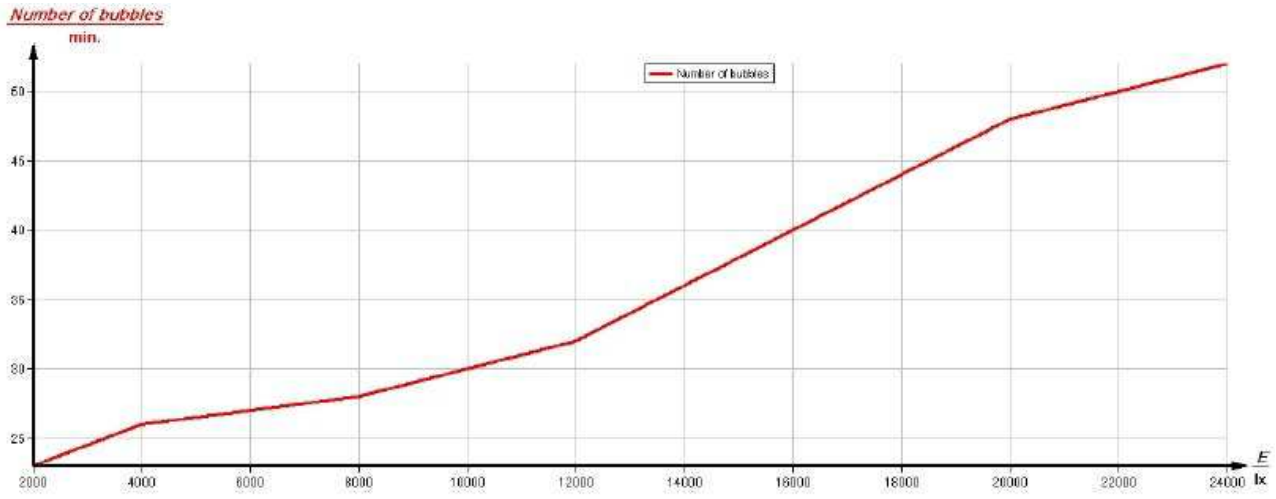

Fig. 4: Exemplary data evaluation of measurements using PHYWE software 'Measure'

Notes

- When the light intensity is higher (e.g. when the lamp is positioned very close to the waterweed), other factors, e.g. the available carbon dioxide, play the limiting role. In this case, the photosynthesis rate does not increase linearly as a function of the light intensity. Instead, it tends to the saturation value.
- The influence on the photosynthesis rate can also be proven by reducing the carbon dioxide content of the water (use tap water instead of mineral water).