Controlling the growth parameters in a greenhouse with Cobra SMARTsense Code

Biology | Ecology & environment | Water analysis

Difficulty level	Group size	Preparation time	Execution time
easy	-	10 minutes	45+ minutes

This content can also be found online at:

http://localhost:1337/c/677e5ba38bdcc400027ea9a9

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Teacher Information

Application

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Experimental setup

The experiment illustrates the connections between water balance, humidity, and plant growth. Using a greenhouse model, it shows how a water pump irrigates the plant and a fan circulates the air. The humidity levels can be adjusted individually to create optimal conditions for photosynthesis.

This experiment allows for the observation of the effects of environmental factors on plant growth. It highlights fundamental biological processes such as the regulation of stomata, nutrient uptake, and photosynthesis—processes that are also carefully optimized in professional greenhouses.

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Other teacher information (1/2)

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Prior knowledge

For this experiment, students should have a basic understanding of photosynthesis.

Scientific principle

In this greenhouse model, the air and soil moisture will be regulated to create optimal conditions for photosynthesis. Sensors continuously measure the soil and air moisture and transmit this information to the Cobra SMARTsense code. Based on the programming, the code controls the water pump and the fan by switching their circuits on or off, adjusting the measured values to the desired set points.

Other teacher information (2/2)

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Learning objective

The students should understand how environmental factors such as air and soil moisture affect photosynthesis and how these factors can be specifically regulated using sensors and automated control systems. Additionally, they will learn how a feedback loop functions in a greenhouse model.

Tasks

1. Assembly of the greenhouse model and connection of sensors, water pump, and fan.
2. Programming the Cobra SMARTsense Code to regulate air and soil moisture.
3. Observation of the plant over an extended period.

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Safety instructions

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

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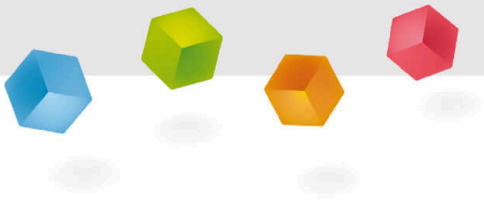

Set-up and Procedure

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Motivation

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Greenhouse

Have you ever wondered why you can buy juicy, fresh tomatoes even in the middle of winter, even though they don't grow outdoors? The answer lies in a fascinating combination of technology and biology: greenhouses! They make it possible to grow plants regardless of the season by creating ideal growing conditions.

A key factor in this process is photosynthesis – the process through which plants convert light, water, and CO2 into oxygen and energy. In greenhouses, this natural process is optimized by controlling parameters like CO2 concentration, soil, and air humidity. In this experiment, we will explore how this works!

Tasks

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Experimental setup

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Material

Position	Material	Item No.	Quantity
1	Cobra SMARTsense Code - Output device for switching relays, LEDs, display	12953-00	1
2	Cobra SMARTsense Soil Moisture - Sensor for measuring soil moisture, 0 ... 100 % (Bluetooth + USB)	12954-00	1
3	Cobra SMARTsense Relative Humidity - Sensor for measuring relative humidity 0 ... 100 % (Bluetooth + USB)	12931-01	1
4	Experiment chamber, 29 cm, for Cobra SMARTsense sensors	64837-00	1
5	Water pump for experiment chamber and ecosystem	64837-10	1
6	Fan for experiment chamber and ecosystem	64837-11	1
7	Experiment chamber accessory kit	64837-12	1
8	PHYWE Mobile power supply to go, rechargeable DC 0...12 V / 0...2A	13510-99	1
9	Connecting cord, 19A ,50 cm, red	07314-01	2
10	Connecting cord,19A,50cm, blue	07314-04	2
11	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Set-up (1/4)

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The **Cobra SMARTsense sensors** and **measureAPP** are required to measure air and soil humidity. Ensure that **Bluetooth is enabled** on your device (tablet, smartphone, or PC with Windows 10). The app can be downloaded for free from the App Store (QR codes below). Once installed, open the measureAPP on your device.

measureAPP for
Android operating systems

measureAPP for
iOS operating systems

measureAPP for
Tablets and PCs with Windows 10

Set-up (2/4)

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Pump circuit

Assemble the circuit for the water pump following the diagram provided.

Ensure the circuit is connected to Switch 1 of the Code so that Code and pump are arranged in series.

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Set-up (3/4)

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Circuit for Fan

Place the plant inside the greenhouse.

Now set up the circuit for the fan according to the adjacent diagram.

Connect the circuit to Switch 2 of the Code, ensuring that Code and fan are also connected in series.

Set-up (4/4)

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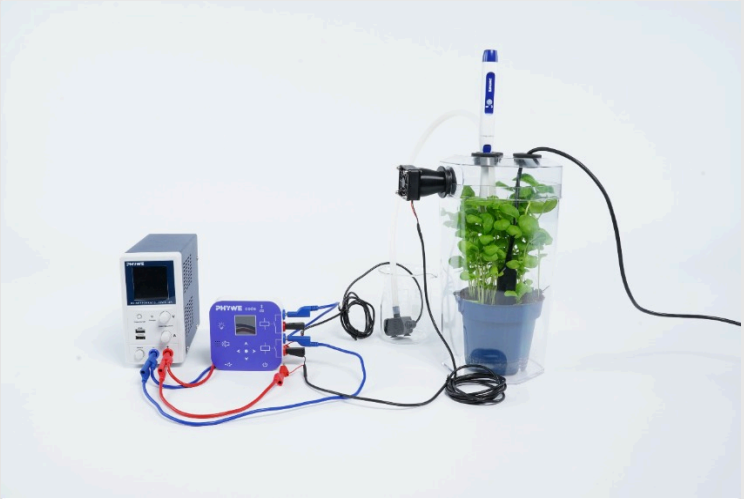

Complete set-up Greenhouse

Insert the Cobra SMARTsense Soil sensor through one of the openings in the greenhouse lid. Push the sensor as centrally as possible into the soil of the plant until fully inserted.

Attach the Cobra SMARTsense Humidity sensor into one of the holes in the greenhouse lid.

Thread the pump's tube through the last opening in the lid and direct it toward the plant's soil. Fill the beaker with water.

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Procedure (1/5)

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Cobra SMARTsense Relative Humidity

Turn on your Cobra SMARTsense Relative Humidity and Cobra SMARTsense Soil by pressing the button on the sensors for 3 seconds.

Open the measure App on your tablet or smartphone and ensure that the device is capable of connecting to Bluetooth devices.

Select the "Cobra SMARTsense Relative Humidity" and "Cobra SMARTsense Soil" sensors.

Procedure (2/5)

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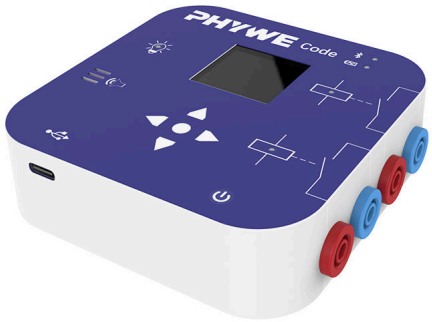

Cobra SMARTsense Code

Now, connect the Cobra SMARTsense Code Sensor to the MeasureAPP.

Repeat the same steps as before.

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Procedure (3/5)

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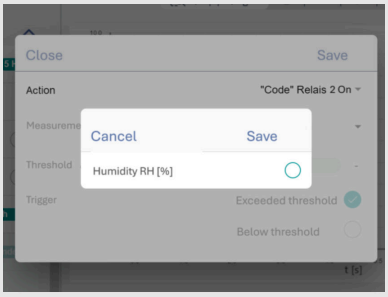

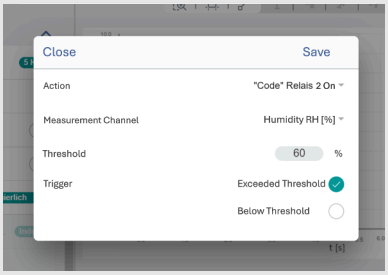

Program the Cobra SMARTsense Code by selecting the actions for the code under "Trigger" in the MeasureAPP.

Choose the action "Code" Relay 2 On and select the measurement channel "Humidity RH [%]".

Set the threshold value to 60% and check the box for " above threshold".

Repeat this process and program the "Code" Relay 2 to turn off, when the threshold of 60% is not reached.

As a result, the air in the greenhouse is exchanged when the humidity level exceeds 60%.

Procedure (4/5)

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Program Relay 1, which controls the pump, using the same principle.

Program the Cobra SMARTsense code so that the pump activates only when the humidity exceeds 50%, and shuts off once the soil has absorbed enough water.

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Procedure (5/5)

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Pay attention to how the water pump irrigates the plant and how the fan circulates the air.

Adjust the humidity levels to match the optimal conditions for the selected plant.

Observe the plant over an extended period. Do signs of healthy growth appear, such as fresh leaves or strong shoots?

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Protocol

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Task 1

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What effect does air humidity have on plant growth? (Select all correct answers)

- [ ] When humidity is too low, the stomata close, preventing CO_2 uptake and halting photosynthesis.
- [ ] High humidity causes the stomata to remain permanently open, leading to excessive water loss.
- [ ] In low humidity, the plant does not transpire at all, conserving more energy.
- [ ] Excessive humidity reduces transpiration, limiting the transport of nutrients from the roots to the leaves.

Check

Task 2

PHYWE

What happens if the soil moisture is too high for the plant?

- ○ Too much water in the soil causes the plant to reverse photosynthesis and instead absorb oxygen from the air.
- ○ Excess water displaces the air in the soil, preventing the roots from absorbing oxygen, ultimately causing the plant to "suffocate."
- ○ The plant absorbs more water, leading to better nutrient supply.

Check

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Task 3

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Which statement about photosynthesis is correct?

- ○ During photosynthesis, carbon dioxide and water are converted into sugar and oxygen.
- ○ During photosynthesis, water and oxygen are converted into sugar and carbon dioxide.
- ○ Photosynthesis only occurs during the night.

Check

Slide	Score / Total
Slide 20: Influence of air humidity	0/2
Slide 21: Influence of soil moisture	0/1
Slide 22: The photosynthesis	0/1

Total Score 0 / 4

Show solutions Retry

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